Toward an Adaptable Architecture
Guidelines to integrate Adaptability in the Building

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Abstract

Urban areas around the world are experiencing many problems related to a poor use of buildings, and high consumption of energy and materials through repetitive buildings' refurbishment or demolition. Inhabitants and users complain about rigidity of their buildings which become inadaptable to their evolving needs through time.

Architecture must embrace adaptability and flexibility to withstand effectively, and with respect of sustainability, the increasing needs of change that our contemporary society knows, and to create a symbiotic relationship between the building and its users. Adaptability helps to achieve a safe, healthy, effective, responsive, harmless, environmental friendly and well integrated building, and thus to ensure a long term value.

Within the context of my PhD research, an analytic review of flexibility and adaptability integration in the building as well as a study of contemporary approaches dealing with these concepts allowed to come out with a hierarchical deterministic approach that takes into consideration the different dimensions related to the building, including social, professional, economical, spatial, functional, and technical aspects. This paper aims to empower architects and designers with an efficient use of adaptability in the building, in order to meet the requirements of sustainable development.

Keywords: adaptability, flexibility, sustainability, guidelines

1. Introduction

Adaptability is the built-in ability to adapt and adjust to change by meeting different uses, allowing various spatial and functional configurations, and updating technologies without requiring significant disruption of the building, the ongoing activities and the environment (Kronenburg, 2007).

On this basis, adaptability plays a major role to improve the building's sustainable attributes. The possibility of lasting through time while the building spaces and components continue to change, generates many opportunities including each one of the pillars of sustainable development (Nakib, 2009): at the individual level, adaptability allows to enhance the user's wellbeing and safety by achieving comfort, health, security, indoor environmental quality, life quality as well as a good interactivity with the building and other users. Socially: Adaptability allows to satisfy continuously the common and individual needs of people, and to support their intervention and interaction (between them and with the space) by providing them a more expressive frame which evolves through time without harming the neighbourhood or compromising future generations. That allows maintaining coherence with social and cultural tendencies and consequently preserving the place identity and specificities. Economically: Adaptability allows the building to fulfil its function more efficiently, remain longer in service, reduce materials consumption through time and take full advantage of technological innovations. It can respond to change faster and at lower cost. That guarantees to keep building viability longer. Environmentally: Adaptability allows reducing resources and energy consumption and ensures a minimum environment perturbation.

Since the Building is a highly complex structure, it is important to highlight that adaptability has to be considered as a combination of many aspects. It can be approached with different perspectives. In this context, and within the framework of my PhD research, an analytic review of flexibility and adaptability integration in the building as well as a study of the different contemporary approaches dealing with these concepts seemed indispensable to put my hand on the different aspects that should be taken into consideration. The most studied approaches are rooted in the hierarchical principle, and most of them are based fundamentally on Habraken (1998) and Brand (1994) works. The most representative among these approaches are: "Open Building"[1] rallied under the Working Commission W-104 of the International Council for Research and Innovation in Building and Construction (CIB); "FlexHousing"[2] developed by CMHC (Canada Mortgage and Housing Corporation); "Ruimtelab"[3] which is a research laboratory in Netherlands supervised by René Heijne and Jacques Vink; and "Adaptable Futures"[4] developed by Loughborough's Innovative Manufacturing & Construction Research Centre (IMCRC). Another approach which is widely applied in the different fields of architecture but very little in adaptability integration is the "fractal geometry". The exploration of this theory helped to include the human dimension and the harmonization with the natural environment

[1] Information about Concepts and implementation can be found in: http://www.open-building.org/

[2] More information can be found in: http://www.cmhc-schl.gc.ca/en/co/buho/flho/index.cfm

[3] More information could be found in can be found in: http://www.ruimtelab.nl/

[4] More information could be found in can be found in: http://www.adaptablefutures.com/

(Nakib, 2010a). The above approaches led to come out with a hierarchical deterministic approach that facilitates the integration of adaptability in the building and which takes into consideration the different levels related to the building including social, professional, economical, spatial, functional, and technical aspects.

