

# The Preference and Environmental Perception of Building Contour Control of Mountain-landscape City

Junru Zhou, Yuan Gao

**Abstract**—This paper focuses on the building contour control of mountain-landscape city based on the research of public preferences and environmental perceptions. Arousal and pleasure were selected as 2 key independent variables to measure the value of people’s environmental perception. Layer-relationship, height-relationship, mountain contour, building contour, the relationship between building group and mountain contour and roof style are 6 spatial factors to characterize the urban skylines. 60 photos of real city scenes were used as the questionnaire materials, and 450 people who were the general public and some designers participated in the test. The main conclusions were drawn: (1) Preference shows a low correlation with arousal, but a high correlation with pleasure. Higher levels of arousal are linked with lower levels of pleasure. (2) Layer-relationship, height-relationship and roof style have great influence on public preferences. (3) Layer relationship, height relationship and the relationship between building group and mountain contour have stronger correlation with pleasure, but have less to do with arousal.

**Keywords**—preference; environmental perception; mountain-landscape City; skylines; building contour

## I. INTRODUCTION

According to “2015 The World 's Best Skylines” list which was reported on the American famous architecture journal “The Almanac of Architecture and Design”, the data shows that, 31 in the top 50 cities have natural mountain background. In other words, they are mountain-landscape cities. The natural mountain element is not only a inherent potential condition of a city, but also a basic carrier of the urban characteristics, and a major feature that distinguishes a city from the others. Defining a meaningful physical relationship between the changing urban environment and its natural setting is a complex task. The ups and downs of the mountain outline can contribute to build an echo relationship with the contour of urban construction elements, and can also serve as a background to enrich the layering of the urban skyline. Thus, the proper utilization of mountain setting is an important reason for the success of many excellent urban skyline design.

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TABLE I  
2015 THE WORLD'S BEST SKYLINES

Ranking	Point	City	Country	Buildings/30m	Ranking	Point	City	Country	Buildings/30m
1	52639	Hong Kong	China	3266	35	4694	Miami	USA	147
2	39772	New York	USA	939	37	4614	Yokohama	China	226
3	38683	Shanghai	China	855	38	4316	Abu Dhabi	UAE	83
4	35722	Dubai	UAE	430	39	3810	Mumbai	India	186
5	29386	Tokyo	Japan	713	40	3818	Bahari	China	108
6	22188	Beijing	China	432	41	3611	Xiamen	China	189
7	19183	Guangzhou	China	439	42	3614	Jakarta	Indonesia	187
8	17957	Bangkok	Thailand	381	43	3616	San Francisco	USA	86
9	17630	Chicago	USA	375	44	3417	Sydney	Australia	135
10	15777	Chengde	China	366	45	3418	Seoul	South Korea	335
11	14779	Manila	Philippines	345	46	3219	Houston	USA	124
12	13475	Singapore	Singapore	450	47	3019	Kuala Lumpur	Malaysia	117
13	12558	Seoul	South Korea	342	48	4619	Doha	Qatar	79
14	12192	Kuala Lumpur	Malaysia	325	49	4305	Dingde	China	98
15	11795	Jakarta	Indonesia	290	50	4319	Wuxi	China	97
16	10961	Toronto	Canada	345	41	4111	Mexico City	Mexico	141
17	9181	Perth	Australia	229	42	4111	Wuhan	China	140
18	8994	Chengde	China	301	43	4111	Hangzhou	China	94
19	8697	Shenyang	China	153	44	4111	Los Angeles	USA	90
20	8395	Tianjin	China	135	45	4111	San Francisco	USA	112
21	7901	Moscow	Russia	222	46	4111	Nanchang	China	67
22	7498	Beijing	China	126	47	4111	Atlanta	USA	86
23	7198	Busan	South Korea	125	48	4111	Wafangdian	China	167
24	7198	Beijing	China	283	49	4111	Suzhou	China	78
25	6998	Doha	Qatar	183	50	4111	Suzhou	China	78

Almanac of Architecture & Design 2014: Media Guide Edition (Almanac of Architecture and Design) [J]. 2015

The high speed development of the city requires enough building density and unit capacity to ensure its functions concentration and efficiency. And the development pressure makes the buildings become higher and higher. Thus, how to deal with the contradiction between the ever-growing buildings and the immovable mountain setting has become a great challenge to the urban design of mountain-landscape city. On the other hand, people who live in the city are the users of the urban landscape, and urban landscape influences their senses all the time. But in many cases, the public evaluation and judgment for the urban landscape are ignored in our city construction. Thus, urban designers must take the public environmental preferences and appeals into consideration. This paper attempts to explore the public preferences and environmental perception of building contour control and its influencing factors.

