

Appearance and Architects' Design Intention of Contemporary Freeform Architecture

現代建築家の設計論にみられる自由曲面の根拠と形式

奥山研究室 19M58038 高 小涵 (GAO Xiaohan)

1.1 Introduction

As digital techniques have spread for architectural design since the 1990s, the number of architectures with an irregular form that cannot be described by primary geometry has increased a lot these days. Such kind of shapes, so-called freeform, are various from the one applied for overall building to partial or inside. The variation of freeform architecture can be seen as the reflection of change of architects' minds on form-giving. This research analyses the appearance and architects' design intention of freeform architecture published in international magazines after 2000, in comparison with representative masterpieces of the 20th century, in order to reveal contemporary architects' recognition of freeform. This thesis ought to provide a clue of how contemporary drawing techniques affect the significance of architecture form.

1.2 Methodology

The research object is defined as "architecture that contains at least one main part with irregular shape that cannot be directly described by primary geometry". 126 cases after 2000 are collected mainly from magazine a+u that published in 2000~2020^[1]. 42 cases of 20th century masterpieces(50~70s) are collected from both magazines and monographs.

For each case, physical appearance from drawings and pictures is studied to find out how architects applied

freeform to their designs, and design intention from texts by architects is also analysed to find out what are their ideas of freeforms' form-giving (fig.1).

2. Physical Appearance

2.1 Expression of Freeform

Firstly, the shape is categorised from two perspectives: applied part and shape feature. fig2 shows the case number of both eras on the basis of this categorisation.

Applied Part discussed to what extent does the freeform compose the whole building. It is divided into Overall Applied and Partly Applied. Partly Applied is further clarified as 3 situations: outside component, component that can be seen from both outside and inside, and only inside component.

Shape Feature discussed how the freeform is shaped and organized. It's divided into 2 groups, {Volume} and {Plane}. The former means self-completed shape that encloses space. The latter consists of one or several surfaces. These two are further separated into 7 groups. {Volume} is divided based on the degree of enclosure: [Closed], [Open] ([Wrapped], [Sheltered]), and [Articulated]. {Plane} is divided based on the plane number and the organization method: [Single], and [Plural] ([Regular Organized] (RO), [Irregular Organized] (iRO)).

It can be seen from the 21stc cases that Overall Applied takes the majority as 5 times more than the number of

	No.118 Absolute Tower, MAD They are something softer and organic, livable and approachable — <u>striving to provide residents with an emotional connection to their city.</u> The twisting compositions of the towers are reminiscent of feminine curves, <u>representing something more sculptural and human, as opposed to geometric and commercial.</u> ... Instead of existing as static forms, they are defined by curvy contours that create a unique aesthetic experience that goes beyond functionality, gently twisting upwards with an expression of movement.	<a+u> vol.600 (2020)	Chapter 2	Chapter 3	Chapter 4
			o-Wv Structure performance: Attachment Material: A2 Surrounding: 1	[Envir.: Urban] [118-1] create new city identity [118-2] opposite to geometric and commercial [Space] [118-3] create unique aesthetic experience	Chapter 2 Appearance × Chapter 3 Intention

Fig.1 Analysis Example

Shape Feature		Volume 66/14				Plane 60/28							
Applied Part		Closed 17/2		Open 42/9		Articulated 7/3		Single 25/12		Plane 60/28			
				wrapped 29/6	sheltered 13/3					Plural 35/16			
										regular organized 8/10		irregular organized 27/6	
Overall Applied	o- 105/35	o-C 12/2	o-Wv 14/2	o-Wh 9/1	o-T 10/1	o-A 7/3	o-S 16/8	o-S' 5/4	o-R 4/6	o-R' 1/3	o-P 6/1	o-P' 9/2	
Partly Applied	po- outside 10/3	po-C 3/0	po-W 1/2	poi-T 1/1	*p-A	po-Sw 2/0	po-Sc 1/0	po-R 3/1	o-Pph 5/1	o-Ppv 4/1			
	poi- outside & inside 2/1												
	i- only inside 9/3	i-C 1/0	i-W 5/1	i-T 2/1	*i-A	i-S 1/0			*i-R		*i-P 0/1	po-P 3/0	
Example		o-C no.72	o-Wv no.87	o-T no.24	o-A no.96	o-S' no.121	o-R no.74	po-R no.105	o-P no.42				
		Ordos Museum, MAD	The Living, Hy-Fi	Fiera Milano, M.Fuksas	Princess Elena Auditorium	Yabuli Conference Center	EXPODACH, Herzog	The Shed, D.Scofidio	Hotel Marques de Riscal				

