EVOLUTION OF CONTEMPORARY JAPANESE ART MUSEUMS
THROUGH THE ANALYSIS OF THE PLAN CONFIGURATION

Architectural Design of Japanese Art Museums since the Second World War

現代日本美術館建築における平面構成の分析による歴史的変遷に関する研究

～ 第二次世界大戦後の日本の美術館を対象として ～

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Art museums are taken in this investigation as an effective sample to analyze architectural design in Japan of the last 65 years. First, through the analysis of the configuration in plan of a selection of 102 cases, this study offers two classifications based on 1) exterior boundary, and 2) interior layout. Second, this study discusses connections between these two classifications, and suggest eight patterns, which help to understand the evolution of architectural design of Japanese art museums through time.

Keywords: *Japan, Art museum, Plan configuration, Typology, Contemporary architecture*

日本, 美術館, 平面構成, 類型学, 現代建築

1. Introduction**1.1. Background and research question**

This study focuses on Japanese art museums built after the Second World War. To nowadays, museum buildings have been characterized for having freer shape than other building types such as offices or houses due to the relative flexibility of the program exhibition requirements. In addition, most of art museums have a larger budget, and architects are encouraged testing how far they can push the limits of their abilities in architectural design.¹ Architects have always been trying to create a different approach to architectural design with the goal of providing differentiation and identity to the building. Changes in the use of material, the shape of the building, its organization or configuration are some of the parameters employed by architects to reach this differentiation.

At the beginning of the 1930s, an identification of “Japan-ness”² to an external gaze began, at the same time when Japan adopted Western modernism in architecture. Since then, the debate of the “Japanese taste” in architectural design remains in the studies of Japanese architecture. In this study Japanese architecture is analyzed as an example of a particular way of thinking architecture, contributing also to enlarge current studies about contemporary architecture.

This investigation takes art museums as an effective sample of

architectural design processes of the last 65 years in Japan. The goal of this research is to establish a classification of Japanese contemporary museums, describing the characteristics of these new types that have emerged over the past years. For this purpose, this study tries to identify some of the elements and characteristics of the contemporary Japanese art museums, and also to establish the relationships between two aspects: the external boundary and the interior layout. The reason why we focused on these two aspects is because they are both fundamental and, at the same time, they can be studied independently. Also, especially in the last years, there is an increasing use of innovative exterior forms, which often contain interior layouts that do not necessary show the same degree of innovation. For example, the main facade of The Tokyo National Art Center has an irregular form but its interior configuration has a front-back hierarchical structure, which has a long tradition in architecture. On the contrary, we can find museums like the 21st Century Museum of Contemporary Art with a regular external geometry, but presenting innovation in the interior conditions with an isotropic layout. Therefore, we consider the comparison of these aspects (external boundary and interior layout) especially relevant to understand the evolution of Japanese art museums until nowadays.

1.2. Methodology and sources

Due to the complexity of architecture, graphic analysis is a method used

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to express architectural form, concepts and systems in a reduced way. Many architects theorized about architectural concepts by using this analytical method. In the 1920s, Alexander Klein³ published some of his most known works where he established a graphic method to study typological classification and make comparison and validations between different buildings. Other architects such as Christopher Alexander⁴, Peter Eisenman⁵ or John Hejduk⁶ are early examples who used graphic analysis and architectural diagrams to express concepts and architectural systems.

In Japan, there are several studies about architectural composition. The methodology described by Kazunari Sakamoto et al⁷ is used for study cases analysis and typology creation. For this study, we follow this methodology trying to adapt it to our specific goals.

In order to achieve a clear understanding of the cases and their design concepts, this study focuses on formal aspects and does not consider intangible aspects such as materiality, or light conditions, in order to identify patterns in geometry, hierarchy or orientation. The analysis of the geometry of the building plan, and the creation of conceptual diagrams, is one way to show how new architectural concepts can be derived. In this paper we use the building plan analysis because, in most of the cases, the plan conveys the

main organizing strategy of a building. It is full of clues about the designer's values and attitudes toward theories of order, methods of construction. The idea is not to use the plan just as a set of data, but also of values, ideas and analogies that had shaped the building in a particular way.

The conceptual diagrams are created from every case like a *parti* diagram. Hejduk⁶ defines a *parti* as "a diagram that delineates the dominant organizational or formal concept governing an architectural scheme". The purpose of this study in plan is not to demonstrate the abstract perfection of ideal form itself but a schematic design process through which the creative intention can embody the complex relation between concept and form, and the internal organization.

For this paper we analyze only one floor for each museum that can be consider that *parti* of the building. Some museums are formed by a single floor plan (21 of 102). When there is a case formed by more than one floor, the plan to analyze is the one containing the largest exhibition area. In most of the cases (87 of 102), the access floor plan contains the largest exhibition area.

