Landscape Visualisation and Visitor Perception in the Guangzhou Urban Planning Exhibition Hall

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Abstract: Recently there has been a trend to use visualisation tools for communication and information in the public participatory process. The urban planning exhibition hall (UPEH) in China is a venue for presenting the urban planning perspectives that connect the past, present, and future of one particular area. This study provides new insights into the representation of landscape as a theme in a larger-scale social context, using the Guangzhou UPEH as a case study. It aims to address two questions: (1) how is landscape presented and communicated in the UPEH; and (2) what are the effects of the physical display and its content on people's perceptions towards landscape visualisation tools. Fifty-five participants were randomly chosen to engage in walking interviews during their visits to the Guangzhou UPEH. The duration and frequency of visits in each exhibit and related comments or behaviours were recorded. It was found that, despite the variability in the form, the landscape themes, as represented in the UPEH, tended to focus on *landscape planning* and *historical conservation*. Less consideration was given for *vegetation and planting design*, *landscape technology* and *landscape theory*. ANOVA tests showed that visitor perceptions of landscape visualisation tools were statistically associated with planning scale, media, and size. Interaction effects were also found between media and scale as well as between size and media on holding visitor attention. Together these results illustrate a better utilisation of content and physical display of landscape visualisation in the communication with the general public.

Keywords: Landscape visualisation, visitor perception, urban planning exhibition hall

1 Introduction

Communication and information are essential for the public participatory process. Many studies have shown, that for humans, the visual sense is the most significant (BRUCE et al. 1996). Therefore, visualisation plays an important role in facilitating dialogue between the general public, designers and policy-makers. Visualisation displays range from the traditional use of analogue tools to the most recent digital devices such as GIS, interactive multimedia and virtual reality (VR). Human responses to environments and visual displays comprise four domains: cognition, affection, behaviour and physiology (ZUBE et al. 1982). Several studies have sought to explore participants' perception of landscape visualisation tools at different planning stages (APPLETON & LOVETT 2005, WISSEN HAYEK 2011, GILL et al. 2013, HEHL-LANGE & LANGE 2016). Most of them have been conducted in workshop environments using subjective self-reporting questionnaires (WISSEN HAYEK 2011) or by objective means, including time-recording (GILL et al. 2013) and behaviour tracking (SHEPPARD 2005). One shortcoming of previous visualisation evaluation studies is that their main focus has been site-scale proposals, with less consideration given to a broader context (i. e., city and regional scale). Besides, they have tended to focus on cognitive and affective effects, while overlooking the behavioural impact (SHEPPARD 2005). Previous research exploring the factors affecting public perception of visualisation tools has also tended to concentrate on the technology itself, rather than other factors such as the physical features and the content conveyed by them.

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The urban planning exhibition halls (UPEHs) in China have spread over the country at an unprecedented rate, reaching 880 UPEHs by 2017. They use a range of visualisation tools to inform the public about the past, present and future development of a specific geographical area. So far, however, few discussions have been carried out on the use of digital technology and visitor perception in the UPEHs. By using the UPEH as a case study, this study seeks to understand the representation of landscape to the public in a larger-scale social context. It aims to investigate: (1) how landscape is presented and communicated in the UPEH; and (2) the effects of the physical display and its content on people's perception towards landscape visualisation tools. By content, we mean the landscape themes and the planning scales of these visualisations. In terms of physical aspects, we look at size and media.

2 Methodology

2.1 Case Selection and Variable Classification

The UPEH in Guangzhou, with an exhibition area of 30000 m^2 and 119 sets of exhibitions, was chosen as a case study due to its strong social impact and richness of visualisation tools. Through on-site observation and off-site verification, the authors determined whether an exhibit belongs to the discipline of landscape. They were then coded according to its theme, scale, media and size. The China Subject Categories by the State Council of China scheme is used for the classification of landscape themes. These include *historical landscape conservation*, *landscape theory*, *landscape design*, *landscape planning and ecological restoration*, *vegetation and planting design* and *landscape technology*. Based on aligned administrative divisions within the Guangzhou municipality, we focus on site, county and township, and city scale. Visualisation techniques are classified by both traditional and computerized tools, including 2D images, 3D physical models and multi-media approaches. The size of the landscape representation is classified through its exhibition area (see Tab. 1-A for a detailed description of the classification system).