Fig.2 Expression of Freeform

perform as structure		attachment
main structure	sub-structure	
47/27	17/9	62/6

Fig.3 Structure Performance

Natural		Artificial				
collect	cut	smash/bend	mix/sinter	smelt	compose	
N0	N1	N2	A1	A2	A3	
eg. bamboo/stone	timber	curved wooden panel	concrete/brick/ceramic/paper	glass/metal	FRP/fabric	
8/0	9/0	6/1	27/33	41/6	29/2	

Fig.4 Material Property

Urban			Nature
Surrounded	Street Corner	Open Space	
29/5	16/5	46/21	35/11

Fig.5 Surroundings

Partly Applied, and {Volume} and {Plane} are weighted equally. In comparison, the 20thc cases show different tendency. {Plane} doubles the number of {Volume}.

2.2 Characteristics of Freeform

Then, three additional aspects are discussed as the most influential factors towards freeform appearance: Structure Performance, Material Property and Surroundings.

2.2.1 Structure Performance

This section studied the supporting system of freeform and the whole building. It is clarified into following 3 categories: main structure, sub-structure, and attachment (fig.3). Almost 20th century cases perform as structure, and 64% of them works as main structure of building. While in 21stc, around 50% cases perform as attachment. It can tell that more cases for now pursue impressive form even at the cost of ignoring structure rationality.

2.2.2 Material Property

This section studied the processing degree of material on freeform. Six degrees are pointed out from natural to artificial (N0, N1, N2, A1, A2, A3)(fig.4). Compared with 20th century's popularity of A1, it no longer takes the majority in new century. More natural materials including regional craft newly emerged (N0,N1) and more processed materials (A2,A3) increased.

2.2.3 Surroundings

Surroundings exposed the shape preference under different conditions of spectator popularity. 4 typical types are extracted: surrounded place, street corner, open space, and nature (fig.5). Compared with 20thc's cases, urban limited sites(the former two) increased remarkably.

2.3 Comprehensive Research of Expression and Characteristics of Freeform

Combining data of shape feature, structure performance and material property, fig.6 is made to figure out

the tendency of freeform shaping. [Sheltered] has the strongest tendency towards structure and a clear connection to A1, which evidenced that concrete-made tulip-shape is one typical pattern as self-supporting freeform. On the contrast, [Closed] and [Wrapped] show another typical pattern as freeform skin supported by frame: both of them have a remarkable part of A2 and A3 as attachment. [Wrapped] also shows the strongest connection to urban limited site (over 50% is in surrounded site or street corner), which may due to its convenient adaption to fit various scale from skyscraper to pavilion. Compared to {Volume}, {Plane} has less main structure cases but more sub-structure cases. Also, more various materials are challenged in 21stc to be main structure than before, especially in {Volume}.

On the other side, a higher proportion of {Plane} as main structure is found in masterpieces. Though the popularity of {Plane} is same, the shape's meaning has changed. [RO] is the only one that had a stronger tendency. Not to mention the technology limitation, another reason why legends preferred the [RO] type may be an old-school aesthetics on order and stability that under such consideration were these organic components designed.