Some related researches which are based on the public perception preference of the landscape of urban skyline, have been already studied and practiced.

James A. Russell and Snodgras (1987), James A. Russell etc.(1989) identified “stimulation-pleasure” as the measure standard, and established the affect grid which evaluating the environment by using "excitement, stress, depression, relaxation".

Sheppard (1989), Arthur Stamps etc. (1993) pointed out that the image stimulation has many advantages, and the correlation index between the photo and the real scene can reach

0.84. On this condition, most of the urban skyline evaluation program can use photos or slides as the scenario simulation.

Zacharias. J (1999) found that the skyline with natural element is more popular, and put forward that, in some conditions, limiting the height of buildings is more advantageous in improving the public preference perception than controlling the number of view corridors.

Tom Heath, etc. (2000) investigated that the visual complexity of high-rise buildings makes the change in the skyline by using the affect grid which based on the arousal-pleasure standard (Fig. 1). Moreover, they putted out that higher visual complexity of the building contour associated with higher perception, and the higher satisfaction at the same time.

Turkey's professor Cagri Imamoglu (2000) investigated the preference choices on the three levels of complexity of building facade sample pictures. Then pointed out that the complexity of the building appearance has a greater influence on the public perception. Particularly, the medium level of appearance complexity is easier to be popular. Furthermore, to some extent, the professional background of participators can influence the outcome of preference choices.

Chun-ming Chen (2001) tried to investigate how do the roof form and height of the tower building these two variable quantities impact the public environment perception and preferences results of the urban skyline. Based on that, he pointed out that the skyline with mixed, helm roof shape and higher attitude variation is more popular.

According to Arthur Stamps (2002), the three basic elements which can influence the quality of the urban skyline are the overall shape of the skyline, the number of the corner of the building contour and the difference of architecture properties. Then, further study showed (2005), the building properties (including height, width, depth, etc.) could influence the skyline preference of the participators more, and should be focused on when the design.

On the basis of Zacharias' research (1999), Leiqing Xu etc. (2013) finished a laboratory study which using artificial photos as stimulation. And finally demonstrated that preference for skylines shows a high correlation with complexity, arousal and pleasure perceived from the urban environment. And professional training was found to affect the preference and perception in the research.

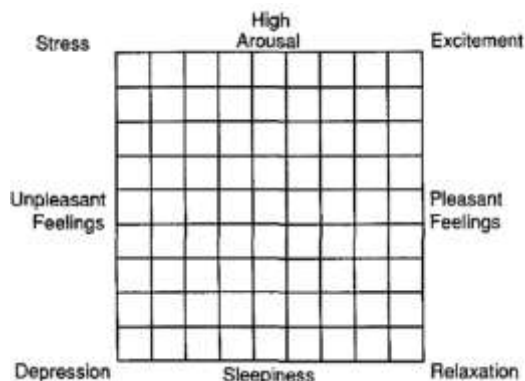


Fig. 1 Affect grid

Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, 57, 493-502.

To sum up, the current research on the urban skyline has three characteristics: the research of laboratory research using virtual scene model debugging (Zacharias, 1999), (Tom Heath, 2000), (Cagri Imamoglu, 2000), (Arthur Stamps, 2002). The dependent variables are basic about preferences, complexity, stimulation and pleasure; The sample size was small, and college students were the majority participators.

## II. METHOD

### A. Research Objective

This research aims at public preference for urban skyline and its relation with the environmental perception and the building contour control of mountain-landscape city, seeking answers to the following questions:

- (1) The correlation between public preference and environmental perception attributes.
- (2) Spatial Factors that influence the public preference.
- (3) The correlation between environmental perception attributes and spatial factors.

### B. Research Method

In this study, urban photos were used as samples. According to the relevant researches, most of the quantitative researches of the urban skyline are based on the method of image stimulation, and mainly by using the laboratory researches which are based on the virtual scene model debugging. But there is no denying that the real scene is far more complicated than the virtual scene, and there are some unavoidably defects when applying the research conclusion to the reality control operation. So, this study use the urban real scene photos as research sample.

### C. Research Sample

Select the typical mountain-landscape cities all around the world, and choose 60 urban skyline photos taken from the classical view points. Then, after the unified color processing and being cut into the same size, we finally get 60 photos as the research sample in order to reduce the interference of photos' color to preference judgment. The 60 photos were numbered 1 to 60, and each 4 was divided into a group, the total 15 groups are recorded as one complete questionnaire. Then, disorder the existing order 4 times to form another 4 complete questionnaires. In the end, we get five sets of questionnaires, with each set contains 15 questionnaires, and each questionnaire contains 4 photos.

