CONCEPT AND PHYSICAL CHARACTERISTICS OF CAPSULE ARCHITECTURE

カプセル建築における設計主題と実体的特徴

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This paper highlights the typology of capsule architecture by studying its concept and basic characteristics of capsules. This is done by sorting out and analyzing examples of capsule architecture through the prototype stage in the early 20th century, full development in the 1960s, and reappearance in modern days. The study introduces three categories of so-called mental capsules, mobile capsules, and growing capsules. Research also analyzes shapes, functions, materials, size, number of capsules, and methods of their arrangement. The paper in overall highlights the potential and usefulness of capsular designs over conventional architecture.

Keywords : *Capsule architecture, Residential units, Modular architecture, Metabolism, Archigram, Megastructures*

カプセル建築, 住宅ユニット, モジュラー建築, メタボリズム, アーキグラム, メガストラクチャ

1. Introduction

1.1 Revisiting the notion of capsule architecture

Stimulus for this research was an investigation following the case of Nakagin Capsule Tower (Fig.1). This building is a representative of Metabolism architectural movement from Japan in 1960-1970s and, so-called, capsule architecture – the architectural typology of buildings consisting of repeating spatial blocks, that is, capsules¹⁾. The tower was envisioned as constantly changing entity which shape and lifespan may be prolonged due to manipulation of capsules. Yet, such manipulation has never occurred. Senk points out an outdated role of a capsule in relation to megastructures^{*1)} being envisioned as future endless cities^{*2)}. Lin and Hosoya also mention a continuous urban metabolism and fluctuations in land prices what makes a long-time planning of capsular buildings unfeasible^{2), 3)}, whilst Sugai and Yokota refer to the intention of Kurokawa to realize a working prototype of Metabolism in the building what led to actual limitation of possible renovation approaches⁴⁾.

Deviation of capsule architecture from ordinary buildings originates from modernist architectural practices. Metabolism as the last of movements with their own manifestos⁵⁾, was similarly influenced by drastic changes in the 20th century and common cultural change to the new type of society, probably, the one radical enough to accept capsules as a part of the celebration of the brave new world. Nakagin Capsule Tower was similarly provided for, how Kurokawa himself puts it, ‘homo-movens’⁶⁾ but nowadays the capsules became both investment and bill to vote for the building’s fate⁷⁾. Such social turnover becomes native to modern architectural paradigms and is often combined with the notion of ‘sustainability’. Or, how Schalk states, revisiting Metabolism have a key to understand the modern inquiry of sustainability usually presented ahistorically⁸⁾. Russel also highlights the dilemma of Metabolists seeking to shift from mechanical model⁹⁾ to the buildings evolving as a living organism¹⁰⁾ while Olivera mentions the ‘collective willpower of the 60s’¹¹⁾ what can resonance today in order to foster a harmonic relationship between a man and environment¹²⁾. Senk also mentions capsule typology as architecture of resistance against conformity ‘between institutions and living environments’, as well as freedom from the fear of imagining

Fig. 1 Nakagin Capsule Tower,
Kisho Kurokawa, 1972

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alternative possibilities in architecture for better future. Thus, some new kinds of capsules are being created again as if updated versions of their predecessors from the 60s as acceptance of change and importance of the role of technology in construction of cities¹³⁾. One of such modern formations is a shipping container^{*3)}, while capsule hotels in a recent decade has become popular outside Japan and brought in a new trend of capsular interior spaces. These new capsules tend to be more self-sustaining, and sometimes, stereotypically, bear solar panels on their roofs and enhance a meaning of urban nomadism.

1.2 Aim of research

Architectural movements from the 1960s as Metabolism or Archigram viewed a capsule as a powerful architectural tool to redefine home and to put new principles of functionalism into practice. However, nowadays the designs utilizing capsules and modular elements appear frequently again. Moreover, the interpretation of a capsule has expanded and nowadays it is highly influenced by trends of green technology and sustainability. Thus, the research, aims to create a comprehensive view onto the typology of capsule architecture and put its various examples on a timescale. By doing this, the research seeks to reinforce a connection between original capsules from 1960s and modern designs to trace the transition of their capacities. The research analyses both capsular buildings and single capsules and treats both as an independent object inside a bigger urban realm (Fig. 5).

1.3 Explanation of gathered data

Data for the research is not restricted by time or place and represents a set of cases of capsule architecture and related cases falling under the designation of a capsule based by Senk's description (see Chapter 2). Moreover, separate cases of capsule hotels and container architecture are also included. The gathered cases also include unrealized projects. That is done due to a significant number of unbuilt projects, which bear notable ideas about possibilities of using capsules. Aiming to create a broad view onto capsule architecture, this research includes 265 cases in total with 115 unbuilt and 150 built examples. The sources for data contains explanation of basic properties of a given example as physical characteristics, function, relation to a core structure, the basic idea applied to a building's design and usage of capsules. The primary sources for data searching include papers of previous studies (as Senk, Hidaka, Ishida), books (as Koolhaas, Dehindem, Kurokawa), periodicals (as Shinkenchiku, SD, A+U), Internet journals (as Archdaily, Architectural Review, Dezeen, Weburbanist, Wikiarquitectura), Internet portals (as Astudejaoublie, Bubblemania.fr, FRAC Centre-Val De Loire, Hidden Architecture, Spatial Agency, The Archigram Archival Project, The Buckminster Fuller Institute). The case study example is shown in Fig. 2.

No.	87
Name	Nakagin Capsule Tower
Year	1972
Architect/Bureau	Kisho Kurokawa
Country/Region	Japan/Asia
Status	Concept / Built / Being renovated
Way of arrangement	Method ③, Plug-in
No. of capsules	140
Shape	Rectangular
Function	Multipurpose
Materials	Steel/Metal frame
Capsule size fit inside	4 m³ cube

Building's descriptions:

"The tower comprises 140 capsules <...> theoretically replaceable at any time." ("Growing capsules")
"<...> the capsule as a monofunctional unit was a generally accepted solution, used in many projects, where a lot of identical units had to be provided" – ("Mobile capsules")

Senk P.: Capsules. Typology of other architecture, Routledge, 81, 85, 2017

"Rather, his ideal capsule operates as a kind of filter to keep un-wanted information out, while accelerating the influx of information desired." – ("Mental capsules")

Leslie T.: Just What Is It That Makes Capsule Homes So Different, So Appealing?
Domesticity and the Technological Sublime, 1945 to 1975, Space and Culture 2006, 9, 183

Fig. 2 Case study example

1.4 Methodology of research

The analysis applied in this research consists of collecting the data and its classification. First, the selected examples are put onto the timeline in order to observe the distribution of the cases. This research also thoroughly explains application of the concept of a capsule and solidifies a vague figure of capsule architecture among other existing architectural typologies. This is done by grouping the common notions provided by architects in their interviews or texts of how they primarily use the capsules for. Similar ideas and approaches are grouped further in order to extract common trends. Again, the data is sorted and organized by the year of design (or construction), their affiliation to either built or unbuilt category, characteristics of capsules used in a given structure and type of relationship between capsules and a structure. This, in general, will facilitate the deeper understanding of common applications of capsules and their primary parameters. The whole data is summarized in Appendix 1.