3. Design Intention

Design intentions are extracted from architects' texts and examined based on KJ method. Five groups are formed according to the intention's target field: <Space>, <Composition>, <Environment>, <Form>, and <Function> (fig.7). <Space> relates to spatial qualities and human perceptions. <Composition> relates to organization of space or integration of components. <Environment> contains <<Urban>> and <<Nature>>, both concerning surroundings. <Form> is divided into <<Morphology>> and <<NewForm>>, the former is

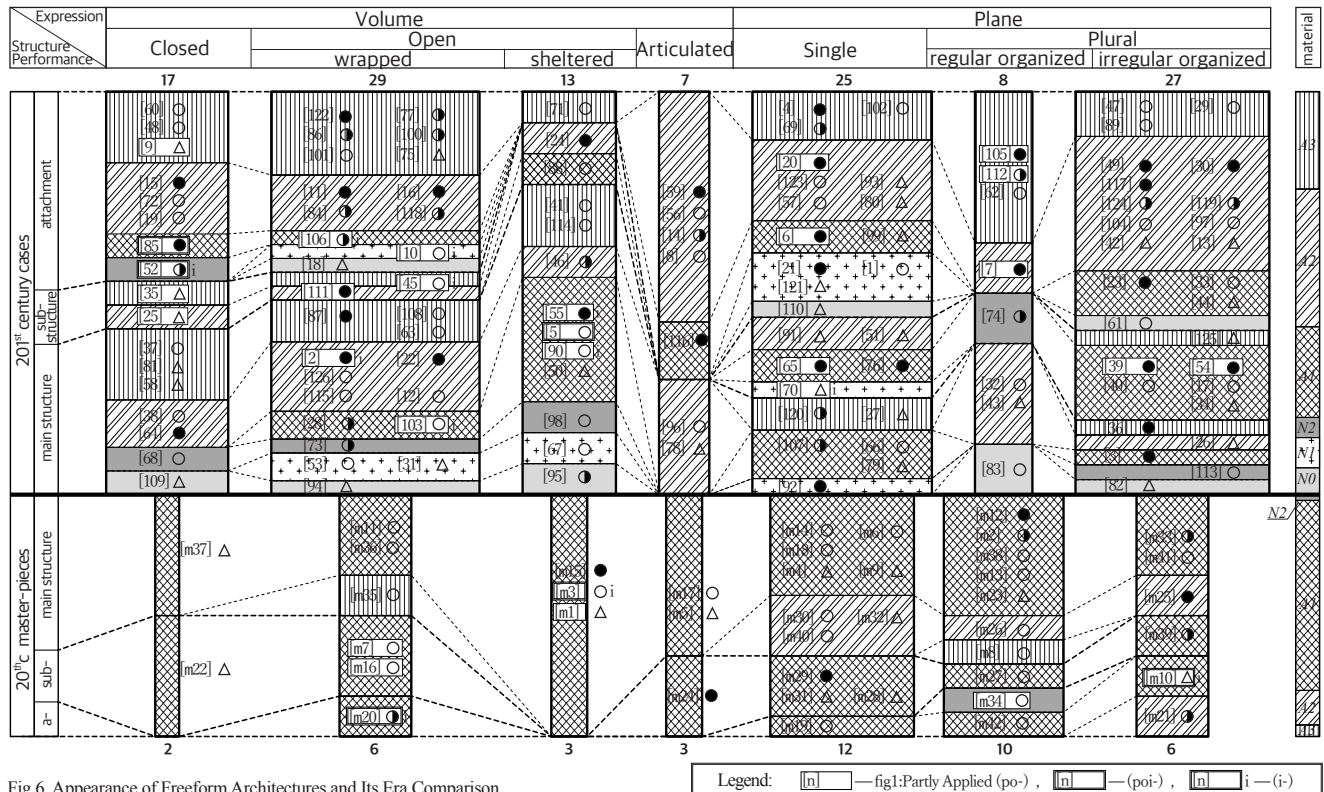


Fig.6 Appearance of Freeform Architectures and Its Era Comparison

Legend: [n] —fig1:Partly Applied (po-), [n] —(poi-), [n] i —(i-)

