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THE DESIGN OF ADAPTABLE BUILDING IN JAPAN

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ABSTRACT

This paper looks at adaptability of buildings in Japan from the perspective of six companies, which represent three distinct practice typologies. Two cases were studied from each typology: large general contractors, large architectural design firms, and small design ateliers. The paper begins by contextualizing the situation in Japan by presenting a lineage of initiatives by the Japanese government. Subsequently, we present the findings from exploratory interviews and discuss how they can inform future comparative studies between the UK and Japan. The interviews reveal current innovations, trends, priorities, and obstacles within each practice in relation to adaptability in design, particularly of offices. The importance of certain physical characteristics and current solutions are examined such as storey height, location of services, planning modules, and structural spacing/spans. The interviewees acknowledge the critical relationship adaptability has with the state of the market, the role planning regulations and other laws serve as obstacles towards adaptability, and misconceptions/variations of the role and meaning adaptability has in practice. These issues are examined and the paper concludes by reflecting on the role and the dilemma of the designer, as both an individual actor and as a practice when dealing with adaptability.

Keywords: adaptability, design process, design practice, innovation, office buildings

INTRODUCTION

The majority of buildings are designed and constructed to suit a particular use at a certain time, with relatively little thought for the future. The Adaptable Futures research group is investigating the development of adaptable buildings in the UK that can better accommodate an often uncertain future (Gibb et al 2007, Schmidt et al 2009). The research is a three year multi-disciplinary project that aims to facilitate the development of adaptable buildings in the UK through academic research and real-life application. The project involves academics and researchers from the following sectors; construction, architecture, quantity surveying, business, project management and engineering.

The investigation looks to evince adaptability as a definable design characteristic with a principle consciousness towards "time" and "layers". Our current definition of adaptability reflects our accrued journey, namely *'the capacity of a building to accommodate effectively the evolving demands of its users and environment, thus maximizing value through life'* (Schmidt et al 2010). "Time" as a design consideration suggests buildings as dynamic systems that interact with a set of evolving endogenous and exogenous demands requiring a capacity to accommodate *change* (space, function, and componentry) through life. "Layers" indicates a design consideration regarding the organization and interfaces between components of varying life spans and functions.

Japan's construction industry has operated over the years with a strong scrap and build ethos, resulting in a short life for most office buildings between 20 to 30 years. This approach has begun to shift with changing market conditions and priorities aligning with a more sustainable agenda. In response, the Japanese construction industry has begun to realize the advantages adaptability can provide in reducing environmental impact and increasing cost-effectiveness.

Achieving greater adaptability demands a shift away from the current emphasis on form and function in response to immediate priorities, towards a 'time-based' view of design. This part of the research explores the role of the practice in this transition, and the attitudes and mindsets of designers, to understand how current processes/ projects either impede or enable adaptability in their practice. There are clear linkages here with the "distributed control" concept which is one of the central principle of Open Building (Kendall et al 1999). The interviews reveal current innovations, trends, priorities, and obstacles within each practice in relation to adaptability in design, particularly offices. The results of the interviews are used as benchmarks for further research.

THE SETTING: JAPANESE LONG LASTING HOUSING

This section describes the transition of Japanese approaches towards building longevity as a background for understanding the evolution of adaptable buildings in Japan. Historically the life expectancy of Japanese buildings were much shorter than that of western countries. With that in mind, Japanese public sectors have initiated several projects, especially pertaining to housing, to prolong life expectancy and adaptability has been seen as a good solution.

Short-life buildings and lower investment into refurbishment

The life expectancy of Japanese housing is about 30 years which is shorter than western countries (Figure 1). In coordination, the ratio of maintenance and renovation in the total investment is lower than western countries (Figure 2). These charts imply

Japanese buildings are rebuilt within a short period and new construction dominates the market.

From Quantity to Quality

After WWII, the Japanese government initiated projects to deal with the shortage of housing. A severe shortage continued through a period of rapid economic growth because of a high concentration of people moving into major cities, along with shifts in family compositions, and so on. In a 1968 census, the number of total residential units were greater than the total number of households. After this period, Japanese housing policies shifted from quantity to quality (MLIT Japan et al, 2008).