2. Concept of capsule architecture

2.1 Historical development of capsule architecture

All studied modern and historical examples of capsule architecture are put over the timeline and divided into built and unbuilt categories

(Fig. 3). The main feature here is two spikes corresponding to original developments of capsule architecture from the 1960s to 1970s and the resumed interest in capsule dwellings from 2000s.

Capsules are referred to 1960s' New Brutalism architectural style, which quickly lost its potential due to over-utopian nature¹⁴⁾. Moreover, the use of plastic as a building and finishing material having its breakthrough in 1956 was eventually shocked by Oil Crisis in 1973, giving simultaneously a formal end to capsules often made from different plastics for the next 30 years. In the period of 1980-1990 examples of modular architecture as well as the architecture which were afresh implying functionalism were rare. The beginning of the 2000s was already the time of grown environmentalist movement. Majority of cities in the developed world updated their waste and pollution regulations fusing the notion of future cities as sustainable environments with greener technology. A new practice of using shipping containers grew into large scale urban projects. Awareness of energy consumption affected both architects and citizens, and facilitated trend of sterile minimal lifestyle and movement from cities towards nature to small, prefabricated tiny houses for refreshment. Capsules of, what may be called 'a second generation' can have solar panels or compost as well as a chemical toilet to gain independence from urban systems and claim themselves as sustainable houses of the future.

2.2 Concept of a capsule and its application

Warren Chalk used the term 'capsule' in the project by Archigram called "Capsule Homes", 1964¹⁵⁾ and later Kurokawa fixed such name in his Capsule Declaration in 1969¹⁶⁾. Before, notions of 'living unit', or 'cell', or 'pod', etc., were also widely used. Senk describes an original capsule as an object which should fall into the following characteristics¹⁷⁾: 1) relative impermeability of the envelope, 2) physical or simulated comfort of the introverted interior enabled by connection to the network, 3) structural, functional and visual integrity, 4) temporal conditionality or interchangeability, 5) smallness enabling movability or mobility. Container architecture or capsule hotels are discussed by Senk as derivations of the original concept¹⁸⁾ which originates from functionalist and experimental approach by several modernist groups. These practices aimed a reestablishment of a house and possibilities of environmental technology and creation of controlled environments 'fit' for living¹⁹⁾. Buckminster Fuller and his 'standard-of-living package' was one of the key examples of Banham's 'un-house' in the pursuit to find the 'other architecture'²⁰⁾ in contrast to the general trajectory of modernism. Similarly, the capsule homes by Archigram in the Plug-in city tried to reinvent the environment by "a series of very sophisticated and highly designed elements locked together... by large-scale industrial design approach"²¹⁾. The original concept of a capsule is weaved into the search for 'other architecture' and later becomes more topical and independent. This concept transits to postmodernism and becomes mixed with notions of microdwellings and modular architecture.

Capsules show a range of properties that vary depending on the author, however, in general, can be summarized into the following major categories. Capsules are often compared to vehicles, which parts may be interchangeable, if only a part is broken²²⁾. Car itself is called by De Cauter as a mobile residence and extension of the house²³⁾. Electric Tesla cars popular nowadays combine sustainability with interchangeability in their models blurring the definition of a car to, rather, 'self-driving functional places'. Another interpretation of a capsule is based on perceptions and acquisition of new experiences via the activity of an individual. Häusermann uses capsules as tools for people to express themselves as co-creators of the urban environment²⁴⁾. Its modern analog - 'Shelter with Dignity' by Framlab is a social platform aiming to provide besides the shelter itself the dignity for people in need after they receive a residence as ordinary citizens²⁵⁾. Capsule architecture also serves as countermeasures to disasters or as social housing. The MDU (2003) by Lot-Ek is a modified shipping container similar to the expandable 'Tetrodon' unit from 1972 by AUA. The MDUs are supposed to be easily transported by sea as ordinary containers to other ports where they can be plugged in again to special shelves bearing dozens of the same units²⁶⁾. These examples play their role in the city metabolism by adjusting themselves to the current urban agenda. Therefore, the application of capsules may be divided into three following categories (Fig. 4).

Fig. 3 Appearance of cases of capsule architecture

Fig. 4 Application of capsules

Capsules utilizing mobility as their prior advantage; the capsules which are aimed to surpass the layer of either building codes of a country or any other paperwork connected to construction permits; and the capsules being financially affordable due to their lightweight and simplicity to assemble or dismount may be categorized into the 1st category – **mobile capsules**. The capsules which serve purposes as a shelter for mind, temporary loneliness or rest; the capsules which due to their closed nature create a different environment in order to isolate an individual from incoming information; and the capsules meant to symbolize innovation, joy of experimentation or provision of new impressions and experience are categorized into the 2nd category – **mental capsules**. The capsules being viewed as a part of a capsule cluster what is able to change its shape, function division, organization and relationship between capsules in response to changing conditions; the capsules customized to be able to pile up onto each other as well as to a supportive core in order to create growing structures; the capsules allowing modification of themselves by fusion with each other; the capsules allowing clipping additional smaller premises to their own body; the capsules meant to be recyclable; and the capsules combined together and representing an independent urban object inside another medium are categorized into the 3rd category – **growing capsules**.

The division above is a separation of capsule's various applications which may be all-encompassing. Some capsules can be claimed by an architect as both a spiritual and mobile, or it can fall into all three categories. The iconic example of Nakagin Capsule Tower shows the capsules able to be movable, be replaced by capsules' exchange over time and provide the new lifestyle (urban nomadism). As it seen in the Fig. 4 there is an equal number of built and unbuilt cases except the category of mental capsules where built examples exceed twice in number. It can be said that this aspect of capsule architecture recently becomes topical. Also, all three application methods are equally often used by architects. Despite the fact that megastructures are out of the focus in modern architecture trends, some utopian projects continue a futuristic agenda. Moreover, the appearance of container architecture showed more flexibility how to decompose and recycle buildings with several successful projects (as Keetwonen or Spacebox capsules TU Delft).

3. Basic characteristics of capsule architecture

3.1 Capsules and capsule clusters

All capsules, in principle, prone to congregate in some structures what enhance their capacities. Thus, characteristics of capsule architecture may be divided into two groups: basic capsule characteristics as **shape, function, material, and size**, and the second group describing capsule clusters (i.e. capsular buildings) with **number of capsules** inside a single structure as well as a **type of their arrangement** (Fig.5). The basic physical characteristics of capsules and the structures which they create as well as their development in both built and unbuilt categories are summarized in Fig 6-11.