1.3. Object of study

102 samples (Table 1) have been selected from the period after the Second World War. These buildings are published in the questionnaires of

Table 1 Cases list and code

No.	Year	Architecture Name	Architect	Code	No.	Year	Architecture Name	Architect	Code
1	1959	Ishikawa Prefectural Mus. of Art	Yoshiro Taniguchi	111-DLpe	53	1995	Nariwa Munic. Mus.	Ando Tadao	110-DLpe
2	1964	Okayama Prefectural Mus. of Art	Kunio Maekawa	111-DLpee	54	1996	Toyota Munic. Mus. of Art	Taniguchi Yoshio	111-ERpeS
3	1966	Nagano Prefectural Shinano Art Mus.	Nikken sekkei	111-ERpel	55	1996	Anpanman Mus.	Furuya Nobuaki	110-DLpe
4	1973	Tochigi Prefectural Mus. of Fine Art	Kiyoshi Kawasaki	101-ELpee	56	1996	Kampo Mus. in Shiga	Team ZOO	100-DLppee
5	1973	Tottori Prefectural Mus.	Nikken sekkei	111-ERpeV	57	1996	Fin/Nijijima Glass Art Mus.	Katsuhisa Hashimoto	100-DLpe
6	1973	Nara National Mus.	Zyuzo Yoshimura	111-ERpeS	58	1996	Hamada Children'S Mus. of Art	Shin Takamatsu	111-DLpep
7	1975	Kitayushu Municipal Mus. of Art	Arata Isozaki	110-ERpeL	59	1996	Okazaki City Art Mus.	Kuryu Akira	111-C2
8	1975	The Mus. of Modern Art Gunma	Arata Isozaki	111-DLpe	60	1997	Sakata City Mus. of Art	Ikehara Yoshiro	111-ERpeS
9	1975	Ikeda 20th Century Mus.	Takeyoshi Inoue	101-DLpee	61	1997	Kumano Kodo Nakahechi Mus.	SANAA	100-C2
10	1974	Chiba Prefectural Mus. of Art	Ootaka Masato	111-ERpel	62	1997	Chihiro Art Mus. Azumino	Naito Hiroshi	111-ERpeS
11	1977	Tokyo Metropolitan Art Mus.	Kunio Maekawa	111-DRpeC	63	1997	Kyoto Hosomi Mus.	Tadasu Ohe	111-DLppe
12	1977	Hokkaido Mus. of Modern Art	Minoru Ota	111-ERpel	64	1998	Akino Fuku Mus.	F. Terunobu+Uchida Y.	110-DLppe
13	1978	Kumamoto Prefectural Mus. of Art	Kunio Maekawa	111-DRpeC	65	1998	Tenshin Memorial Mus. of Art	Naito Hiroshi	111-ERpeS
14	1978	Iwasaki Art Mus.	Maki and associates	111-ERpeL	66	1998	Sagawa Art Mus.	Takenaka corporation	111-DRpeC
15	1979	Shiseido Art House	Yoshio Taniguchi	100-DLpee	67	1998	Idate Mus.	Tadao Ando	100-DLpep
16	1981	The Shoto Mus. of Art	Seichi Shirai	100-DLppe	68	1999	Shimane Art Mus.	Kikutake Kiyonori	01-ERpel
17	1981	Shizuoka Munic. Serizawa Keisuke Art Mus.	Seichi Shirai	101-DLppee	69	1999	Nemunoki Art Mus.	Shigeru Ban	101-A
18	1982	Japanese Ukiyo E Mus.	Kazuo Shinohara	110-DLpe	70	1999	Univ. Art Mus., Tokyo		
19	1982	The Miyagi Mus. of Art	Kunio Maekawa	111-DLpe			National Univ. of Fine Arts and Music	Rokkaku+N. Sekkei	111-ELpepe
20	1983	The Mus. of Modern Art, Saitama	Kisho Kurokawa	01-ERpeV	71	1999	Kirishima Art Hall	Kumihiko Hayakawa	111-DLpee
21	1984	Izunochohachi Mus.	Osamu Ishiyama	100-ERpeV	72	2000	Bato Machi Hiroshige Mus.	Kuma Kengo	111-DLpee
22	1984	Tanamura Mus.	Murano Mori Associate	100-ERpeS	73	2001	Tokyo National Mus.		
23	1984	Fukushima Prefectural Mus. of Art	Ootaka arc	100-DLpee			The Gallery of Horyuji Treasures	Taniguchi Aichi	111-DLpee
24	1984	Shiga Prefectural Mus.	Nikken Sekkei	110-ERpeS	74	2001	Hyogo Prefectural Mus. of Art	Tadao Ando	111-DRpeC
25	1985	Okanoyma Graphic Art Mus., Nishiwaki	Arata Isozaki	01-ELpepe	75	2002	Gunma Mus. of Art, Tatebayashi	T.Takahashi+D.Kobo	100-ERpeS
26	1986	Setagaya Art Mus.	Syozo Uchii'	111-ERpeL	76	2002	Pola Mus. of Art	Nikken Sekkei	100-C1
27	1986	The Tasaki Mus. of Art	Koji Hara	101-ELpe.e	77	2003	The Mus. of Modern Art Hayama	AXS SATO INC	111-ERpeL
28	1985	Shizuoka Prefectural Mus. of Art	Shizuoka S. Rengou	111-DLppe	78	2004	21st Century Mus. of Contemp. Art	SANAA	100-B
29	1986	The National Mus. of Modern Art, Kyoto	Fumihiko Maki	111-DLpe	79	2004	Chichu Art Mus.	Ando Tadao	110-DLppee
30	1987	Nagoya City Art Mus.	Kisho Kurokawa	01-DLppee	80	2004	Kagawa Prefectural Higashiyama		
31	1989	Iida City Mus.	Koji Hara	101-DRpeC			Kaai Setouchi Art Mus.	Yoshio Taniguchi	111-DLpe
32	1989	Nakagawa Kazumasa Art Mus.	TAK Architects INC.	111-ERpeS	81	2004	Ehon Mus.	Tadao Ando	110-C2
33	1989	Informel Nakagawamura Mus.	Kikou Mozuna	100-DLpe	82	2005	Tomihiro Art Mus.	Yokomizo Makoto	111-DRpeC
34	1989	Hiroshima City Mus. of Contemp. Art	Kisho Kurokawa	100-ERpel	83	2005	Nagasaki Prefectural Mus.	Kuma K.+N. Sekkei	111-ERpeV
35	1989	Yokohama Mus. of Art	Kenzo Tange	100-ERpeV	84	2005	Kanno Mus.	Hitoshi Abe	111-C1
36	1990	Nagano Prefectural Shinano Art Mus., Higashiyama Kaai Gallery	Yoshio Taniguchi	111-ERpeL	85	2006	Aomori Mus. of Art	Aoki Jun	100-C1
37	1990	Kawamura Memorial Dic Mus. of Art	Ichiro Ebihara	100-ERpeL	86	2006	Sakanouenokumo Mus.	Tadao Ando	101-C2
38	1989	Imazumi Mus.	Hisao Kouyama	100-DLpe	87	2007	Keyforest871228 Keith Haring Mus.	Kitagawara Atsushi	101-DLppee
39	1991	Autopolis Art Mus.	Hiroshi Naito	111-ERpel	88	2007	Yokosuka Mus. of Art	Yamamoto Riken	111-ERpeL
40	1992	Nooshima Contemp. Art Mus.	Tadao Ando	100-DLppe	89	2007	Okinawa Prefectural Mus. & Art Mus.	Ishimoto+Niki	111-ERpeV
41	1992	Koriyama City Mus. of Art	Yagagisawa T.	111-DRpeC	90	2007	The National Art Center, Tokyo	Kurokawa Kishou	01-DRpeC
42	1992	Shinsyu Takato Mus. of Art	Tadanaga Miyamoto	100-DLpee	91	2007	Suntory Mus. of Art	Kengo Kuma	111-DLpee
43	1993	Shima Art Mus.	Hiroshi Naito	111-DLppe	92	2007	Nemunoki Children Mus.	Terunobu Fujimori	01-ELpepe
44	1993	Jingu Mus. of Fine Arts	Hiroshi Ohe	111-ELpe.e	93	2008	Towada Art Centre	Nishizawa Ryue	01-ERpeS
45	1994	Rias Ark Mus.	Osamu Ishiyama	01-ERpeV	94	2008	Hara Mus. Arc	Arata Isozaki	110-ERpeV
46	1994	Nagi Mus. of Contemp. Art	Arata Isozaki	100-ERpel	95	2009	Nezu Mus.	Kuma Kengo	111-DLppe
47	1994	Garden of Fine Art, Kyoto	Tadao Ando	101-A	96	2010	Teshima Art Mus.	Nishizawa Ryue	00-A
48	1995	Museum of Contemp. Art Tokyo	Yagagisawa T.+TAK	111-ERpel	97	2010	Lee Ufan Mus.	Ando Tadao	101-ERpeS
49	1995	Ehime Mus. of Science	Kurokawa Kisho	100-DLppe	98	2010	Hoki Mus.	Nikken Sekkei	100-DLpee
50	1995	Suntory Mus.	Ando Tadao	100-DLppe	99	2010	Mus. of The Light	Tadao Ando	111-DLppe
51	1995	Miyazaki Prefectural Art Mus.	S.Okada+ Sekkei	100-ERpel	100	2011	Hiroshi Senju Mus. Karuizawa	Nishizawa Ryue	00-A
52	1995	Shoji Ueda Mus. of Photography	Takamatsu Shin	100-DLppe	101	2011	Ken Iwata Mother and Child Mus.	Toyo Ito	00-A
					102	2012	Akita Mus. of Art	Tadao Ando	101-DLpep