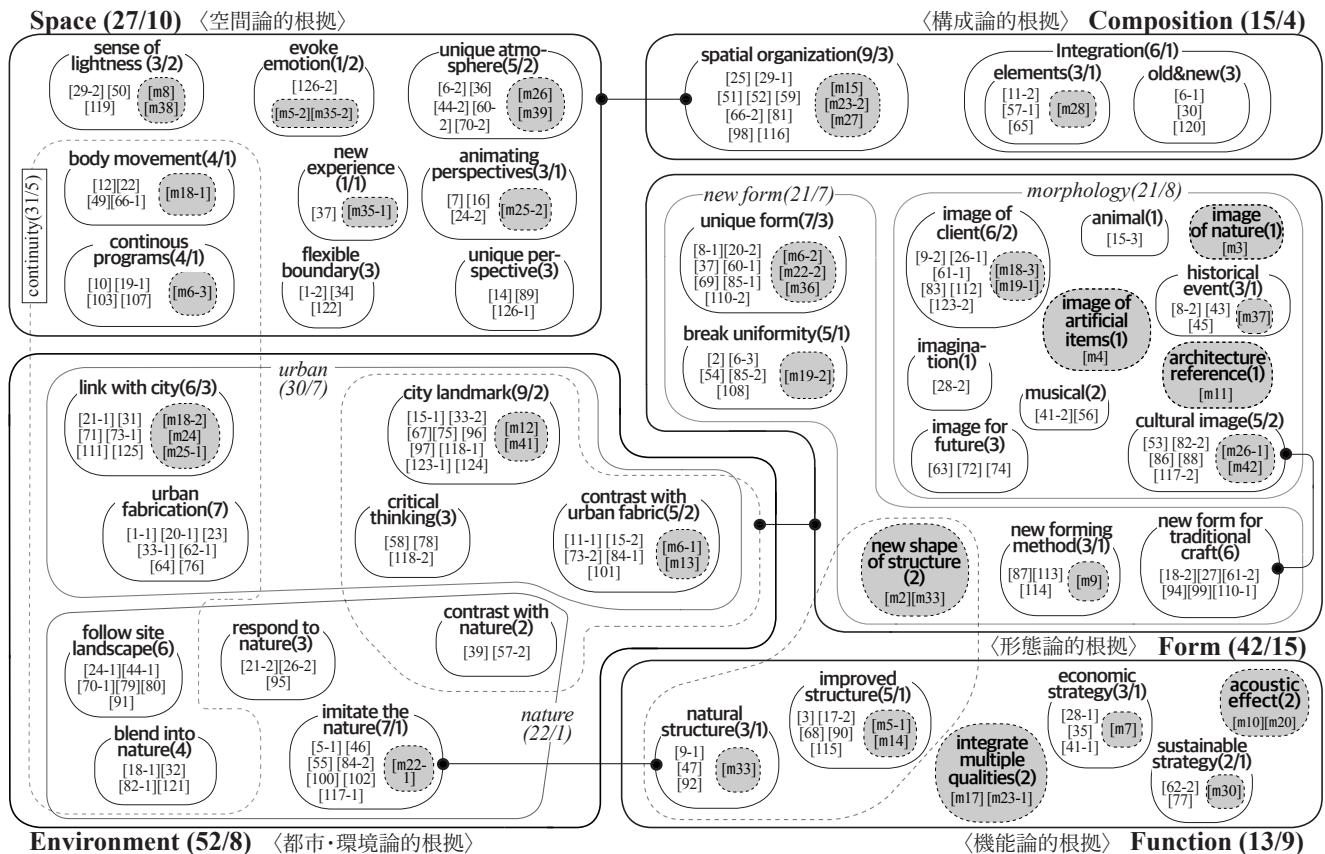


Fig.7 The Content of Intention of Freeform through Design Theory

	Specific	21 st century Cases	Contrast or Development Relationship	20 th century Master-pieces	Specific
Space	flexible boundary (3) unique perspective (3)	6			
Composition	Integration of old&new(3)	3			
Environment	urban urban fabrication(7) critical thinking(3)	nature follow site landscape(6) respond to nature(3) blend into nature(4) contrast with nature(2) 10			
Form		morphology animal (1) imagination(1) musical (2) image for future(3) 15		image of nature (1) image of artificial items (1) architecture reference(1) 5	
Function		new form new form for traditional craft(6) 13		new shape of structure (2) integrate multiple qualities(2) 2	acoustic effect(2) 2