Fig. 5 Specification of characteristics of separate capsules and capsule architecture (Clusters in the Air, Arata Isozaki, 1962)

3.2 Characteristics of capsules

Capsules can be of different shapes unrestricted by own typology. However, capsules usually have to rely on connections to the neighboring capsules or supporting structures, which require a solid edge representing a wall or connection of a size of, approximately, a door between capsules. Fig. 6 represents a number and percentage of each shape in the total number of studied cases. The common shapes are: Rectangular (48,5%), Custom shape (24,2%), Cube (6,1%), Polygonal (4,5%), Tube (4,2%), Sphere (3,8%), Egg-shaped (3,8%), Vehicle (1,5%), and lastly Domes, Honeycombs, Cylinders and Hexagons as rarely occurring cases (3,4% all together).

Despite the fact that capsules are usually monofunctional, the clusters which they create may be polyfunctional architecture as a whole. Capsule architecture is not limited to house provision and may allow using capsules for a different purpose and to be able to adjust and change functional content by rearranging capsules' roles or their contents. Fig. 7 represents the percentage of each function from the total number of studied cases. The percentages of each functions in both built and unbuilt categories are: Residential (46,5%), Hotel room (15,2%), Attraction (9,9%), Multipurpose (9,6%), Commercial space (5,7%), Utilities (4,6%), Office (3,9%), and the capsules aimed to create Extensions of a house, Auditoriums or study rooms, Urban vertical farms and Sport facilities are the rarest examples (4,7% in total). If compared to conventional buildings capsules' structures are often a monocoque structure or a similar bearing frame, to which various infill is applied. Capsules can consist of several components combined together to create an envelope. This section concentrates on primary materials from which the capsules are made from. It includes both materials for bearing structure and shells. It is not rare when a capsule's structure and walls are made from a single material. Fig. 8 represents the percentage of studied cases where each described material is shown. The distribution shows a gradual decrease in material use from 'plastics' to 'unspecified'. The category named 'unspecified' indicates the lack of information regarding materials in the given design that is omitted by an architect. So happens if a

selected project is a concept, sketch or study which contains useful information about other properties of capsules, but lacks in clarifying materials' as a secondary characteristic⁴⁾. In the built category the 'unspecified' section is obviously zero. The percentage of each given material are: Plastics (32,8%), Metal/Steel (17,6%), Containers (17,2%), Reinforced concrete shells (RC) (12,9%), Wood (10,5%), Unspecified (4,7%), together with Concrete pipes, Glass (capsules mostly made from glass or designed to highlight glass material as a feature) as well as Other objects (besides shipping containers) (4,4% in total).

Capsules appear in a variety of sizes. There are even capsules which fit inside a square of 2-meters side, while some capsules can include even several floors within its structure, and their longer side may exceed 10 meters⁵⁾. Shapes of capsules vary drastically, especially those of a custom design. Therefore, it is confusing to correlate their actual size to only three spatial parameters. What can be alternatively done is **to adjust a capsule's size to a cube** with the defined dimensions in order to see if a capsule fits inside. This allows comprehensively evaluating an actual volume of a capsule as a set of various dimensions due to a capsule's shape. The Fig. 9 shows different capsules' sizes as follows: 2 m³ (14,7%), 3 m³ (22,6%), 4 m³ (16,6%), 5 m³ (11,3%), 7 m³ (29,1%), 10 m³ (4,2%), 20 m³ (1,5%).

3.3 Characteristics of capsule clusters

Capsule architecture is unique, and composition of capsules is not limited and may change over time. Nonetheless, the fact of natural 'shapelessness' of capsule architecture rises the question how to relate to capsules' count per single structure. In this research it is decided to count the current number of capsules in the built and unbuilt examples if the shape is conditionally and temporary determined by an architect (in the case of Nakagin Capsule Tower it is 140 capsules, despite the fact that in concept the building may grow to thousands of units)⁶⁾. Moreover, in the cases when a capsule is presented as a prototype and, in principle, the potential scale of expansion is undefined the capsule refers to the number '1+(no limit)'. Another note which should be clarified is the category named '1'. This corresponds to some examples where a capsule is not meant to be mass-produced, but is chosen due to other characteristics, as simulated comfort, smallness, mobility, etc. Fig. 10 shows a number of capsules per single structure as follows: 1+(no limit) (31,5%), 1 (8%), 2-10 (16%), 11-20 (11,3%), 21-50 (13,9%), 51-100 (6,3%), 101-200 (3,8%), 201-500 (3,8%), 501-1000 (1,3%), 1001 and more(4,2%).

Fig. 6 Common shapes of capsules

Fig. 7 Common functions of capsules

Fig. 8 Common materials of capsules

Fig. 9 Common capsules' sizes

Fig. 10 Number of capsules inside a single structure

Fig. 11 Methods of capsules' arrangements

Capsules usually form complex structures with different kinds of relationship but they can be summarized in four basic ways²⁷⁾ of arrangements. Two of them do not require supporting structure and two latter ways free capsules from structural loads. The Fig. 11 shows each method of arrangement as follows: Method 1 (distribution) (35,6%), Method 2 (stackability) (28,7%) , Method 3 (plug-in) (27,6%), Method 4 (insert) (8%).

4. Relationship between concept of capsule architecture and its application

Initially capsules were closely related to postwar projects of megastructures serving as a tabula rasa for a community to form their own environments and individual living spaces – capsules²⁷⁾. In the West it also coincided with the trends of consumerism, progressiveness and pursuit for the new spirit of time²⁸⁾ while Japanese Metabolists, mostly focused on notions of the 'recreation' of the 'age of high metabolism'²⁹⁾. Despite being treated as inherent for modernist movement the capsules may have evolved into what can be called 'the second generation'. These capsules find their implementation in the examples of pop-up architectures, urban shelters, or entire green cities continuing the development of synthetic urbanism³⁰⁾. Their role can be summarized in three major design topics – 'mobile', 'mental' and 'movable' capsules. The data shows even distribution of such approaches numerically and in both generations, what may indicate a common reoccurring interest towards the capsule's concept in general.

It reflects on capsule's objective characteristics, particularly shapes, sizes, and materials. While there is a stable trend of abandoning the plastic visage of a capsule, the strict rectangular shape continue combining in itself its ergonomic features in order to be mass-produced, moved in or out, and pile up in a cluster. Size of capsules varies - it both contributes to development towards the high-density living environment which is still topical in developing countries³¹⁾, however there is a trend of small reduction of spatial capsules' sizes in the modern examples. Despite the obvious dominance of residential function in the conducted analysis, the hotel rooms and multipurpose capsules are also applicable to the same category (Fig. 7). Moreover, recent developments of container architecture and working business model of capsule hotels provide residence in extreme environments or cheap short stay combined with low-cost travelling.