Abbreviations according to Oxford English Dictionary: Museum-Mus.; Contemporary-Contemp.; University-Univ.;Municipal-Munic.

Fig.1 Number of cases by years taken in five years periods

Fig.2 Number of cases by main floor area size in squared meters

the periodical Shinkenchiku Magazine year-end special edition (Nen-matsu Tokushu) from 1950 to 1990, and in Japanese Architecture Yearbooks (The Japan Architect magazine) and GA Publication from 1990 to 2015. This study uses these sources because their consistent review-oriented approach and the precision of its data. The information is based on architectural drawings and pictures found in those sources.

The purpose of the buildings is *art museum*, excluding other purpose museums such as natural museums or science museums. Small pavilions and galleries annexed to other buildings different from the art museum are not considered. Renovations and temporary buildings are also excluded. In the cases that museum program is mixed with other uses such as library or auditorium, only the examples where the main public access area is intended

Table 2 Concepts for external boundary

REGULARITY = 1				REGULARITY = 0	
ORTHOGONALITY = 1				ORTHOGONALITY = 0	
AXIALITY = 1				AXIALITY = 0	
STRAIGHTNESS = 1				STRAIGHTNESS = 0	
MIX = 1				PURE = 0	

for exhibition use are considered.

In an overview of samples (Fig. 1) it can be noted that most of the works have been built after the 1990s (66 cases), especially from 1995 to 1999 (24 cases). As for the size (Fig. 2), more than half of the cases are built within 5,000 m² (81 cases) and the most common dimension ranges from 1000 m² to 5,000 m² (55 cases). While size matters for obvious programmatic reasons, it depends on the exhibited artwork. Variations in size are not considered for the purpose of this study as it is focused on the external boundary form and the interior configuration layout. Nevertheless, it can be pointed out that the dimensions under 200 m² (4 cases) and over 10,000 m² (4 cases) are clearly exceptions in Japanese contemporary art museums size.