Table 1: Classification system of landscape exhibitions of the Guangzhou UPEH

	A		B	
Variable	**Classification**	**Detailed description of classification**	**Count**	**Percent**
Theme	Historical landscape convention	Protect and manage historical landscape values and important ecological services	22	47.8 %
	Landscape theory	Applied theory of origin, evolution, development and formation of landscape	0	0 %
	Landscape design	Small and medium sized outdoor recreational space design	4	8.7 %
	Landscape planning and ecological restoration	Multi-scale landscape protection and implementation across biosphere, land, region, town and community	18	39.1 %
	Vegetation and planting design	Vegetation and conservation for green space, tourism, sanatoriums, etc.	2	4.3 %
	Landscape technology	Technical principles, material production, maintenance and management	0	0 %

Table 1 (continued)

	A		B	
Variable	**Classification**	**Detailed description of classification**	**Count**	**Percent**
Scale	Site	Detailed planning and design of a landscape development	8	17.4 %
	County and township	Landscape planning and design within 135 subdistricts and 35 towns in Guangzhou	20	43.5 %
	City	Landscape planning and design at the municipal level of Guangzhou	18	39.1 %
Media	2D image	Plan, satellite image, section, perspective, bird-eye view, photo, etc.	10	21.7 %
	3D physical model	Models made from sand, polyvinyl chloride, wood, acrylic, resin, etc.	14	30.4 %
	Multi-media	A combination of different content-such as text, audio, images, animations, video and interactive content	22	47.8 %
Size	Small	Exhibition area < 5 m^2	10	21.7 %
	Medium	Exhibition area > 5 m^2 and < 20 m^2	23	50.0 %
	Large	Exhibition area > 20 m^2	13	28.3 %

2.2 Data Collection and Analysis

Building on the free-choice learning environment of the Guangzhou UPEH and museum research (HOOPER-GREENHILL 2013), two parameters were used to examine the effectiveness of landscape exhibits: 'attracting power' (the frequency that the visitor comes to a complete stop and look at an exhibit) and 'holding power' (time of duration that the visitor stays at an exhibit). Participants' comments, behaviours and interactions were combined with the observational results for causal interpretations. The methods for selecting participants was designed to be unbiased and broadly representative of the typical visiting public of the Guangzhou UPEH. One adult from every fifth group at the UPEH entrance was randomly approached and invited for a walking interview. Throughout each journey, the participant was asked to lead the way and explore different exhibits at his/her own pace. The frequency of visits and time of duration in each exhibit and their related comments or interaction with companions were recorded in a predesigned sheet. Altogether 55 participants were recruited, and their behavioural and verbal data related to landscape exhibits were analysed for this study.

IBM SPSS Statistics 25.0 was used for the analysis of the spatio-temporal data. Due to the skewness of independent variables, Log transformations [Log (time of duration) and Log (frequency of visit)] were used to ensure that data fulfilled normality checks. A one-way ANOVA was first conducted to see the main effect of each factor on outcomes. If only one factor showed significant results, then the report ended this investigation. If two or more variables were significant, then line graphs would be plotted to visualise whether there were interaction effects between these factors. Finally, the verbal and behavioural records during visits were transcribed and analysed through NVIVO 12 to illustrate the findings.

3 Results

3.1 Landscape Visualisation in the Guangzhou UPEH

Throughout the Guangzhou UPEH, 46 out of 119 sets of exhibits cover information about landscape, with most themes relating to *historical landscape convention* (47.8 %) (Fig. 1-a) and *landscape planning and ecological restoration* (39.1 %) (Fig. 1-b). Few exhibits address *landscape design* (8.7 %) (Fig. 1-c) and *vegetation and planting design* (4.3 %) (Fig. 1-d). The themes *landscape technology* and *landscape theory* are not mentioned. In terms of the scale of these themes, visualisations at the county and township level have the most significant number of exhibits (43.5 %), followed by city scale (39.1 %), and site scale has the fewest of all (17.4 %). Regarding size, medium-sized exhibits dominate half of the landscape visualisations, while small and large exhibits represent roughly one quarter (see Tab. 1-B for the detailed proportion of each variable).