Summarized by Leslie as a 'technological nihilism'³²⁾ the capsular structures can in principle grow indefinitely. Yet, the majority of capsular homes' designs in the 1960-1970s were left on paper. This experimentation continues in modern times, and some new startups present their vision onto small movable houses with the possibility to grow into bigger structures (Coodo, Loftcube, Kasita). Such developments, similarly to their predecessors, mostly position themselves as progressive hi-tech living environments. The modern capsular structures mostly do not implement any additional bearing elements or use the existing urban environment as a medium to be plugged-into or clipped-on. Despite the iconic example of Nakagin Capsule Tower where capsules are attached to the so-called 'vertical ground', the new image of capsular structures may be summarized in Container City (2001) consisting of shipping containers which could eventually gain the desired scale of mass-production multiplied with reusability, adaptability, and sustainability in order to be regarded as a modern capsule's archetype.

5. Conclusion

In overall capsules may be divided into two generation corresponding to increased number of capsular designs in the 1960s and also recently. The dashing development of technology and industry together with trends of sustainability and flexibility entrusted to the modern cities would influence the future urban environment as never before even considering the inertia of construction methodology evolving slowly. Yet, completely capsular cities will, probably, remain mostly inside the conceptual realm. Opposite to the drastic change of

urban matter proposed by many architects in the 20th century, nowadays the cities are thought to gradually tune themselves into more eco-friendly, resilient entities while the capsules will serve their new duty inside the current trend of sustainability by the provision of nomadic closed spaces, moveable spaces, pop-up architecture, housing for the unprotected social stratum, and temporary dwellings. The understanding of properties of such architecture will allow creating the buildings of higher quality. And another important question that capsule architecture raises is the temporality of buildings which have their defined lifespan. Therefore, architects may give consideration about the life and eventual physical death (demolition) of their architecture, or, on the opposite, its renovation into something what fits current time and purpose. In a sense, this is also sustainable architecture.

Reference

- 1) Lin Z.: Nakagin Capsule Tower and the Metabolist Movement. Revisited. 98th ACSA Annual Meeting Proceedings, Rebuilding, pp.514-518, 2010
- 2) Lin Z.: Nakagin Capsule Tower and the Metabolist Movement. Revisited. 98th ACSA Annual Meeting Proceedings, Rebuilding, pp.515, 518, 2010
- 3) Hosoya H. and Schaefer M.: Tokyo Metabolism, Project On The City 2, Taschen, 749, 2001
- 4) Sugai T., Yokote Yo.: Study on the Sustainability of Nakagin Capsule Tower Building in Kisho Kurokawa's Metabolism thought, Summaries of Technical Papers of Annual Meeting, Architectural Institute of Japan, History and Theory of Architecture, pp. 757-758, 2014. 7 (in Japanese)
菅井 隆史, 横手 義洋:黒川紀章のメタボリズム思想と中銀カプセルタワービルの現状, 日本建築学会大会学術講演梗概集, 建築歴史・意匠, pp. 757-758, 2014. 7
- 5) Koolhaas et al.: Project Japan, Metabolism Talks, Taschen, 19, 2011
- 6) Kurokawa K.: Oh! The Code of the Cyborg, SD-Space Design 03/1969, 50 (in Japanese)
- 7) Hidaka J.: Nakagin Capsule Tower, UIA 2011 Tokyo Design 2050, pp.16-17, 2011 (in Japanese)
- 8) Schalk M.: The Architecture of Metabolism. Inventing a Culture of Resilience, Arts 3, 279, 2014
- 9) Russell S.: Metabolism Revisited: Prefabrication and Modularity in 21st Century Urbanism, Without a Hitch - New Directions in Prefabricated Architecture, 253, 2008
- 10) Russell S.: Metabolism Revisited: Prefabrication and Modularity in 21st Century Urbanism, Without a Hitch - New Directions in Prefabricated Architecture, 247, 2008
- 11) Lemes de Olivera F. Of Metabolism: future cities for our contemporary world, NSCO 14, 77, 2011
- 12) Pernice R.: Metabolism Reconsidered. Its Role in the Architectural Context of the World; Journal of Asian Architecture and Building Engineering, 357, November 2004
- 13) Senk P.: Capsules. Typology of other architecture, Routledge, 182, 2017
- 14) Senk P.: Capsules. Typology of other architecture, Routledge, pp.28-39, 2017
- 15) The Archigram Archival Project: Capsule Homes project, project No: 62, <http://archigram.westminster.ac.uk/project.php?id=58> (accessed 2020.12.24)
- 16) Kurokawa K.: Metabolism in Architecture, Capsule declaration, Westview Press, pp.75-85, 1977
- 17) Senk P.: Capsules. Typology of other architecture, Routledge, 5, 2017
- 18) Senk P.: The Concept of Capsule Architecture as Experiment, Prostor, 352, 2.46, 2013.21
- 19) Langevin J.: Reyner Banham: In Search of an Imageable, Invisible Architecture, Architectural Theory Review 16(1):2-2, 8, 2011
- 20) Langevin J.: Reyner Banham: In Search of an Imageable, Invisible Architecture, Architectural Theory Review 16(1):2-2, 7, 2011
- 21) The Archigram Archival Project: Capsule Homes project, project No: 62, <http://archigram.westminster.ac.uk/project.php?id=58>, (accessed 2020.12.24)
- 22) The Archigram Archival Project: Capsule Homes project, project No: 62, <http://archigram.westminster.ac.uk/project.php?id=58>, (accessed 2020.12.24)
- 23) De Cauter L. and Patteeuw V.: The Capsular Civilization: On the City in the Age of Fear, NAI Publishers, pp.78-79, 2004
- 24) Frac Centre-Val de Loire, Pascal Häusermann, <http://frac-centre.fr/collection-art-architecture/rub/rubauteurs-58.html?authID=87> (accessed 2020.12.24)
- 25) Framlab, Shelter with Dignity, <https://framlab.com/homed> (accessed 2020.12.24)
- 26) Lot-Ek, Mobile Dwelling Unit, <https://lot-ek.com/MDU-Mobile-Dwelling-Unit> (accessed 2020.12.24)
- 27) Senk P.: The Plug-in Concept: Technology and Aesthetics of Change, Architecture, Research, 44, 2013/1
- 28) Senk P.: The Concept of Capsule Architecture as Experiment, Prostor, 352, 2.46, 2013.21
- 29) Schalk M.: The Architecture of Metabolism. Inventing a Culture of Resilience, Arts 3, 283, 2014
- 30) Senk P.: The Plug-in Concept: Technology and Aesthetics of Change, Architecture, Research, 48, 2013/1
- 31) Lin Z.: Nakagin Capsule Tower and the Metabolist Movement. Revisited. 98th ACSA Annual Meeting Proceedings, Rebuilding, 520, 2010
- 32) Leslie T.: Just What Is It That Makes Capsule Homes So Different, So Appealing? Space and Culture 2006, 9, 180, 2006