### D. Questionnaire Design

In order to collect the public's preference value, environmental perception variable (arousal and pleasure) and possible spatial influence factors for the photos, the questionnaire mainly ask the following three questions:

- (1) Choose your favorite skyline picture, and select or add the spatial influence factors (preference).

- (2) Choose a photo that you feel most stimulating (arousal)
- (3) Choose a photo of that you feel most pleased with (Pleasure).

*E. Investigation Process*

The questionnaire survey used ipad to show only one questionnaire each time, so that the participator could make their choice. Firstly, the research asked participants to choose a favorite skyline photograph, and select or supplement the spatial factors which affecting their preference: layer-relationship, height-relationship, mountain contour, building contour, the relationship between building group and mountain contour and roof style. Secondly, the participants were then asked to select a picture of the urban skyline which was most stimulating or exciting (arousal) and a picture which was most pleasant (pleasure). In the process, the investigator should focus on the explanation of the two important concepts of "arousal" and "pleasure" in order to help the participator to understand and choose correctly. The investigation needs to be judged based on personal preference and the understanding of some semantic concepts, all the participators are required to have certain language understanding ability and urban landscape sensibility.

*F. Participators*

450 people who were the general public and some designers participated in the research, and between the ages of 18 to 60. Among them, 246 female and 204 male participants accounting for 54.7% and 45.3% respectively, and 152 professional and 298 non professional participants taking up 33.8 % and 66.2 % respectively.

III. RESULT AND ANALYSIS

*A. Single Frequency Analysis*

The preference, arousal and pleasure scores of each photo sample are shown in table II. The "preference" was the total number of being chosen as "the favorite photo". Through data consolidation, we can find that the photo with the highest preference score is NO.26. It was chosen 20 times and the effective percentage is 22.2%. The "arousal" was the total number of being chosen as "the most stimulating or exciting photo". We can find that the photo with the highest arousal score is NO.18. It was chosen 23 times and the effective percentage is 25.6%. The "pleasure" was the total number of being chosen as "the most pleasant photo". We can find that the photo with the highest pleasure score is NO.26. And it was chosen 20 times and the effective percentage is 22.2%.

TABLE II  
THE PREFERENCE, AROUSAL AND PLEASURE SCORES

No.	preference	arousal	pleasure	No.	preference	arousal	pleasure	No.	preference	arousal	pleasure	No.	preference	arousal	pleasure
1	15	5	15	16	4	2	9	31	6	3	6	46	2	19	1
2	7	13	3	17	16	3	15	32	16	4	8	47	3	3	5
3	0	5	3	18	6	25	4	33	2	4	3	48	4	2	1
4	15	13	11	19	7	11	4	34	10	3	14	49	6	2	8
5	12	19	3	20	2	14	1	35	3	15	1	50	1	12	3
6	7	5	6	21	4	1	5	36	10	1	18	51	1	9	0
7	14	22	2	22	3	17	3	37	10	4	12	52	6	0	12
8	5	3	6	23	1	5	3	38	7	15	8	53	11	16	8
9	16	4	17	24	7	5	4	39	3	4	8	54	10	3	7
10	4	5	10	25	0	0	1	40	16	20	4	55	8	19	8
11	5	20	3	26	20	2	20	41	6	1	3	56	9	5	8
12	7	5	14	27	17	4	18	42	1	2	1	57	4	11	2
13	14	3	14	28	10	1	14	43	7	1	3	58	4	3	6
14	16	6	12	29	5	3	11	44	4	2	9	59	6	4	9
15	11	23	4	30	18	3	13	45	0	3	4	60	4	2	9

*B. Ranking Analysis*

Firstly, extracting the top 10 in preference, arousal and pleasure ranking, and trying to seek for the influence of arousal and pleasure on preference score. As table III shows, among the top 10 of the preference ranking, we get 1 in the top 10 of the arousal ranking, and 5 in the top 10 of the pleasure ranking at the same time. Secondly, extracting the top 20 in preference, arousal and pleasure rank, and trying to seek for the influence of

arousal and pleasure on preference score. As the table IV shows, among the top 20 of the preference ranking, we get 6 in the top 20 of the arousal ranking, 12 in the top 20 of the pleasure ranking, and 1 in all the ranking chart at the same time. It's obvious that the effect of pleasure on the preference score is slightly bigger than arousal.