1.4. Previous studies

After the Second World War, the Japanese socio-economical context allowed architects to develop new ways of experimentation in architectural design. In this way, Japanese art museums are able to show the architectural thinking evolution, and very often they are open to public debate. There

R: regularity O: orthogonality S: straightness
e: exhibition spaces p: public services r: restricted access areas

Fig.3 Analysis example 1

R: regularity O: orthogonality S: straightness
e: exhibition spaces p: public services r: restricted access areas

Fig.4 Analysis example 2

Table 3 Concepts for interior conditions

ISOTROPY		LAYOUT	PHASED											
A	B		C		D					E				
			SEQUENCE			LINEAL					RAMIFIED	LINEAL		RAMIFIED
				C1	C2	pe	pee	ppe	ppee	pe.e	peC	pepe	pel	peL

public space (p)

exhibition space (e)

are multiple books about museums around the world including Japanese examples⁸, but they are mostly just photographic collections without any analytical classification. We can also find popular media publications about Japanese museums⁹. There are also several studies on Japanese contemporary architecture and museum typology that show a relation with this paper. Nakai, Moriama and Sakamoto¹⁰ focus their research on exterior conditions. Using the architectural composition methodology described in “methodology and sources” part (sec. 1.2), they make a typology classification based on museum elements composition, the relation with the conditions of location, and the external spatial composition in terms of the public characteristics of the typology. In the case of Koike and Nakagawa¹¹, they focus their research on interior conditions using Space Syntax, where spaces are broken down into components and analyzed as networks of choices, describing the relative connectivity of those spaces. In this investigation, both external and internal conditions are studied and combined under the same formal analysis method. This allows us to find new patterns and connections resulting from this

combinatorial analysis.

2. Concepts definition

Two descriptive criteria are considered: external boundary and interior conditions. We diagrammed the entire samples according to these criteria, and identified them by a code (Table 1).

2.1. External boundary

For the external boundary the interior space information is systematically discarded in order to emphasize the shape, as a figure-ground diagram. For the creation of these diagrams, secondary elements such as exterior open galleries or small walkways are not considered.

The analysis has been realized according to the following concepts: *Regularity, orthogonality, axuality and straightness* (Table 2). What follows is a description of each concept:

- *Regularity*: This paper follows Ching’s definition of regularity, where “regular forms refer to those whose parts relate to each other in a consistent

Table 4 External boundary types - Museums plans represented at several scales (Table 5)

REGULARITY	ORTHOGONALITY	AXIALITY	STRAIGHTNESS										
R = 1	O = 1	A = 1	S = 1	6	29	43	54	58	70	72	82	84	91
				99	1	2	3	5	8	10	11	12	13
R = 0	O = 0	A = 0	S = 0	26	28	32	36	39	41	44	48	59	60
				62	63	65	66	71	73	74	77	80	83
R = 1	O = 1	A = 1	S = 1	88	89	95	7	18	24	53	55	64	79
				94	69	86	102	4	9	17	27	31	47
R = 0	O = 0	A = 0	S = 0	87	76	78	42	67	98	52	57	22	16
				15	35	37	38	40	46	49	50	51	56
R = 1	O = 1	A = 1	S = 1	61	75	85	20	25	30	45	68	90	92
				93	96	100	101						
R = 0	O = 0	A = 0	S = 0										

and orderly manner. They are generally stable in nature and symmetrical about one or more axes. [...] Forms can retain their shapes even when transformed regularly dimensionally or by addition or subtraction of elements”¹². Ching also explains regularity from an experiential point of view when we can construct mentally the original whole of a form even when fragments are missing or added. In this study, regular forms refer to square, triangle, circle and oval simple forms, or composed by addition or subtraction of them. *Irregular forms* are those whose parts are dissimilar in nature or composed by other forms different to the regular ones. They are usually free-form and flowing in appearance. In this paper we called them *mix irregular forms* if they are composed of a regular form with some irregular form element or part. On the other hand, the ones that are totally irregular are called *pure irregular forms*.

- **Orthogonality:** Two types of regular forms can be distinguished: The cases where the reconstruction of the whole form is made of combination of one or more rectangular or squared shapes are defined as orthogonal examples. Non-orthogonal examples are characterized for being formed by regular shapes whose internal angle are different to 90 degrees, such as trapeziums, or regular curve forms such as circles or ovals.
- **Axiality:** Axiality defines the rotation of elements and a main axial direction. For the group of cases whose elements are defined as regular and orthogonal there are some of them with axiality following the main axis and others where the elements interact with turns (non-axial).
- **Straightness:** For non-orthogonal forms, there’s still one more characteristic to consider: The presence of curved elements. Straightness in the cases is related to the presence or absence of curve parts in the boundary configuration. Cases are subdivided into two categories: those whose boundary is composed by straight sections and those that include curved parts.

2.2. Interior conditions

For the interior conditions, not only the shape of the spaces is relevant, but also the program and the connections between them. In this study we have developed programmatic diagrams, distinguishing three different areas: areas for private use restricted to public access, such as office or storage (r); areas for public services, such as cafeteria, auditorium or library (p); and areas for exhibition spaces or galleries (e) (Fig. 3 and Fig. 4).

The plan is diagrammed according to the *layout* and the *sequence* (Table 3). The layout refers to a way of organization, independent of the size. Sequence is the connections between spaces, the order of spaces depending on the area use.