Notes

- *1) The term 'megastructures' is usually fixed to Metabolists, although there are different names as 'superstructures' or 'macrostructures' representing an enormous three-dimensional urban infrastructure with no architecture but a combination of functional spaces, living units, roads, etc. Dahinden J.: Urban Structures for the Future, Praeger Publishers, pp.14-18, 1972
- *2) "The concept of the capsule, explicitly naming compact, minimal, completely furnished and equipped living units, has generally been presented in architectural history in relation to the trend of megastructures and utopian radical architectural experiments with uncritical faith in technological and scientific progress of the 1960s", Senk P.: The Concept of Capsule Architecture as Experiment. Origins and Manifestations with Selected Examples from Slovenia and Croatia, Prostor, 352, 2.46, 2013.21
- *3) Datinhen would usually call a 'container' the entire urban structure with rigid borders, simulated comfort inside or how the author himself put it "containers of human activities" long before the first housing projects utilizing containers occur. Dahinden J.: Urban Structures for the Future, Praeger Publishers, 8, 1972. Senk P.: Capsules. Typology of other architecture; Routledge, 6, 2017
- *4) Despite the fact that some studied cases might have are labeled 'unspecified' in this research, the number of cases in 'unspecified' category may not have a noticeable influence on the received results.
- *5) See projects by Kenji Ekuan – Dwelling city (1964) and World of chlorophyll by IAMZ Design Studio (2012)
- *6) Also, it is not excluded that an architect may utilize an unfinished appearance of a building and potential of growth as a tool for architectural expression.
- *7) This separation is based on Senk's classification of the capsules as: method 1 – 'independent cells', method 2 – 'composite cells', method 3 – 'clip-ons/plugin-ins, parasites', method 4 – 'pendants, inserts'. Senk P.: Capsules. Typology of other architecture, Routledge, pp.114-146, 2017