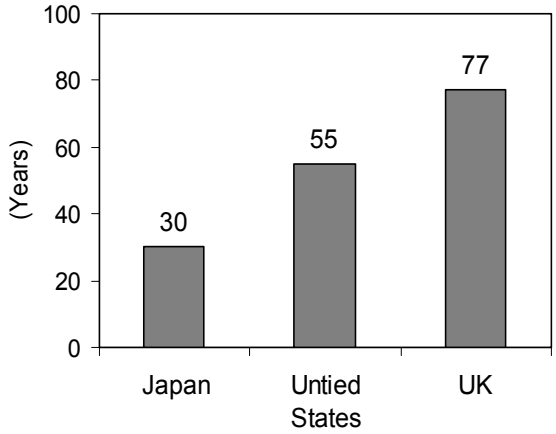

Figure 1 *International comparison of average years elapsed before a house is demolished in around 2000 (Quoted: MLIT Japan et al, 2008, "A Quick Look at Housing in Japan", p48)*

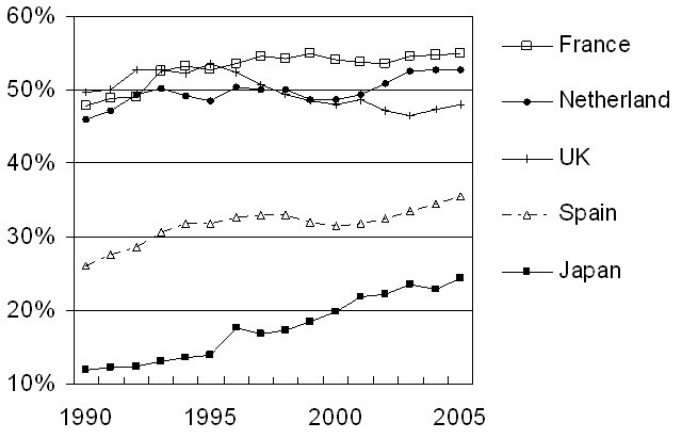

Figure 2 *The transformation of the percentage of maintenance and renovation in the total investment in building activities during 1990-2005. (Sources: Euroconstruct. 1992, 1996, 2000 and 2003 and MLIT Japan 2006)*

KEP: Kodan-Experimental housing Project (1973-)

During the housing shortage period, a large number of reinforced concrete apartment houses were constructed and related technologies developed. Around the 1970s, the Japanese housing industry shifted to respond to the demand of various types of housing and their quality.

KEP is an experimental project conducted by the Japanese Housing Corporation (called Kodan at the time) in order to incorporate flexibility and adaptability into housing from 1973. They categorized the building into structural frame and four subcategories of components - exterior, interior, kitchen & bath and other devices (piping, wiring and etc.). The intention was to identify interface details between each category and facilitate the use of “open” components. During the 1980s and 90s, some projects were designed based on this system.

Century housing system (1980-)

In order to prolong the life expectancy of housing this system proposes to divide the building parts into five categories based on experience and estimated life expectancy; 1) *the main structural members*, which are most difficult to replace lasting 50 to 100 years, 2) *roofs, exterior doors and windows* lasting 25-50 years, 3) *partitions and furniture* lasting 12-25 years, 4) *home appliances, piping and wiring* lasting 6-12 years and 5) *light bulbs and sealants*, which are the easiest to replace lasting 3-6 years. The crux of this system is that buildings need to be designed so that parts with long life spans are not damaged when parts with short life spans are replaced (Utida 2002). This system facilitates the future maintenance and exchange of parts as well as a response to changes in residents’ life styles.

SI: Skeleton Infill (1990s-)

This system supplies buildings in two steps; first “S” (skeleton) which signifies the long-lasting part and social property and second “I” (Infill/ fit-out) which represents the short-lasting part and private property (NEXT21 editorial committee 2005). However, in general, most of the Japanese construction industry tends to recognize this system purely as a physical issue, such as “S” means structural frame and “I” means interior and services (Matsumura 2009). This is despite its origins deriving from the “open building” approach by N. John Habraken, which incorporates more of the softer issues such as decision making levels in the management of residential areas (Matsumura 2009). The NEXT 21 project by Osaka Gas (1993) is the most famous project in Japan and both public and private sectors were brought together to develop SI technologies in experimental and practical projects (Kendall et al 1999). In these days, The national government now uses SI in their policies so this word is quite widespread in Japan.

200-year Housing (2006-)

In 2006, the Basic Plan for Housing (National Plan) indicated a transition to a stock-based housing policy leading to the promotion of the “200-year Housing” initiative which aims to extend the useful life of housing (Minami 2009). More specifically, this concept involves the construction of houses that boast excellent durability and are easy to manage and maintain (MLIT Japan et al, 2008).