TABLE III  
THE TOP 10 IN PREFERENCE, AROUSAL AND PLEASURE RANKING

Preference-ranking	No.	like	arousal	pleasures	Arousal-ranking	No.	like-ranking	pleasure-ranking	No.	like-ranking
1	26	20	3	20	1	18		1	26	3
2	30	18	3	13	2	15		2	27	9
3	23	17	4	18	3	7		3	16	
4	9	16	4	17	4	40	8	4	9	4
5	14	16	6	12	5	11		5	17	6
6	17	16	3	15	6	9		6	1	9
7	12	16	4	8	7	15		7	13	
8	40	16	20	4	8	46		8	14	
9	1	15	5	11	9	22		9	18	
10	4	15	11	11	10	93		10	12	

TABLE IV  
THE TOP 20 IN PREFERENCE, AROUSAL AND PLEASURE RANKING

Preference-ranking	No.	like	arousal	pleasures	Arousal-ranking	No.	like-ranking	pleasure-ranking	No.	like-ranking
1	26	20	3	20	1	18		1	26	3
2	30	18	3	13	2	15	14	2	27	9
3	27	17	4	18	3	7	11	3	16	18
4	9	16	4	17	4	40	8	4	9	4
5	14	16	6	12	5	11		5	17	6
6	17	16	3	15	6	9	13	6	1	9
7	12	16	4	8	7	15		7	13	12
8	40	16	20	4	8	46		8	14	17
9	1	15	5	11	9	22		9	18	16
10	4	15	11	11	10	93	10	10	12	
11	7	14	22	2	11	38		11	30	2
12	13	14	3	14	12	35		12	14	5
13	9	12	19	3	13	10		13	17	19
14	23	11	29	4	14	50		14	17	19
15	15	11	16	8	15	4	10	15	4	10
16	28	10	1	14	16	2		16	29	
17	34	10	3	14	17	57		17	30	
18	36	10	1	16	18	19		18	33	
19	17	10	4	12	19	51		19	19	
20	54	10	9	7	20	54	5	20	44	

TABLE V  
THE CORRELATION ANALYSIS BETWEEN PREFERENCE, AROUSAL AND PLEASURE

copy	More table copya	preferenc e	arousal	pleasure
preferenc e	Pearson coefficient correlation	1	0.051	0.666**
	Sig.(2-tailed)		0.698	0
arousal	Pearson coefficient correlation	0.051	1	-0.407**
	Sig.(2-tailed)	0.698		0.001
pleasure	Pearson coefficient correlation	0.666**	-0.407**	1
	Sig.(2-tailed)	0	0.001	

(2) Preference - Spatial Factors

Preference is selected as the dependent variable, and 6 spatial factors are selected as independent variables. Trying to seek for what factors will lead to higher preference through correlation analysis. As the table VI shows, there is a high positive correlation between preference and 6 spatial factors(p < 0.01). Among which, preference has the highest positive correlation with layer-relationship, and the correlation coefficient reaches 0.895 (p < 0.01) . Secondly is the positive correlation between preference and height-relationship, and the correlation coefficient reaches 0.837 (p < 0.01) . Next is the correlation between preference and roof style, and the positive correlation coefficient reaches 0.848 (p < 0.01) . In conclusion, layer-relationship, height-relationship and roof style have greater influence on public preference choice.

(3) Arousal - Pleasure - Spatial Factors

Arousal and pleasure are selected as the dependent variable, and 6 spatial factors are selected as independent variables. Trying to seek for what factors will lead to higher arousal and pleasure through correlation analysis. As the table VII shows, there is a lower correlation between arousal and 6 spatial factors. Among which, arousal has the lower positive correlation with the relationship between building group and mountain contour, and the correlation coefficient is 0.246(p=0.058). At the same time, there is a higher positive correlation between pleasure and 6 factors. Among which, pleasure has the highest positive correlation with layer-relationship, and the correlation coefficient reaches 0.718 (p < 0.01) . Secondly is the positive correlation between pleasure and mountain contour, and the correlation coefficient reaches 0.630(p < 0.01). In a word, layer-relationship and mountain contour have greater influence on public pleasure choice, and all factors have a weak effect on public arousal choice.

IV. DISCUSSION

This study gives us the following three conclusions:

- (1) Preference shows a lower correlation with arousal, but a higher correlation with pleasure. Higher pleasure score is associated with higher preference score, but higher arousal score is linked with lower pleasure score.
- (2) layer-relationship, height-relationship and roof style have greater influence on public preference choice. Urban designers

C. Ratio Analysis

Among the participators, there were 95 people who choose the most stimulating or exciting photos and favorite photos are the same, and they accounting for 21.11% of the total number of the participators. 227 people who choose the most pleasant photos and favorite photos are the same, and they accounting for 50.40% of the total. Then, as for the others, whose favorite photos are neither the one they feel the most stimulating nor the one they feel the most pleasant. As the figure 5 shown. So, the effect of the pleasure on the preference score is slightly higher than arousal.