Appendix 1. Selected examples

No	Year	Name	Architect/Bureau	Concept	Characteristics	Country
				Mental Growing Mobile Shape Function Material Size Number Method		
1	1930	Dymaxion house	Buckminster Fuller		10 3 1	US
2	1940	Mechanical wing	Schneiderman		10 3 1	US
3	1945	Structural blocks housing	USSR Research Inst.		10 3 1	USSR
4	1950	Rotel	Rotel Company		10 3 1	Germany
5	1955	House of the future	Alison Smithson		10 3 1	UK
6	1956	Mobile hotel cabin	Lothar Schein		10 3 1	France
7	1956	Plastic house	Schein		10 3 1	France
8	1960	Futuro House	Matti Suuronen		10 3 1	Finland
9	1960	Ville Spatiale	Yona Friedman		10 3 1	Global
10	1960	Stackable Multipurpose Cells	Jean-Louis Rey		10 3 1	Global
11	1960	Residential area	Pascal Hausermann		10 3 1	Swi-land
12	1960	Hanging hotel	Takis Zenetos		10 3 1	Greece
13	1960	Cable city	Takis Zenetos		10 3 1	Greece
14	1961	Ball House	Johann W. Ludowici		10 3 1	Germany
15	1961	Helix City	Kisho Kurokawa		10 3 1	Japan
16	1961	Urban Area Reconstr. Plan	Yukio Otani		10 3 1	Japan
17	1962	Plastic Sky Lodge	Kenji Ekuan		10 3 1	Japan
18	1962	Clusters in the air	Arata Isozaki		10 3 1	Japan
19	1962	Ikebuku Plan	Kiyonori Kikutake		10 3 1	Japan
20	1962	Prefab. box-type apartments	Kisho Kurokawa		10 3 1	Japan
21	1962	Tree housing tower	Arthur Quarmby		10 3 1	UK
22	1962	Emerg. Mass Housing Units	Arthur Quarmby		10 3 1	UK
23	1963	Prefabricated Plastic Cells	Paul Maymont		10 3 1	France
24	1963	Marine City	Kiyonori Kikutake		10 3 1	Japan
25	1964	Pumpkin House	Kenji Ekuan		10 3 1	Japan
26	1964	Dwelling city	Kenji Ekuan		10 3 1	Japan
27	1964	Village housing	Kenji Ekuan		10 3 1	Japan
28	1964	Tortoise House	Kenji Ekuan		10 3 1	Japan
29	1964	Potteries Thinkbelt	Cedric Price		10 3 1	UK
30	1964	Office Towers	Peter Cook		10 3 1	UK
31	1964	Plug-in City	Archigram		10 3 1	UK
32	1964	Capsule Homes	Archigram		10 3 1	UK
33	1964	Multi-purpose cell prototype	Jean-Louis Chanéac		10 3 1	France
34	1965	Gasket House	Archigram		10 3 1	UK
35	1965	Plug-in University Node	Archigram		10 3 1	UK
36	1965	Lucky Dome	Buckminster Fuller		10 3 1	US
37	1965	The Environment Bubble	Francis Allegret		10 3 1	France
38	1966	Flow-out village	Archigram		10 3 1	Global
39	1966	Living pod	Archigram		10 3 1	Global
40	1966	Paddington East	Archigram		10 3 1	UK
41	1966	Homesey Housing Study	Archigram		10 3 1	UK
42	1966	Cylindrical building	Guy Dessauges		10 3 1	Global
43	1966	Noverly Space Houses	Pascal Hausermann		10 3 1	France
44	1967	Hotel in Menorca	Pascal Hausermann		10 3 1	France
45	1967	Cylindrical houses	Guy Dessauges		10 3 1	Swi-land
46	1967	Bubble House	Jean Manaval		10 3 1	France
47	1967	Pneumatic House	Haus-Rucker-Co		10 3 1	Swi-land
48	1967	House of stacked units	Wolfgang Döring		10 3 1	Global
49	1967	Shizuoka Press Broad. Cntr.	Kenzo Tange		10 3 1	Japan
50	1967	JA: 1967 Comp. 1st place	K. Harakawa et al		10 3 1	Japan
51	1967	JA: 1967 Honour. Mention	Takamizawa Sh. et al		10 3 1	Japan
52	1967	JA: 1967 Honour. Mention 2	Sadao Tanaka		10 3 1	Japan
53	1967	JA: 1967 Honour. Mention 3	Hiroshi Inagaki et al		10 3 1	Japan
54	1967	JA: 1967 Honour. Mention 4	N. Fujimoto et al		10 3 1	Japan
55	1967	JA: 1967 Honour. Mention 5	Kuniaki Suda et al		10 3 1	Japan
56	1967	JA: 1967 Honour. Mention 6	R. Esnard et al		10 3 1	Japan
57	1967	JA: 1967 Honour. Mention 7	R. Esnard et al		10 3 1	Japan
58	1968	Parasitic cells	Jean-Louis Chanéac		10 3 1	Swi-land
59	1968	Hexacube	G. Candilis et al		10 3 1	France
60	1968	Plastic Modular Home	Wight Plastics Lmt.		10 3 1	UK
61	1968	Residence of M. Ginot	Pascal Hausermann		10 3 1	France
62	1968	Drive-in House	Michael Webb		10 3 1	UK
63	1968	Habitat Puerto Rico	Moshe Safdie		10 3 1	Puerto-R.
64	1969	Plastic cells	Pascal Hausermann		10 3 1	Swi-land
65	1969	Mobile theatre	Pascal Hausermann		10 3 1	Swi-land
66	1969	Inflatable mobile office	Hans Hollein		10 3 1	Austria
67	1969	Yadokari Capsule Lodge	Kenji Ekuan		10 3 1	Japan
68	1969	K67	Sasa J. Mächting		10 3 1	Slovenia
69	1969	Capsule Houses	Wolfgang Döring		10 3 1	Germany
70	1970	Modular leisure habitat	Jacques Beaufre		10 3 1	France
71	1970	Pirate bubble	Jean-Louis Chanéac		10 3 1	Swi-land
72	1970	Expo70	Luigi Colani		10 3 1	Germany
73	1970	Total Housing Unit	Luigi Colani		10 3 1	Germany
74	1970	Expo Tower	Kiyonori Kikutake		10 3 1	Japan
75	1970	Takara Beautifon	Kisho Kurokawa		10 3 1	Japan
76	1970	Capsule for living	Kisho Kurokawa		10 3 1	Japan
77	1970	Steinham	New Metal Prid.		10 3 1	US
78	1970	Tekitte II habitat	Alaska Fisheries		10 3 1	US
79	1971	Venturo	Matti Suuronen		10 3 1	Finland
80	1971	Do-Bausystem Plastic house	J.C. Ventalon et al		10 3 1	Germany
81	1971	Domobles	Pascal Hausermann		10 3 1	Swi-land
82	1972	AZM Offices	Laurens Blesseroux		10 3 1	Ne-lands
83	1972	Oase N7	Haus-Rucker-Co		10 3 1	Austria
84	1972	Tetradon	AUA		10 3 1	France
85	1972	Microhouse	Ken Isaka		10 3 1	US
86	1972	Tower of Youth	Suga Yoshitomi		10 3 1	Japan
87	1972	Nakagin Capsule Tower	Kisho Kurokawa		10 3 1	Japan
88	1972	Capsule village	Kisho Kurokawa		10 3 1	Japan
89	1973	Capsule house K	Kisho Kurokawa		10 3 1	Japan
90	1973	Interpod Tower I	William Morgan		10 3 1	US
91	1973	Residence Gamma	J. M. Rancet, A. Parisot		10 3 1	France
92	1974	SIRH Option 75	Claude Prouve		10 3 1	France
93	1974	Ludres-Experimental Building	Claude Prouve		10 3 1	France
94	1974	Metastadt building system	Richard J. Dietrich		10 3 1	Germany
95	1974	Kotto Building	Kisho Kurokawa		10 3 1	Japan
96	1975	Um Al Khanazeer island dev.	Kisho Kurokawa		10 3 1	Japan
97	1976	Sony Tower	Sony Tower		10 3 1	Japan
98	1976	Conservatoire de Montreuil	Claude Le Goas		10 3 1	France
99	1979	Capsule Inn Osaka	Kisho Kurokawa		10 3 1	Japan
100	1980	Capsule Inn Sapporo	Kisho Kurokawa		10 3 1	Japan
101	1984	Globe Houses	Exp. Housing Dev.		10 3 1	Ne-lands
102	1990	7th kilometer	Km company		10 3 1	UK
103	1991	Egg of the winds	Toyo Ito		10 3 1	Japan
104	1992	Industrialized housing	Richard Rogers		10 3 1	Korea
105	1995	Reps. buildings in pr. Venus	Jacques Fresco		10 3 1	US
106	2000	Mixer	Lot-Ek		10 3 1	UK
107	2000	Morton Loft	Lot-Ek		10 3 1	UK
108	2001	Tree village	Micro Compact Hous.		10 3 1	Europe
109	2001	Torino Porta Susa Station	Lot-Ek		10 3 1	Italy
110	2001	Container city	Container city TM		10 3 1	UK
111	2002	Cave	Toru Murakami		10 3 1	Japan
112	2003	Challenge space architecture	Shuichi + Ikeda Lab.		10 3 1	Japan
113	2003	House in Azeitão	Aires Mateus		10 3 1	Portugal
114	2003	DST Pods	Cannata/Fernandes		10 3 1	Portugal
115	2003	MDU	Lo-Ek		10 3 1	Global
116	2004	Loft Cube	Werner Aissinger		10 3 1	UK
117	2004	Rotor house	Luigi Colani		10 3 1	Germany
118	2005	Rucksack-House	Stefan Eberstadt		10 3 1	Germany
119	2005	Riverside building	Container city TM		10 3 1	UK
120	2005	Expandable ISO shelter	AAR		10 3 1	UK
121	2005	Halley VI Antarctic Res. St.	Hugh Broughton Arch.		10 3 1	Antarctica
122	2005	Symbolic Living machine	G. Shimada et al		10 3 1	Japan
123	2006	HUIK Own home and office	Sculp Architects		10 3 1	Ne-lands
124	2006	Freitag freeway shop	Yves Netzhammer		10 3 1	Germany
125	2006	Papertainer	Shigeru Ban		10 3 1	Korea
126	2007	Nomadic Museum Tokyo	Shigeru Ban		10 3 1	Japan
127	2007	DH1 Disaster House	Gregg Fleishman		10 3 1	US
128	2007	Barier	G-Wood		10 3 1	Japan
129	2007	Yotel Air Gatwick hotel	Yo Company		10 3 1	UK
130	2007	Lafayette Tower	Lot-Ek		10 3 1	UK
131	2007	Hotel Elmad	S. Lang, D. Baumann		10 3 1	Swi-land
132	2007	Simple Haus	Front Architects		10 3 1	Poland
133	2008	Puma City	Lot-Ek		10 3 1	US
134	2008	Sky-Village	Adept		10 3 1	Denmark
135	2009	Bayside Marina Hotel	Yasutaka Yoshimura		10 3 1	Japan
136	2009	Platoon	Graft Architects		10 3 1	Korea
137	2009	Contained Calls	Aedas		10 3 1	UK
138	2009	Pocket of Active Resistance	Stephane Malka		10 3 1	France
139	2009	9h Kyoto	Design Studio S		10 3 1	Japan