Comparing the layout, five different groups are defined (A to E). A

and B are differentiated for been isotropic spaces. Isotropy is uniformity in all orientations. By contrast, anisotropy cases (C, D and E) are those in which space properties are directionally dependent. Layout C has a central distribution. D and E have a hierarchical distribution for the areas depending on the use. In D cases the program distribution attends to the program separating exhibition spaces from public spaces. For E cases, the public space acts as a link between exhibition spaces.

Interior conditions in terms of shape and position are defined by the terms above. But there’s still one more parameter to consider: the connections between spaces expressed with arrows in Table 3. The cases are also classified attending to the circulation sequence from the main entrance to the exhibition space. We consider the sequence independent from the layout configuration. The layout attends to the main distribution of spaces, while the sequence is defined through the visitor movement from the entrance to the exhibition spaces. Among the analyzed cases, 87 cases have the entrance at the same floor as the exhibition spaces. In the 15 cases where the chosen plan does not coincide with the access floor, we consider the floor main access point (such as stairs, ramps or elevator) as the sequence start point. There are two sequence types as explain below:

Lineal sequence involves spatial connections where public and exhibition spaces are followed one by another (pe, pee, ppe, ppee, pepe). For example, in “ppee” pattern the access public space is followed lineally by another public space and two exhibition spaces. In some cases, exhibition spaces are connected by secondary spaces (pe.e).

Ramified sequence involves a clear hierarchy between public and exhibition spaces. The most common patterns are those such as comb (named as peC), herringbone (named as peI), and other branching formations (peV, peL, peS). Patterns named “peV” attend to a V shape ramification, “peL” to an L shape ramification, and “peS” is used to describe other branching formation without any specific shape.

2.3. Coding and examples

Every case has been identified with a code notation composed by two parts separated by a dash. For example, the analysis of Example 1 (Fig. 3) is defined as “100-DLpee”. The first part of the code represents the external boundary and the second part the interior layout and the sequence pattern.

A boolean notation is used as a compact way to code with two possible values: true (1) or false (0). The first digit of the code defines the regularity (regular forms=1; irregular forms=0). For the regular cases, the second digit defines the orthogonality (orthogonal forms=1; non-orthogonal forms=0). For orthogonal cases, the third digit defines the axiality (axial forms=1; non-axial forms=0). For non-orthogonal cases, the third digit defines the straightness (straight forms=1; non-straight forms=0).

For irregular cases, two digits form the code: The first digit (0) defines the irregularity, while the second digit indicates if it’s an irregular mixed case (1) or irregular pure case (0).

The second part of the code (after the dash) describes the layout type (A, B, C, D or E) and the sequence pattern. The sequence pattern is only specified for the layouts C, D and E. For C layout cases, C1 (centrifugal) or C2 (centripetal) is specified. For D and E layout cases the sequence is specified as linear (L) or ramified (R) in the first letter, continued by the

Table 5 Museums plans represented at several scales

Scale	No. case
1:2.000	69, 84, 99
1:5.000	1, 2, 3, 6, 9, 15, 16, 17, 18, 20, 21, 22, 25, 27, 29, 32, 33, 39, 40, 43, 46, 55, 57, 58, 61, 62, 63, 64, 67, 70, 73, 80, 81, 86, 87, 91, 92, 93, 96, 100, 101, 102
1:7.500	7, 8, 14, 30, 31, 36, 37, 38, 42, 44, 46, 47, 50, 51, 53, 56, 59, 71, 72, 77, 79, 82, 94, 95, 97, 98
1:10.000	4, 12, 13, 23, 26, 28, 34, 52, 54, 60, 65, 74, 76, 83, 90
1:15.000	5, 19, 24, 35, 41, 48, 49, 66, 68, 75, 78, 85, 88, 89
1:20.000	10, 11

sequence order letters.

For example, the analysis of Example 1 (Fig. 3) is defined by “100-DLpee” code. The first part of the code (100) defines the case in terms of external boundary; the second part describes a “D” layout and “Lpee” sequence pattern. Figure 4 shows an irregular case example with “00-A” code (irregular pure case with an A layout).

3. Arrangement

3.1. Compositional diagrams. Typologies based on external boundary

In order to understand the external boundary, cases are divided according to their specific qualities and similar arrangement in terms of formal composition. In Table 4, concepts are shown in the left column and the result of the classification in the right column, distinguishing the following six different types:

- *Rectangular-orthogonal* type (code 111) is defined by their regularity, orthogonality and axuality and it represents the simplest shape boundary condition. The rectangular shapes are combined to create the whole composition of the plan (46 cases out of 102). Sometimes (11 out of 46) just one shape is enough to conform the whole building plan.
- *Rectangular-rotated* type (code 110) whose composition in plan is also based in rectangular forms, but the axuality is lost (9 cases out of 102).
- *Regular-straight* type (code 101) is formed by regular but non-orthogonal cases formed with rectilinear boundary composition (11 cases out of 102).
- *Regular-curved* type (code 100) is formed by regular but non-orthogonal cases including curved boundary elements (25 cases out of 102).
- *Irregular-mixed* type (code 0M) present cases formed by irregular forms combined with regular parts (8 cases out of 102).
- *Irregular-pure* type (code 0P) is composed by cases with organic form

Table 6 Interior condition layouts - Museums plans represented at several scales (Table 5)