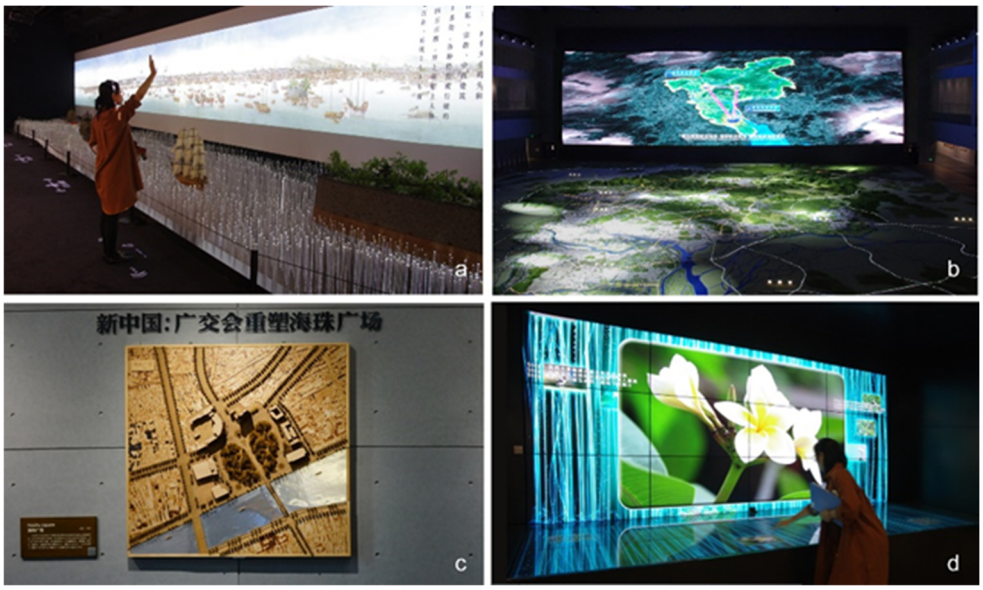


Fig. 1: Examples of landscape visualisations by themes: (a) Historical landscape convention; (b) Landscape planning and ecological restoration; (c) Landscape design; (d) Vegetation and planting design

The fundamental sources of information about landscape for most exhibits are 2D images. They are rarely exclusively used, as shown in Fig. 2-a, the native species and their blossom seasons are identified through static images. Rather, they are often used as subsidiary information alongside other advanced tools. 3D physical models are also widely appointed (30.4 %). An example being the demonstration of the Lychee Lake Park in Guangzhou (Fig. 2-b). The current topics such as *historical landscape convention* and *landscape planning and ecological restoration* are often presented with a variety of multi-media methods (47.8 %). These comprise visualisation using imaging technology including holographic cin-

ema, 4D and 6D animations; synthetic interactive technology combined with the effect of sound, light and electricity, such as touch screen device, dynamic stepping device, interactive demonstration and answering device; and new emerging high-tech multi-media applications including VR, AR and immersive games. For instance, Fig. 2-c shows the interaction between a visitor with the time lapse of rural landscape. Fig. 2-d illustrates the panorama view of the city's new axis through a VR game. Visitors can therefore immerse and interact with the productivity and variety of collections through watching, waving, stepping and driving.

Fig. 2: Examples of landscape visualisations by media: (a) 2D image; (b) 3D physical model; multi-media such as (c) UAV driving and (d) Immersive games

3.2 Visitor Perception of Landscape Visualisation

The influence of content and physical aspects of landscape visualisations on 'attracting power' and 'holding power' were calculated using SPSS. Among the four variables (theme, scale, media, size), only size ($p = 0.001$) showed a significant impact on people's frequency of visit. Visualisations categorised as large ($M = 34.38$) have a greater pull on visitors compared with small ($M = 20.3$) or medium ($M = 15.6$) (Fig. 3-a). However, there were no significant influences of theme, scale and media on generating 'wow' effects.

Regarding their influences on time spent in each visualisation, scale ($p = 0.023$), media ($p = 0.007$) and size ($p = 0.000$) showed statistically significant effects. Post-hoc analysis using Steffe's F test indicates that exhibits at the city scale ($M = 5026$s) report significantly more time of duration than the county and township scale ($M = 1874$s) (Fig. 3-b). However, county and township scale does not differ significantly from the site scale. Fig. 3-c demonstrates that on average people engage 62 minutes longer in multi-media devices than 3D physical models. Regarding size, visualisations in large volume ($M = 7155$s) differ significantly from either of the other groups (Fig. 3-d).