ADAPTABULE BUILDINGS IN JAPANESE PRACTICES

This section describes the current situation of adaptable buildings, especially about office buildings based on designers' comments from our interviews.

Japanese Architectural Practice Typologies

Japanese architectural design practices fit three distinct typologies: large general contractors, large architectural design firms and small design ateliers. Large general contractors offer a complete package, a one-stop shop, for a complete service ranging from property acquisition, design, construction, maintenance, R&D and so on. According to company profiles as of 2009, the top five companies have more than 2000 licensed architectural designers in house. Large architectural design firms deal mainly with the design stage of relatively large projects (e.g. more than 10,000 m^2 total floor area office buildings). They will also sometimes get involved with Construction Management (CM) and Project Management (PM) businesses as well. The larger companies have about 300-700 licensed architectural designers. Small design ateliers typically consist of a few to a couple of dozen people and deal with relatively small projects, such as private housing. World-famous architects' offices are included in this category. Two practices were interviewed and studied from each typology.

Design trends for adaptable buildings

Currently, clients are not thinking about adaptability, but are becoming more aware of green issues and responsibilities. Therefore, at present, designers and clients share the necessity to consider sustainability, and many carbon reduction technologies have been developed and equipped. This has also led to the demand for more adaptable buildings, as people recognize the correlation between long life buildings and sustainability. However adaptability is not a priority in the consideration of sustainability in Japan, many seeing it as a separate issue.

Current market trends for office building design are moving towards a lower overall height of the building with larger floor space, in comparison to a typical high-rise tower building. Upgrading building services is a big issue driving service space locations which are easy to maintain, such as outside or on the facade of the building (e.g. balcony). Furthermore, a strategy of decentralized services is popular, subdividing as much as possible to respond to each individual tenant's needs (which has parallels to the "distributed control" principle).

Case studies

The following three projects are examples of Japanese adaptable office buildings which the designers were involved in.

Case study A) Mega-floor Office

Constructed in 2004, the total floor area is 33,000m^2 and 7 stories high (see Figures 3-5). The three major concepts of this building are; 1) high efficiency (high quality work place for employees), 2) green building and 3) low cost solution (both initial cost and total life cycle cost). The structural bay is a 10.8m grid for low cost, which is typically used for shopping centers and parking; in contrast to the typical span of office buildings of 16-18m, or even more than 20m. Future change was considered: if in 10 years they wanted to change locations the building could easily expand, contract, or change use into retail or hotel for example.

The design philosophy incorporated into the office layout encompasses a strong sense of openness through a continuous visual connection between floors and spaces (no walls and easy communication) and scattered core items (not centralized but “pack” of core).

Figure 3: *Façade (Source: Interviewee)*

Figure 4: *Interior (Source: Interviewee)*

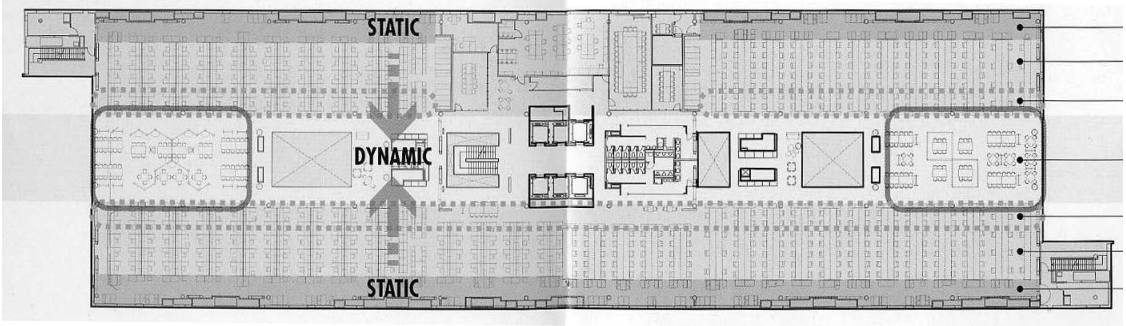

Figure 5: *Plan (Source: Interviewee)*

Case study B) Adaptable system

In this system the core is centralized and the columns surround the perimeter so that they provide a strong resistance to earthquakes and allow the space to be more flexible, such as change of layout (see Figures 6-7). Moreover, it is easy to construct and can reduce the length of construction. Originally this system was developed for residential buildings because of the demand for adaptable housing. Even under construction, the housing market and regional structure, such as population, can be changed. They developed an office permutation adding steel beams. However, this system does not fit the market well at this point, because of its current limitation in floor depth of 14m, while the average office depth is 18m.