D. Correlation Analysis

(1) Preference - Arousal - Pleasure

Table V shows the results of the correlation analysis between preference, arousal and pleasure. Preference is slight positively correlated with arousal, but the correlation coefficient is only 0.051. Preference is moderate positively correlated with pleasure, and the correlation coefficient is 0.666 (p < 0.01) . Arousal is moderate negatively correlated with pleasure, and the correlation coefficient is 0.407 (p < 0.01) . Thus, the public perception of arousal has little impact on its preference choice. Higher pleasure score is associated with higher preference score, and higher arousal score leads to lower pleasure score at the same time.

should focus on the control of the above three factors.

(3) layer-relationship and mountain contour have greater influence on public pleasure choice, and all factors have a weak effect on public arousal choice. We need to strengthen the selection of the tower building and the control of its height. And the coverage relation between the building layer and the

mountain layer need to be further studied in order to raise the public pleasure.

TABLE V  
THE CORRELATION ANALYSIS BETWEEN PREFERENCE AND SPATIAL FACTORS

		arousal	pleasure	layer relationship	height relationship	mountain contour	building contour	relationship between building group and mountain contour	roof style
arousal	Pearson correlation coefficient	1	-0.352**	0.069	0.213	-0.067	0.144	0.246	0.065
	Sig.(2-tailed)		0.006	0.061	0.102	0.612	0.271	0.058	0.624
pleasure	Pearson correlation coefficient	-0.352**	1	0.718**	0.509**	0.630**	0.591**	0.454**	0.582**
	Sig.(2-tailed)	0.006		0	0	0	0	0	0
layer relationship	Pearson correlation coefficient	0.069	0.718**	1	0.827**	0.737**	0.769**	0.740**	0.769**
	Sig.(2-tailed)	0.601	0		0	0	0	0	0
height relationship	Pearson correlation coefficient	0.213	0.509**	0.827**	1	0.726**	0.622**	0.786**	0.783**
	Sig.(2-tailed)	0.102	0	0		0	0	0	0
mountain contour	Pearson correlation coefficient	-0.067	0.630**	0.737**	0.726**	1	0.568**	0.499**	0.742**
	Sig.(2-tailed)	0.612	0	0	0		0	0	0
building contour	Pearson correlation coefficient	0.144	0.591**	0.769**	0.622**	0.568**	1	0.601**	0.732**
	Sig.(2-tailed)	0.271	0	0	0	0		0	0
relationship between building group and mountain contour	Pearson correlation coefficient	0.246	0.454**	0.740**	0.786**	0.499**	0.601**	1	0.712**
	Sig.(2-tailed)	0.058	0	0	0	0	0		0
roof style	Pearson correlation coefficient	0.065	0.582**	0.769**	0.783**	0.742**	0.732**	0.712**	1
	Sig.(2-tailed)	0.624	0	0	0	0	0	0	

TABLE VII  
THE CORRELATION ANALYSIS BETWEEN AROUSAL, PLEASURE AND SPATIAL FACTORS

		preference	layer relationship	height relationship	mountain contour	building contour	relationship between building group and mountain contour	roof style
preference	Pearson correlation coefficient	1	0.895**	0.666**	0.770**	0.792**	0.807**	0.848**
	Sig.(2-tailed)		0	0	0	0	0	0
layer relationship	Pearson correlation coefficient	0.895**	1	0.827**	0.737**	0.769**	0.740**	0.769**
	Sig.(2-tailed)	0		0	0	0	0	0
height relationship	Pearson correlation coefficient	0.873****	0.827**	1	0.726**	0.622**	0.786**	0.783**
	Sig.(2-tailed)	0	0		0	0	0	0
mountain contour	Pearson correlation coefficient	0.770**	0.737**	0.726**	1	0.568**	0.499**	0.742**
	Sig.(2-tailed)	0	0	0		0	0	0
building contour	Pearson correlation coefficient	0.792**	0.769**	0.622**	0.568**	1	0.601**	0.732**
	Sig.(2-tailed)	0	0	0	0		0	0

relationship between building group and mountain contour	Pearson correlation coefficient	0.807**	0.740**	0.786**	0.499**	0.601**	1	0.712**
	Sig.(2-tailed)	0	0	0	0	0		0
roof style	Pearson correlation coefficient	0.848**	0.769**	0.783**	0.742**	0.732**	0.712**	1
	Sig.(2-tailed)	0	0	0	0	0	0	

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