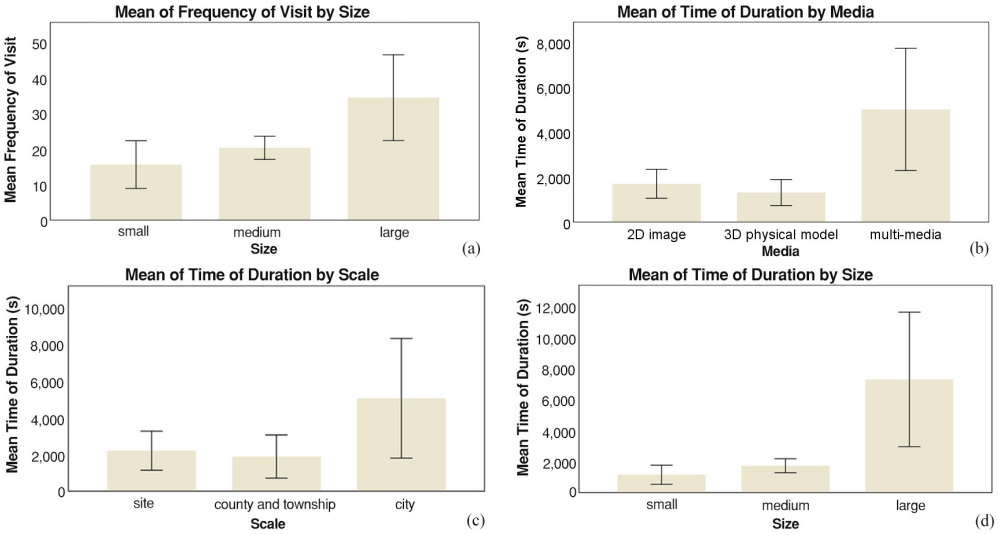
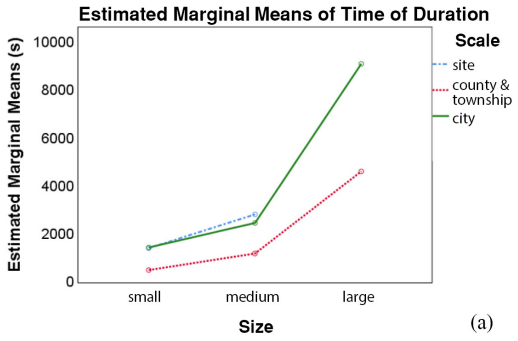


Fig. 3: 95 % CI error bars: (a) Mean of frequency of visit by size; (b) Mean of time of duration by scale; (c) Mean of time of duration by media; (d) Mean of time of duration by size

Interaction plots were then conducted to investigate the effects of every two categorical variables among scale, media and size on the time of duration. Fig. 4-a shows that there is no interaction between size and scale as the lines are reasonably parallel. At each planning scale, participants spend more time when the size increases. Interactions effects occur between scale and media (Fig. 5-a). For both 3D physical model and 2D image, the time of duration grows as the scale expands. However, the holding power of multi-media peaks at the city scale and bottoms out at the county and township scale. Fig. 6-a displays an apparent interaction effect between size and media. 2D image has the best performance with a medium size, whereas other media groups reach their highest levels at large sizes.

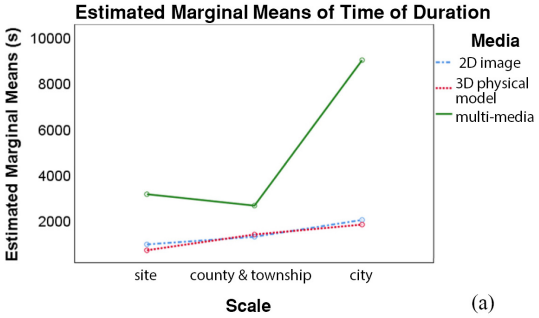


Size * Scale Crosstabulation

		Scale			
		site	county & township	city	Total
Size	small	3	2	5	10
	medium	5	13	5	23
	large	0	5	8	13
Total		8	20	18	46

(b)

Fig. 4: (a) Means of time of duration by size and scale; (b) Scale * Media Crosstabulation