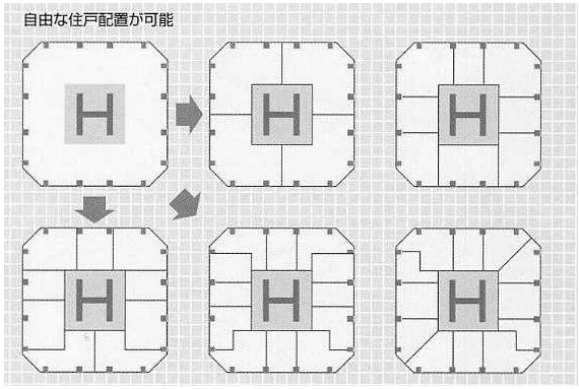

Figure 6: *Layout pattern (Sources: Interviewee)*

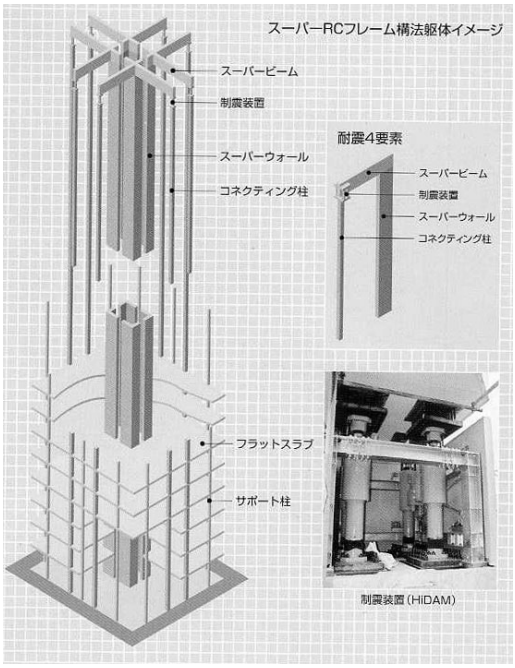

Figure 7: *Structural frame (Sources: Interviewee)*

Case study C) Adaptable material

In general, there are very strict regulations regarding fire resistance in Japan, so to use predominantly wood as a component in an urbanized area, especially more than three storeys high and non-residential, is extremely rare. This project aims to revive Japanese wooden culture in an urbanized area. Wooden components are used on the façade, interior and some parts of the structure all of which are made by a standard size distributed by the timber market in Japan so that they're easy to replace in the future (Figures 8-9).

Figure 8: *Façade (Source: Interviewee)*

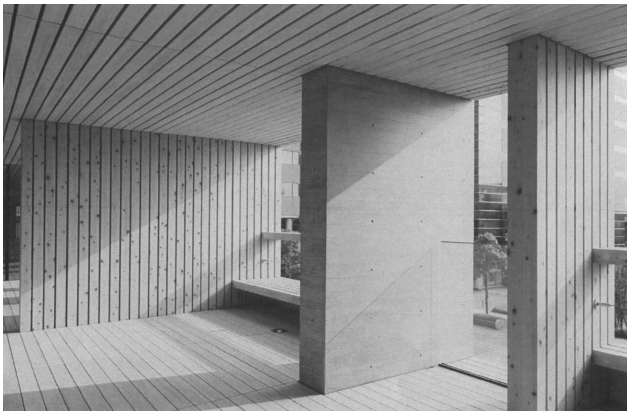

Figure 9: *Interior (Source: Interviewee)*

Design criteria

Through our conversations, the floor to floor height was found to be the most critical design parameter for adaptability. In general, the average floor to floor height is getting higher, from 2.500mm to 2.800mm. With 40 year old offices (built in 1960's) the structural floor height is not large enough for renewal due to the demand for raised flooring to equip the latest service devices. Enlarged personal space has increased the floor module as well from 3m to 3.2-3.6m. Moreover, the current typical span between columns is 6.8m or 7.2m by 16m or 19m.

Obstacles

The clients' mindsets have a huge influence. It is not easy to convince clients when adaptability of the building increases its initial cost, although it is relatively easier with government bodies because they can invest more cost initially and are willing to cooperate to reduce the CO^2 emission for example. Private clients' budget is typically less and they are not completely committed to environmental issues.