ISOTROPY	A	B	A										B									
			47	69	96	100	101	101	101	101	101	101	78	78	78	78	78	78	78	78	78	78
PHASED	D	LINEAL	C1										C2									
			76	84	85	59	61	81	86	86	86	86	59	61	81	86	86	86	86	86	86	86
			1	8	18	19	29	33	38	53	55	57	80	1	8	18	19	29	33	38	53	55
			2	4	9	15	23	42	71	72	73	91	98	2	4	9	15	23	42	71	72	73
			16	28	40	43	49	50	52	63	64	95	99	16	28	40	43	49	50	52	63	64
			17	30	56	79	87	58	67	102	58	67	102	17	30	56	79	87	58	67	102	58
			11	13	31	41	66	74	82	90	11	13	31	41	66	74	82	90	11	13	31	41
			22	24	32	54	60	62	65	75	93	97	22	24	32	54	60	62	65	75	93	97
			3	6	10	12	34	39	46	48	51	68	3	6	10	12	34	39	46	48	51	68
			7	14	26	36	37	77	88	7	14	26	36	37	77	88	7	14	26	36	37	77
			5	20	21	35	45	83	89	94	5	20	21	35	45	83	89	94	5	20	21	35
			27	44	25	70	92	27	44	25	70	92	27	44	25	70	92	27	44	25	70	92

Table 7 Boundary-interior connections - Museums plans represented at several scales (Table 5)

		BOUNDARY					
		Rectangular-orthogonal	Regular-curved	Regular-straight	Rectangular-rotated	Irregular-mixed	Irregular-pure
LAYOUT	A			XI 69 47	PATTERN 7		XVII 100 96, 101
	B		XV 78 PATTERN 8				PATTERN 6
	C	 59	XIII 61 76, 85	XVI 86 	XIV 81 PATTERN 5		
	D	I 1 2, 8, 11, 13, 19, 23, 28, 29, 41, 43, 58, 63, 66, 71, 72, 73, 74, 80, 82, 91, 95, 99	VIII 35 21, 22, 34, 37, 46, 51, 75	IX 97 27	VI 64 18, 53, 55, 79	X 90 30	
	E	II 3 5, 6, 10, 12, 14, 26, 32, 36, 39, 44, 48, 54, 60, 62, 65, 70, 77, 83, 88, 89	V 15 16, 33, 38, 40, 42, 49, 50, 52, 56, 57, 67, 98	III 4 9, 17, 31, 67, 102	IV 7 24, 84	VII 68 20, 25, 45, 92, 93	LEGEND: X - No. combination xx - No. example case - exhibition space xx, xy, ... - No. cases
		PATTERN 1	PATTERN 3	PATTERN 2	PATTERN 4		

along the entire boundary (3 cases out of 11).

3.2. Sequence diagrams. Typologies based on interior conditions

As for the internal organization of the museums, cases are divided according to their specific qualities and similar arrangement in terms of interior layout and sequence. Concepts are shown in the left column of the Table 6 distinguishing two main groups:

Isotropy group (6 cases out of 102) is formed by cases where the layout presents an isotropy space configuration. Two different layouts are considered in this group:

- Layout A (5 cases out of 102) is formed by unitary small spaces.
- Layout B (1 out of 102) is formed by multiple exhibition spaces connected in a non-hierarchical way.

Phased group (96 cases out of 102) includes cases related to phased architecture sequence with a hierarchical formation layout. Three types are included in this group (C, D, E). In D and E layout types, the classification in terms of sequence is specified within two subgroups: Lineal sequence and ramified sequence.

- Layout C (7 cases out of 102) is formed by central layout cases. In this type, the direction of the movement is described when talking about sequence. In this way, there are centrifugal cases where the exhibition space surrounds the public space (C1, 3 cases out of 7) and centripetal cases where the public space surrounds the exhibition space (C2, 4 cases out of 7).
- Layout D (49 cases out of 102) is formed by cases with hierarchical layout, where the use of the areas is divided clearly in exhibition space and public space.
- Layout E (40 cases out of 102) is formed by cases with hierarchical layout, where the exhibition space areas are divided in two or more areas and connected by public space areas.

3.3. Boundary-interior connections

Once cases have been analyzed and classified based on their external boundary and interior conditions, the resulting typologies are combined as

shown in Table 7. By creating a matrix, the classification for external boundary is related to the classification for interior layout. As a result, we obtain 17 combinations identified by a number from I to XVII (upper-left corner of each cell). Every combination is represented by an exemplary museum plan in order to provide an easier understanding.

As an overview, it can be shown that the combinations I and II are the most common. On the contrary, other combinations (IV, IX, X, XI, XII, XIII, XVII) have few cases (less than 3) or even just one simple case (XIV, XV, XVI). We can also identify combinations with quite numerous cases, such as V and VIII, that are not so common as the regular-orthogonal ones (combinations I and II), but still present D and E layouts, but with regular-curved external boundary.

4. Discussion

After the classification of the cases in the different combinations (table 7), we made a grouping of these combinations attending to their external boundary and interior layout. We call every group of combinations a “pattern”. Given the results mentioned above, we first aim to suggest similar characteristics among combinations, in order to discuss later a possible understanding of their evolution in time.

4.1. Patterns creation

From the typology viewpoint, every pattern shows specific design strategies. The patterns characteristics are the following:

Patterns 1, 2 and 3 are related to a classical understanding of architecture and characterized for having a regular boundary and hierarchical layout. Pattern 1 is formed by cases with a rectangular-orthogonal external boundary and D or E layout, like in the Nagano Prefectural Shinano Art Museum (no.3). For this pattern, museums plan external boundary is composed by just one rectangle or a combination of several rectangles with 90-degree angles relation between them, presenting a simple constructive configuration. Pattern 2 is formed by cases with regularity and straightness (regular-rotated and

regular-straight external boundary) and also presents D or E layout, like in the Kitakyushu Municipal Museum of Art (no.7). In pattern 2, the simplicity of the composition is based on straight lines external boundary, but including dynamism through the use of axialities and shapes rotation. Pattern 3 is formed by cases with a regular-curved external boundary and D or E layout, like in Shiseido Art House (no.15). The characteristic of this pattern is the inclusion of curved elements in the external boundary. It has a simple constructive approach, but with a contemporary dynamic appearance.