No	Year	Name	Architect/Bureau	Concept	Characteristics	Country
				Mental Growing Mobile	Shape Function Material Size Number Method	
140	2009	Sleepbox	Arch Group		2 2 20	Global
141	2009	Paco	Schemata		1 1	Japan
142	2009	The box office	Joe Haskett		2 1-10	US
143	2009	Treehouse	Terri Chiao		3 3	US
144	2009	Diogene	Renzo Piano		1+ 1	Germany
145	2009	Urban Transducer Skysc.	Daniel Nelson		>1000	US
146	2009	Subway Cell	Aaron Berman		1+ 1	US
147	2010	Lookhotels	Lookhotels TM		44 44	Spain
148	2010	Pier 57	Lot-ek		101-200	US
149	2010	Tubohotel	T3ARC		101-200	Mexico
150	2010	Plug-in Housing Dev.	Tay Yee Wei		51-100	Malaysia
151	2010	Capsule Hotel	Unknown		2 2	Ne-lands
152	2010	Cité A Docks	Cattani Architects		101-200	France
153	2010	Sergo Marketing Suite	Container city TM		71-250	UK
154	2010	Container Cities (Haiti)	Richard Moreta		101-200	Domin. R.
155	2010	Immersive cocoon	Nau		1 1	Germany
156	2010	Inbox capsule hotel	Inbox		2 16	Russia
157	2010	Bubble suite	Gites Insolites		4 1	France
158	2010	SkyLodge adventure suites	Naturavive		2 10-100	Chile
159	2011	42/5	Lot-Ek		101-200	US
160	2011	Spacebox studios	TU Delft		5 39	Ne-lands
161	2011	Genussrefel Exhibition	BMW		7 16	Austria
162	2011	Living Roof	Nau		5 1+	Germany
163	2011	Nomad Skyscraper	Luca D'amico et al		>1000	Global
164	2011	Box home	M3House + UAO		7 2	China
165	2011	Suguroku office	Daiken Met		7 7	Japan
166	2012	Portishead quays	Container city TM		7 21-50	UK
167	2012	BBC broadcasting studios	Container city TM		7 11-20	UK
168	2012	Boxpark Shoreditch	BDP		7 7-12	UK
169	2012	Afterlight	Interrupt		7 18	Singapore
170	2012	Das Park hotel	Das Park hotel		4 3	Germany
171	2012	Free Spirit Spheres	Free Spirit Spheres		3 1+	Canada
172	2012	World of Chlorophyll	IAMZ Design Studio		20 1-100	US
173	2012	Eco-pod	Squared Design Lab		3 5+	US
174	2012	Mangal city	Chimera		2 201-500	US
175	2012	Xian Youth Capsule Hotel	Unknown		2 21-50	China
176	2012	City Hub Amsterdam	City Hub		3 50	Ne-lands
177	2012	New bivouac Gervasutti	Leapfactory		7 1	Italy
178	2012	Uplift concept	Basecampzero		7 21-50	US
179	2012	Egg microhouse	Hitca		7 3	Russia
180	2012	Vertical community	Baichuan Song		5 201-500	Global
181	2012	Suburbia tower	Aaron Berman		3 21-50	US
182	2012	Mobile suburbia	Aaron Berman		3 1+	US
183	2012	Interchangeable Habitation	Jonas Ersson		20 1001+	Sweden
184	2012	Moving city	Manuel Dominguez		5 133	Spain
185	2012	Toretores village	Toretores village		4 11	Japan
186	2013	T2 Unit	SUS		5 120	Japan
187	2013	Office complex in Bogota	Unknown		7 11-20	Columbia
188	2013	Aether Apparel - Proxy	Envelope A+D		7 3	Japan
189	2013	Swiss Tubes	TCS Camping		7 5	Swi-land
190	2013	A-Kamp47	Stephane Malka		23 23	France
191	2013	Pengsheng space cap. hotel	Pengsheng sp. caps.		2 21-50	China
192	2013	Micro House in Tsinghua	Liu Lubin		4 1+	China
193	2013	Pop-up neighborhood	James Alford		7 3	US
194	2013	Archipod	Archipod		10 1+	UK
195	2013	Agueda concept	Agueda concept		10 1+	Portugal
196	2014	The hut factory	Kasert Rafel		5 51-100	Malaysia
197	2014	EBA51	Holzer Kobler Itd.		7 15	Germany
198	2014	Modular home prototype	Garrison Architects		7 3	US
199	2014	Mill Junction	Clitip		7 56	S. Africa
200	2014	Rotating plug-in capsules	Boijing Co		7 201-500	China
201	2014	Attrap Reeves Bubble Hotel	Attrap Reeves		3 3	France
202	2014	Songpa Micro-Housing	SsD architecture		5 11-20	Korea
203	2014	Hive-inn	OVA studio		10 101-200	China
204	2014	PointN New Bridge	Stephane Malka		7 3	France
205	2014	Unit Fusion	Y Design Office		7 11-20	China
206	2014	Casa Futebol	A. D. Stampa et al		10 101-200	Brazil
207	2014	Wow pod	Ideo Design		3 1+	Global
208	2014	B-and-Bee	B-and-Bee		2 2-10	Belgium
209	2014	Containerville	Scott Kyson		7 44	UK
210	2014	Container skyscraper	CG Architects		20 45	America
211	2015	Clipper house	Container city TM		7 7	UK
212	2015	Sleeping Pod	Yazdani Studio		5 1+	US
213	2015	Common ground	Urbanrainer		7 51-100	Korea
214	2015	Living Roof	Nau		5 1+	Germany
215	2015	Eco capsule	Christian Weber		3 1+	Slovakia
216	2015	Sleeppod	VATC		7 16	Vietnam
218	2015	Container Skyscraper	Ganti+Associates		7 201-500	India
219	2015	Proove house	Richard Rogers & P.		3 2	US
220	2015	Lifepod	Michael R Weekes		7 11-20	Sweden
221	2015	creative space	StogkStuveback		7 11-20	Sweden
222	2015	Living roof capsule 2	Nau		4 1+	Germany
223	2015	Exo	Michael McDaniel		3 1+	US
224	2015	Sleeperoo	Langefreunde Design		2 1+	Germany
225	2016	B4 Head office city	Container city TM		10 11-20	UK
226	2016	Kasta	Kasta company		5 11-20	US
227	2016	QUO Container center	BZZ Architectura		7 11-20	Argentina
228	2016	First cabin Tsukiji	First Cabin		3 160	Japan
229	2016	Tree House	Richard Rogers		7 101-200	Global
230	2016	Campera bubble suit	Campera hotel		7 21-100	Mexico
231	2016	Fuselage	Tree Tents		4 4	Mexico
232	2016	Xpod	Dendroliervleugels		5 1+	Ne-lands
233	2016	3D printed office unit	Winsul Global		7 1+	UAE
234	2016	Container market	Siwabonga Gondwe		7 51-100	S. Africa
235	2017	Shipping container home	Modes International		7 1+	Global
236	2017	Quadrum-Gudauri	Quadrum Ski & Yoga		7 20	Germany
237	2017	Drivelines studios	Lot-Ek		7 51-100	S. Africa
238	2017	Coodo	Coodo TM		5 1+	Germany
239	2017	Mobile podcast studio	DN&co and Fantom		3 1	UK
240	2017	3 unit blocks	Oris architects		4 1	Slovenia
241	2017	Pod Versus Machine Scysc.	Pod Versus Machine		4 1	Japan
242	2017	Shelter with Dignity	Framlab		4 51-100	US
243	2017	Abu Aboud Stadium	Fenwick Iribarren		5 101-200	Qatar
244	2017	Heil-berg	Luca Beltrame et al		7 201-500	Global
245	2017	The Capsule Hotel	The Capsule Hotel		2 11-20	Australia
246	2017	Container hotel	Orzo Architects		7 101-200	Germany
247	2017	Snoozebox	Snoozebox Hotel		2 1+	UK
248	2017	Bed and Boarding	Carlotta Tartarone		2 51-100	Italy
249	2017	Inn the park	Inn the park		3 2-10	Japan
250	2017	Matices Hotel de Barrias	Matices Hotel		4 11-20	Mexico
251	2017	Blowing the building out	China Keapne		7 21-100	US
252	2017	Cozy box	S&P architects		7 2	Ukraine
253	2018	Kaoshiung Stereo Cont. Inn	ML Architect		7 51-100	China
254	2018	Starbucks in Taiwan	Kengo Kuma		7 11-20	Taiwan
255	2018	Albanq capsule	Yoon Space		3 1+	Korea
256	2018	Silver bullet	Airstream		7 1+	US
257	2018	Sphere hotel	Huisten Bos (HTB)		7 7	Japan
258	2018	OPod Tube Housing	James L. Cybertech.		5 11-20	China
259	2018	9h Akasaka	Design Studio S		2 168	Japan
260	2018	Keitwonon	Tempohousing		7 1001+	Ne-lands
261	2018	Cooling modules	N. Syropoulou		7 1	Greece
262	2018	Stackt Market	Stackt Market		7 2-10	Canada
263	2018	Home coming home	S. Minakami et al		4 21-50	Japan
264	2018	Rubner haus	P. Scoglio, C. Griffa		3 1+	Italy
265	2019	Capsule hotel Lucerne	Hirschengraben		2 11-20	Swi-land
Explanation of figures:						
Shapes: □ - rectangle, △ - custom, □ - cube, ○ - tube, ○ - sphere, ○ - polygonal, ○ - egg-shaped, ○ - vehicle, ○ - dome, ○ - honeycomb, ○ - cylinder, ○ - hexagon						
Functions: ○ - residential, □ - hotel, □ - multipurpose, □ - commercial, □ - office, □ - attraction, □ - utilities, □ - extension, □ - auditorium, □ - vertical farms, □ - sports facilities						
Materials: □ - plastics, □ - shipping containers, □ - metal/steel, □ - reinforced concrete, □ - wood, □ - unspecified, □ - concrete tubes, □ - glass, □ - other objects						
Methods of arrangement: ① - Method 1 Distribution, ② - Method 2 Stackability, ③ - Method 3 Plug-in, ④ - Method 4 Insert						
Index number: Regular - unbuilt, Bold - built						