Fig.8 Unique Content of Two Eras and Their Relations

about symbolic shapes while the latter pursues newness. <Function> means physical qualities including structure and cost. Grey color distinguishes 20th century contents. In 21st c cases, <Environment> and <Form> count the most. The latter has similar importance in 20th c, while the former counts far less. It can be said that the concerns relating environment is unique in nowadays. As for <Composition>, it is unique in 21st c using freeform to integrate the old and new in renovation projects. 20th c cases show more concern in <Form>. It's interesting that, although freeform are plenty used to express newness in <<NewForm>>, both eras also use freeform to represent culture images according to <<Morphology>>. Unique contents of each era's cases are further extracted for relation research(fig.8). In 21st c, new attention of <Space> and <<Urban>> are paid while the thoughts on <<Nature>> developed a lot. Two eras show different preference on <<Morphology>>, from old-day's

concrete reference to nowadays interest in immaterial ideas. Another new trend is in <<NewForm>>, freeform is used to renew traditional crafts that itself became a symbol of modernization. 20th c cases show more concern in <Function>. Taking freeform as a tool to combine multiple qualities is quiet unique, comparing that most cases in nowadays tend to use one form for one main concept or quality.

4. Comprehensive Investigation

Based on the former two chapters, a comprehensive understanding is investigated to find out the recognition of freeform appearance regarding to intentions (fig.9). Inside <Environment>, <<Nature>> shows the strongest tendency to {Plane} among all the others (e.g I), while {Volume} distinctively composes a lot in <<Urban>> (e.g II). Additionally, <<Nature>> is the only group that has no case of [Closed] or [Articulated], either of which has a clear sense of enclosure. It evidenced a typical image

relation between outspreading space and the nature. Inside <Form>, though the balance between {Volume} and {Plane} is always same in both two groups, there's contrastive tendency in {Plane}. [Plural] has the largest proportion in <<Morphology>>, while [Single] takes a big part in <<NewForm>>. Many cases in <<NewForm>> · [Single] considered freeform surface as one additional element to attach new meanings to spatial relations (e.g III). From <<Morphology>> · [Plural], it's clear that clustered units, no matter repetitive or random, are more common for symbolization (e.g IV). It suggests that single plane and plural planes have different meaning in form-making.

<Composition> shows distinctive tendency of {Volume} that the ratio of [Open] is the smallest. Meanwhile, it has the largest ratio of [Single] in {Plane}. It means self-completion shape such as [Open] is less preferred; More flexible Surfaces are wider used for composition (e.g I). Differently, [Open] composes the most in <Space>. However, the two sub-groups inside [Open], [Wrapped] and [Sheltered], differ a lot. Using <Space> · [Wrapped] to achieve flexible boundaries (e.g VI) or a sense of spatial continuity is unique in nowadays.

<Function> has the strongest tendency to {Volume}.

As for 20th c cases, <Function> · {Volume} is similarly distinguished with 21st c cases, it shows a constant consideration from structural and economic perspectives. The biggest change is seen in <Environment>, the image of freeform shape has changed dramatically. Back to 20th c, {Plane} is more used for <<Urban>>, but now {Plane} is more used for <<Nature>>. Oppositely, more cases now choose {Volume} for <<Urban>> expression. Last but not least, <Composition> and <Environment> both show a developed diversity in {Volume} expression.

5. Conclusion

This research mainly discussed the tendency of freeform architectures' form-giving patterns and design intentions in both 20th c and 21st c. As a result, the diversity of both appearance and intention has increased in nowadays; wider range of image is represented. Thus, the usage of freeform is more flexible, not only as a leading theme, but also works supportively and additionally in complex themes. It gives architects more freedom but less interest to integrate aspects by one freeform, like 20th c cases did.

Notes:

[1]. Totally 126 projects published on international magazines between 2000 to 2020 are studied (no.1~126). The main magazine source is a+u (118 cases). Additionally, El Croquis (7 cases) and AV (1 case) are aimly included for supplementary information. 42 masterpieces of the 20th century, specifically speaking from 50s-70s' modern and late-modern age (no.m1~m42) are collected from both magazines and architects' monographs.