Pattern 4 also shows a hierarchical layout (D or E), but with irregular-mixed external boundary, like the Shimane Art Museum (no.68). For this pattern, cases present a contrast between organic and regular shapes in the external boundary.

Pattern 5 is formed by central layout cases, presenting several different external boundary type compositions (rectangular-orthogonal, regular-curved, regular-straight and rectangular-rotated), like for example the Kumano Kodo Nakahechi Museum (no.61). For this pattern, there is a project decision of creating directionality from and to the center of the proposal, an overall strategy to generate a centralized plan layout, but avoiding a strong symmetry. These cases have more dynamic boundary and an isotropical configuration, where the external boundary is less dominant.

Patterns 6, 7 and 8 have an isotropic layout, but with differences in their external boundary. Pattern 6 is formed by irregular-pure cases, presenting a non-hierarchical layout (type A) and composed by a single exhibition space as in the case of the Hiroshi Senju Museum of Karuizawa (no.100). Pattern 7 is formed by cases that also presents a non-hierarchical layout (type A) and composed by a unitary space, but with a regular-straight external boundary, as in the case of the Nemunoki Art Museum (no.69). Pattern 8 contains only one case (21st Century Museum of Contemporary Art, no.78), and it is a singular case formed by several exhibition spaces, presenting a regular-curved plan boundary and, at the same time, having a layout composition that suggest the release from hierarchical order.

4.2. Timeline

Finally, patterns are discussed in terms of time (Fig. 5). Cases are plotted along their pattern number timeline according to the year when they were built. A progression in the timeline can be noted, giving some clues about concepts evolution. As an overview, the results suggest a tendency for the use of irregular forms in the boundary conditions, allowing museums design became more dynamic.

The result shows that regular-orthogonal boundary type with static phased layout type (Pattern 1) prevails over time. This pattern includes early cases (e.g. Ishikawa Prefectural Museum of Art, 1959) and also recent ones

(e.g. Akita Museum of Art, 2012).

Around the 1970s we noticed the emergence of cases involving changes at the external boundary (Patterns 2 to 8). In Pattern 2 the axiality of the plan is lost (e.g. Akino Fuku Museum, 1998), and in Pattern 3 there is an incorporation of the use of curve elements in the plan form (e.g. Yokohama Museum of Art, 1989).

From the 1980s, Pattern 4 appears involving more dynamic plan configurations through the use of irregular forms in the external boundary (e.g. National Art Center of Tokyo, 2007). There are also some regular boundary type museums that have been built in the last two decades showing a significant change with regard to the layout, having more dynamic layout compositions (Patterns 6 and 8).

In the 1990s, Pattern 5 comes out with a central layout and diverse external boundary forms. For example, Kanno Museum (2005) has a centrifugal central layout and rectangular-orthogonal external boundary. Another example of this pattern but with centripetal central layout and regular-curved external layout is the Kumano Kodo Nakahechi Museum (1997).

In the case of Pattern 6, museums as the Hiroshi Senju Museum of Karuizawa (2011) have appeared as irregular pure forms with an isotropic layout. The timeline shows how this irregular shape is the latest pattern for this research, and we can identify a tendency to irregular external boundaries and the use of isotropic interior layouts.

For Pattern 7 the isotropy of the interior layout is created by the unity of the space, as in the Nemunoki Art Museum (1999), and the regularity of the external boundary appears earlier than other isotropic patterns (6 and 8).

In the case of the Pattern 8 represented by the 21st Century Museum of Contemporary Art (2004), the building has a regular-curved external boundary, but the multiplicity of spaces within a non-hierarchical plan layout makes it different to other museums built in the same period, as for example the Kagawa Prefectural Higashiyama (2004).

When we compare these patterns, we can find some relations and contrast between them. The comparison between Patterns 1 to 4 indicates that, within the same static and phased layout (D or E), an evolution through time from regular to irregular shapes can be noted. Whereas the characteristics of rectangular-orthogonal boundary found in Pattern 1 continues over time, cases with irregular boundary are appearing during the last years of the timeline. This means that some cases, even if they follow the tendency on external boundary for including irregular forms, the layout configuration remains static according to the previous years patterns. For example, case 20 (The Museum of Modern Art of Saitama, 1983) presents an irregular-mixed external boundary and E layout. By contrast, some of the regular boundary type museums that had been built in the last two decades (Patterns 5, 6 and 7) show a significant change with regard to the layout and have more dynamic interior conditions (A, B and C layout types). For example, case 84 (Kanno Museum, 2005) has a regular-orthogonal external boundary and a C1 layout.

For the cases built in the last years (Patterns 6, 7 and 8), there is not still enough information due to the lack of cases. We do not know if the configurations of these museums will continue in future projects, but we can notice the intention of several architects to innovate in the creation of new architectural expressions by introducing new plan configurations.