At the design stage, obstacles for adaptability are regulations and the mind-set of designers. Designers can adopt adaptability as a concept into their projects to extend the physical longevity; however, they cannot cope with the social longevity reflected in the market and people's demands. On the other hand, one designer said, *"If the building has a good enough structural frame, including large open spaces, there are no obstacles to realize adaptability".*

Innovations in design process

In some cases, designers attempted an innovative approach to realize adaptability within the design stage. To *share motivation within the design team and client*, such as to get an award (i.e. building recognition) helped to unify their organization in producing an innovative solution. In this sort of attempt, designers should make the effects of adaptability clear. If they get an award, this would be an incentive for both designers and client.

Good communication with manufacturers was necessary in another project. One design team used the latest manufacturing technology regarding digital fabrication enabling them to produce components with a unified standard. This allowed the same size of material to be produced readily making it easier to replace the material. The communication between designers and manufacturers throughout the design process was of extreme closeness and critical from the brief stage - which is not typical.

Designers' dilemma: profits and incentives

Commercial buildings tend to be designed to maximize profitable space allowances, locking buildings into specific uses, making conversions more difficult. Moreover, the development of many technologies has a detrimental effect on adaptability. As an example, when a technology for a high-rise building is developed, the more it is used and inevitably evolved to reduce costs, the more specific it becomes leaving less 'space' for future change.

In residential development, the developer can get incentives which enable them to exclude some floors from the floor area ratio calculation (FAR) for a particular use, such as common aisle space, balconies and service spaces which are designed for saving energy. However, in the future the capacity to change those buildings into another use could become a big issue regarding the additional floor space gained, making it impossible sometimes.

Negative mindsets of designers

There are some designers' negative mindsets against adaptability. One designer said that by making something adaptable, there might be a loss of certain characteristics and identity. Another designer said that *"adaptability works as an academic idealism (e.g. Habraken's open building and SI system), but is not practical within the realistic realm.*" Moreover, if buildings last more than 30 years, it might reduce designers' work in Japan.

BRIEF COMPARISON – JAPAN AND UK

This section describes a brief comparison between Japan and UK, using two sources conducted by the research partners of the Adaptable Futures project to understand the UK situation; a questionnaire to potential stakeholders (Reid Architecture 2006) and a conversation in response to the Japan findings with a UK-based designer (Warner 2009).

Similar points are: according to the questionnaire, the most important technical challenges are service and plant space, capital cost and life-cycle cost and story height. From the designer's point of view, floor heights are the most critical and increasingly getting taller creating a huge problem with buildings in the 1960s. Moreover, the minimum floor module for services is critical as well. UK's average module for plan is 3m or 3.6m and 1.2m. On the other hand, society demands new buildings and clients are much more interested in green issues than adaptable issues.

Differing points are: according to the questionnaire, more than 80% of the stakeholders saw a need for adaptable buildings and more than 60% perceived an adaptable building shell as being standard quality (not high like SI in Japan). From the designer's point of view, a bigger problem is the footprint (shape of building). UK policies created a greater awareness of mixed use as a "green" solution; while deconstruction activities in the UK remain incredibly cheap compared to other EU countries.

CONCLUSION – BENCHMARKED BY JAPANESE PRACTICES

How do we design adaptable buildings? What follows is what we've learnt from the Japanese experience as a benchmark for future research in the UK.

Role of design practices

The most difficult issue for designers is to change the mindsets of clients and improving cost effectiveness. Clients tend not to accept adaptable buildings with a higher initial cost. Moreover, the more cost efficient buildings sometimes result in a lower level of adaptability. The balance between cost and adaptability is a critical issue requiring a whole life economics approach. On the other hand, if the building has a suitable structural frame, including large open spaces, there might be few or even no obstacles to realizing adaptability. The other approach towards adaptability is good management of the relationships between stakeholders, to keep their motivation high and sharing benefits between the design team and client and to maintain a good communication between designers and manufacturers. This approach by Japanese practices supports the "distributed control" principle and needs further investigation in terms of adaptability.

Gap between theory and practice

In Japan, SI and sustainability are quite commonly used phrases that help designers to discuss adaptability more easily with their clients and manufacturers. However, designers see the SI system is as an idealized concept rather than as a practical solution. This implies the need for a discussion with industry about the more practical issues.

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