Summary in Japanese

本論文は、世界各国で設計されてきたカプセル建築の基礎的研究として、それらの特徴を総体的に検討するものである。まず、先行研究に基づいてカプセル建築を定義し、最初期の事例と考えられるモダニズム期の 1930 年から、現代に至るおよそ 1 世紀弱の期間において 265 の事例（非実現プロジェクト含む）を蒐集し、それらが 1960 年代前後と 2010 年代前後の 2 つのピークに集中して設計されていることを見出している。その上で、カプセル建築の設計主題を検討し、それらを「可動性 (mobile)」(カプセルが動かせることに重点を置く主題)、「精神性 (mental)」(閉じたカプセルの内部での経験やそれに関する感覚、新しい精神性に重点を置く主題)、そして「拡張性 (growing)」(カプセルを増減できることに重点を置く主題) の 3 つの主題とその組み合わせで整理できることを述べ、さらにそれらカプセルの形状、機能、素材、サイズ、個数、またカプセル建築の構造を基礎的検討として通時的に整理している。

カプセルの実体的特徴としては、長方形の形状、住宅機能、金属とプラスチックの素材、3m³から 7m³のサイズが相対的に多いことが分かった。カプセルのサイズについては、カプセルが構造的に他のカプセルに繋がれることにより特殊な形状（例えば関節部、コンソール部、脚部などをもつ形状）をもつことから、見た目のサイズと内部空間のサイズに齟齬が生じることが散見された。カプセルが単一の構造をもつ場合、実現プロジェクトではカプセル数が 50 ユニットを超えない傾向があり、一方、非実現プロジェクトでは、カプセル数が数千のユニットからなる事例もみられ、さらに都市全体まで拡張できるとする壮大なプロジェクトもみられた。カプセルの配置については、「①地形上に広がる」、「②積み重ね」、「③プラグイン」といった方法が多くみられ、「④構造グリッド内に挿入」が最も稀なタイプだと分かった。

以上の検討は、カプセル建築の構想・設計における設計主題と実体的特徴を総体的に把握・検討したもので、今後のカプセル建築の研究のための基礎的な研究として位置づけられると考える。

Summary in English

This paper concentrates on the concept of capsule architecture and its application. The study uses the definition of a capsule provided by previous studies as a basis and follows the common trend of reevaluation modernist practices with the focus on capsular designs from the 1930s and their modern successors. The paper aims to create a comprehensive view of the history of the development of capsule architecture and supports the idea of the continuous nature of such development. In order to achieve this study collects 265 cases of capsular buildings as well as separate capsule examples and inspects them from different aspects to observe major trends. The research showed that the concept of capsule architecture, despite being interpreted by architects in different ways, usually falls into three main categories which can be named 'mental', 'growing', and 'mobile' capsules. Some capsules' design can utilize all of these categories, and, in principle, be claimed by an architect as a universal and flexible architectural tool. Also, the concept's application directly reflects on capsules' basic characteristics namely shape, function, materials, size, number of capsules per structure, and method of capsules' arrangements. This helps to better classify capsules depending on their application and construct a capsule's common image. Therefore, a capsule generally can have a rectangular and various custom-made shapes, bear mostly residential function, made of plastics or metal, and has a size of approximately fitting inside 3 to 7 m³ cube chosen as a tool of measurement due to a big number of custom-made shapes where it is difficult to obtain correct measurements. This is partly because capsules can have a shape allowing conglomeration with similar units, so a capsule can have joints, consoles, legs, etc. If capsules form a single structure, in the built examples this number tends not to exceed 50 units, while in the unbuilt section this number is more spread among different scales of capsular structures able to grow to thousands of units and entire capsular cities. Lastly, the method of capsules' arrangement already well defined by previous studies and is as follows: (1) the capsules spreading on topography, (2) stackable, (3) plug-in, and, notably, (4) the capsules inserted inside a grid and which are the rarest type. The general characteristics of capsules allow demonstrating the common image of a capsule as a phenomenon in the architectural realm and showing the potential and usefulness of capsular designs over conventional architecture and serve as a basis for the further research onto capsule architecture.

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