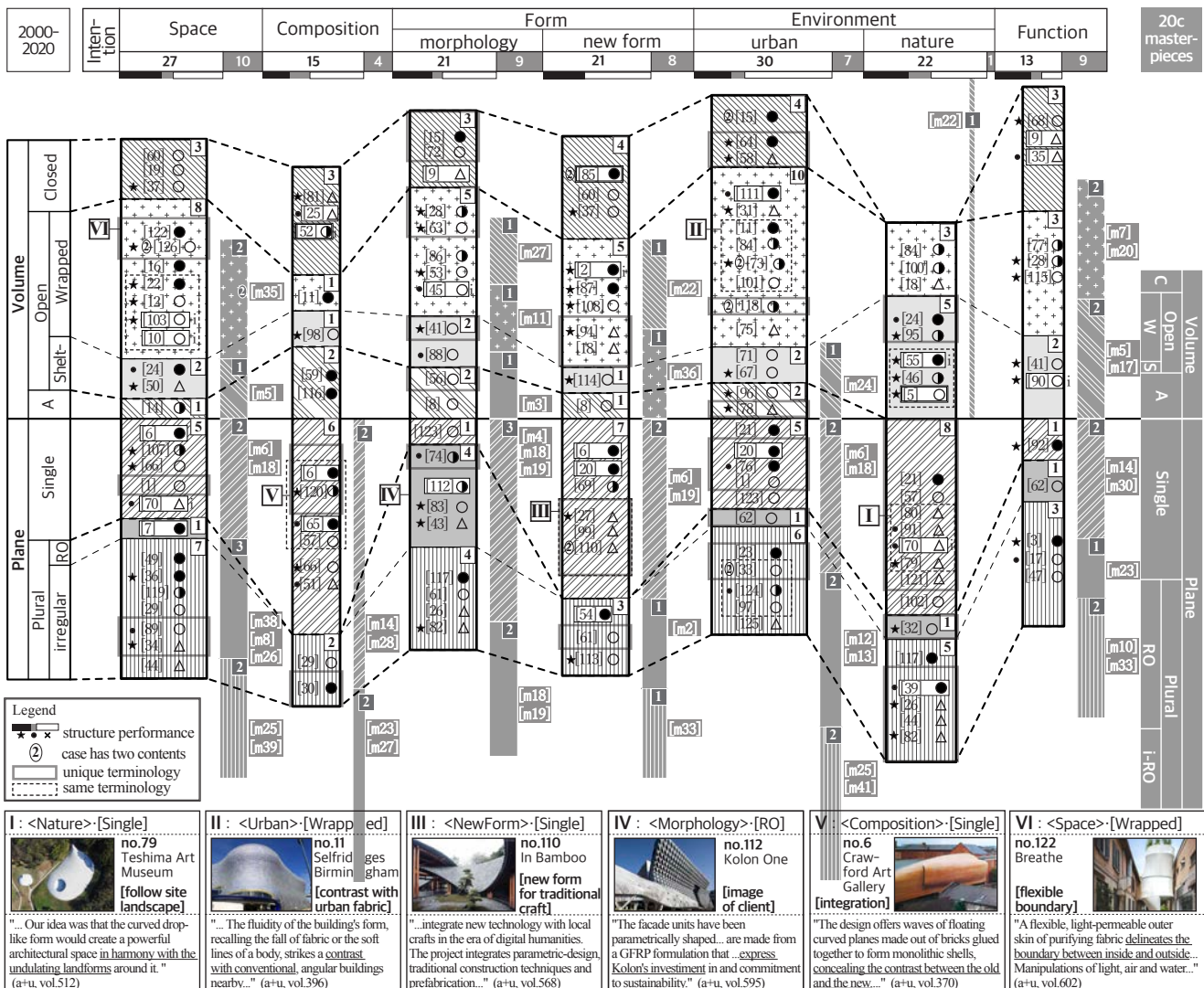


Fig.9 Relationship of Appearance and Intentions