Fig.5 Timeline groups distribution

5. Conclusions

This study takes 102 post-war Japanese art museums as a sample to analyze some of the characteristics of contemporary Japanese architecture and its evolution. After the Second World War, the Japanese socio-economical context allowed architects to develop new ways of expressing ideas, sometimes through the use of new forms in the external boundary, sometimes through the design of more dynamic interior conditions. We chose these two aspects (*external boundary* and *interior conditions*) as the base for our analysis. The goal is to clarify the formative ideas and the architect's intentions by building a taxonomy and an evolution analysis of post-war Japanese art museums based on the plan as a *parti* diagram.

For the external boundary, we defined four different concepts: *Regularity*, *orthogonality*, *axiality*, and *straightness*. From these concepts we obtained six types: *Rectangular-orthogonal*, *rectangular-rotated*, *regular-straight*, *regular-curved*, *irregular-mixed*, *irregular-pure*. For the interior conditions we defined two concepts: *Layout* (isotropy and phased) and *sequence* (lineal and ramified). From these concepts we obtained five layouts: A, B, C, D, E.

Finally, by crossing these two sets of concepts in a matrix and finding their relations we suggest eight *patterns*. Patterns 1, 2 and 3 are characterized for having a regular boundary and hierarchical layout. Pattern 4 also shows a hierarchical layout, but with irregular-mixed external boundary. Pattern 5 has a central layout with diverse external boundaries. Patterns 6, 7 and 8 share an isotropic layout. Pattern 6 contains a unitary exhibition space with irregular-pure external boundaries. Pattern 7 contains a unitary exhibition space with regular-straight external boundaries. Pattern 8 (the 21st Century Museum of Contemporary Art) is formed by several exhibition spaces with regular-curved external boundary.

When we consider these patterns through their evolution in time we can identify some tendencies. Regular-orthogonal boundary with static phased layout (Pattern 1) prevails over time. In Patterns 2, 3 and 4 the changes in the external boundary appear gradually through time. There are also some regular boundary museums built in the last two decades (in Patterns 5, 6 and 7) that show central or isotropic layouts, which differ from early patterns. The timeline analysis suggests a tendency towards irregular external boundaries and the intention of finding non-hierarchical plan layouts. This tendency might be interpreted as the architects' response to new ways of enjoying art – with more free and dynamic circulations – and also with the new role of museums as urban icons in Japanese cities.

The aim of this paper was to obtain an overall view of multiple cases using abstract concepts that allowed comparison and analysis. In further studies we also want to study specific cases within each pattern, and the circumstances surrounding the conception and design of the most representative cases.

Acknowledgment

I would like to give special acknowledgements to Ayaka Sakai, Koutaro Sato and Ryo Kawai, for their contribution to this study.

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和文要約

本研究では日本の現代建築の特性と歴史的な変遷の一端を分析するために、102の日本の戦後の美術館建築をサンプルとして抽出した。第二次世界大戦後、日本の社会経済状況により建築家たちは新しい形の外部境界やダイナミックな内部条件の設計を通して、新しい表現方法を発展させられるようになった。ここでは、外部境界と内部構成の2つの軸に着目し、分析を行った。平面構成に基づいた「パルティ」ダイアグラムを用いた戦後日本の美術館について類型を行い、時代ごとの変遷を分析することで、建築家の設計意図や美術館の造形に対する考えを明らかにすることを目的とする。

外部境界として regularity(規則性)、orthogonality(直行性)、axiality(軸性)、straightness(直線性)の4つの概念を抽出し、ここから rectangular-orthogonal(長方形・直行性)、rectangular-rotated(長方形・回転性)、regular-straight(規則性・直線性)、regular-curved(規則性・曲線性)、irregular-mixed(不規則・混合性)、irregular-pure(不規則・単体性)の6タイプに分類した。内部構成では layout(配置)—— isotropy(等方性)と phased(段階性)——と sequence(シークエンス)—— lineal(直線性)と ramified(分岐性)——に着目し、A～Eの5つのタイプに分類した。これらを2軸としてマトリクスにまとめ、その関係を考察することで8パターンに分類した。パターン1、2及び3は規則的な境界とヒエラルキーのある配置が特徴である。パターン4もヒエラルキーのある配置であったが、不規則で混合した外部境界が見られた。パターン5では求心性のある配置で多様な外部境界を持っている。パターン6、7、そして8は等方性の配置であり、パターン6は、不規則で単体の外部境界を持つ単一の展示空間が見られた。パターン7は、規則的で直線の外部境界を持つ単一の展示空間が見られた。パターン8(21世紀美術館)は規則的な曲線の外部境界を持ち、複数の展示空間で構成されていた。

これらのパターンを時代の変遷を通して考察すると、いくつかの傾向が見られた。段階的な配置で規則的で直交の境界をもつパターン1は、どの時代でも建てられている。パターン2、3そして4では外部境界が時代とともに徐々に変化している。パターン5、6、そして7のように、最近20年間に建てられた規則的な境界を持つ美術館は、戦後直後に建てられたものと違い、求心性、等方性の配置が見られた。これらの時代ごとの分析は、不規則な外部境界への傾向とヒエラルキーのない平面構成への意図を提言している。この傾向は、より自由で、ダイナミックな動線を持つという、美術を楽しむ新しい方法への建築家の答えであると同時に、日本における都市のアイコンとしての美術館の新しい役割となっていると考えられる。

本論文では、複数事例の比較分析を可能とする抽象的な概念を用いた全体像を得ることを目的とした。さらに今後の展望として、各パターンや最も代表的な事例の起源やデザインを含んだ状況についてより詳細な分析に発展させることができるだろう。

(2016年4月10日原稿受理、2017年2月10日採用決定)