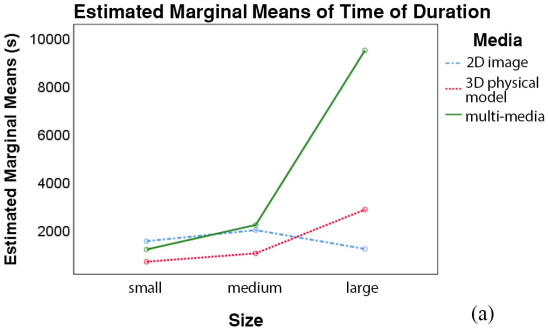
(a)

Scale * Media Crosstabulation

		Media			
		2D image	3D physical model	multi-media	Total
Scale	site	1	2	5	8
	county & township	2	9	9	20
	city	7	3	8	18
Total		10	14	22	46

(b)

Fig. 5: (a) Means of time of duration by scale and media; (b) Scale * Media Crosstabulation



(a)

Size * Media Crosstabulation

		Media			
		2D image	3D physical model	multi-media	Total
Size	small	4	3	3	10
	medium	5	8	10	23
	large	1	3	9	13
Total		10	14	22	46

(b)

Fig. 6: (a) Means of time of duration by scale and media; (b) Scale * Media Crosstabulation

4 Discussion

Historical landscape conservation and *landscape planning and ecological restoration* are popular themes in the Guangzhou UPEH. Less focus has been given to more theoretical and technical aspects. The reason therefore might be, that presenting knowledge in these aspects to non-specialists in an accessible way is difficult. Furthermore, with the purpose of city branding, priority for exhibition design will be to present its overall historical and urban development, rather than theoretical and technological part. Various visualisation techniques are utilised in the Guangzhou UPEH. But it also raises the question regarding their performance: are these tools beneficial for attracting visitors and boosting landscape perception?

ANOVA tests showed that large-size landscape visualisations were more likely to attract and hold attention. This correlates with participants' responses. Faced with the big model with an area of 1600 m^2 (Fig. 1-b), participants expressed interests in its size, behaviours like photo- and video-taking were in evidence. At exhibits at the city scale, people spent more time than at other planning scales. As addressed by participants, the depth and breadth of information contained at this scale, and the unusual perspective on the city that it provides, could be two of the reasons for this. Multi-media approaches showed a better 'holding power' compared to the exclusive use of 2D images or 3D physical models. This supports the previous finding by GILL et al. (2013) that traditional media and computer-based technologies can complement

each other. Newer interactive visualisation techniques also show potential for public engagement. This is emphasized by a participant, whose comment to the 6D animation, showing the landscape in 2050, is: "I might not live until 2050, but this is so cool and immersive that I could experience the promising future of Guangzhou vividly…" Noticeably, the observed relationship between landscape theme and visitor perception was not significant. One reason could be the uneven distributions of subgroups, which fail to cause sufficient differences (Tab. 1-B). Additionally, the landscape exhibits in the Guangzhou UPEH are all well-ordered urban landscapes with water network and high green coverage. As these are preferred landscape features (JACOBS 2011), they might be fairly successful in attracting and holding visitors' attention. The interaction plots have represented the combined effects of scale, media and size on time spent at each visualisation. The result is of assistance to understand the appropriate size of visual displays and the efficiency of media for each planning scale. However, considering the small sample size in some subgroups (Fig. 4-b, 5-b, 6-b), these data need to be interpreted with caution to avoid potential false-positive errors.

5 Conclusion and Outlook

This study has analysed the representations of landscape in the Guangzhou UPEH and the effects of physical display and its content on visitor perception. The results revealed that, despite the variability in the form, the landscape themes in the Guangzhou UPEH tended to focus on landscape planning and historical conservation while neglecting the theoretical and technological dimensions. It was also shown that visitor perceptions of these visualisation tools were statistically associated with planning scale, media and size. In a culture-specific context, this study lays the groundwork for UPEHs to assess and adjust their curatorship. In a bigger picture, it provides insights into better utilisation of landscape visualisation for public engagement. Admittedly, this research has adopted behavioural observations to evaluate the effectiveness of landscape visualisation, supported by visitors' comments. Future in-depth qualitative studies could be conducted to investigate visitors' feedback and designers' intention, in order to enrich the spatio-temporal findings.

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