2. Guidelines to integrate adaptability in the building

It is very important to highlight that every building is unique by its physical structure, its function, as well as its relationship with the users and the surrounding environment. We don't pretend through these guidelines that we are providing a recipe which adapts to every situation, but just a way to think and some tools to facilitate the adaptability and evolutionability of the building.

2.1 Socio-professional guidelines

The success of adaptability integration is strongly related to the nature and behaviour of the different interveners on the building. A better knowledge of the users' and inhabitants' needs and expectations as well as a judicious choice of the professional specialists are both crucial. Furthermore, the following guidelines should be respected:

- Support flexible thinking.

- Encourage open architecture based on a transformation and evolution process rather than a perfect finished product.

- Call for different decision making levels in the design, construction and modification of the building, and precise clearly the responsibilities and rights of every one. The intervention of the different decision making levels must be organized hierarchically from the collective to the individual (ex: building inhabitants – floor inhabitants - flat inhabitants- room inhabitants), and from the formal: authority, organism, town planner, architect, etc. to the informal: the users (Kendall, 2004)

- Involve users in the decision-making process, and guarantee the balance between the freedom of their intervention and formal control assured by of the upper levels (e.g. Regulations). This is crucial for the environmental and socio-cultural coherence of the building.

- Encourage professional interdisciplinarity and coordination between the different specialists (urban designers, architects, interior designers, engineers, etc). Precise and differentiate the different responsibilities in order to reduce dependency, conflict and interferences (Kendall, 2004)

- Ensure the respect of the local context, its identity and specificities.

- Guarantee an active and regular maintenance of the building after its occupation.

- Raise awareness and spread information in all levels (inhabitants and users, professionals, regulatory institutions, clients, investors, etc.). Promote academic researches and practical experimentations.

2.2 Economical guidelines

- Put forward simple and inexpensive solutions before the technically and financially complicated ones. Sometimes, simple local solutions inspired from traditional architecture could be more efficient and cost less than modern ones.

- Invest more in the design and construction to spend less in modifications and maintenance.

2.3 Spatial and functional guidelines

An adaptable building should provide a space plan able to be arranged in several scenarios to meet different needs, life styles and uses. Functional and spatial adaptability can be achieved by respecting the following guidelines:

- Design the building as a combination of independent system-based layers organized hierarchically according to their expected lifespan and rate of change (structure, circulation routes and access, envelope, technical services and installations, space plan and furniture). This differentiation allows upgrading, adding, replacing or removing the components of each layer without affecting the structure of the others or the whole, Fig (1).

- Design every layer to allow different alternatives in the lower layer.

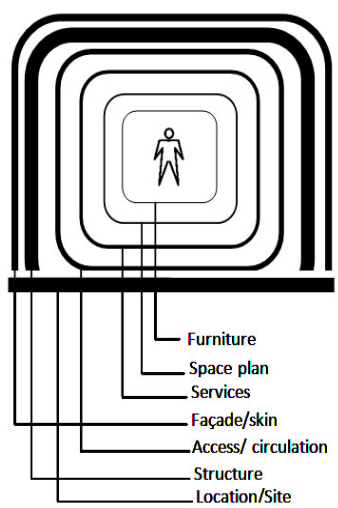

Figure 1: Building's independent layers (Hinte and Neleen, 2003)

- Include multifunctional spaces allowing for a large variety of functions, as well as transfunctional spaces leading to the creation of new undetermined and unpredictable activities according to the users' personal experiences and their consumption of space, Fig (2).

- Include mobility: install partitions and furniture that are light, mobile, demountable, reusable and recyclable, Fig (2).

- Support elasticity and divisibility: design the building to be easily extended (vertically or horizontally) or subdivided into different functional entities without hampering its functioning or its coherence, Fig (2). That requires a specific attention to the functional layout arrangement, the relationship between units and the distribution of accesses and services.

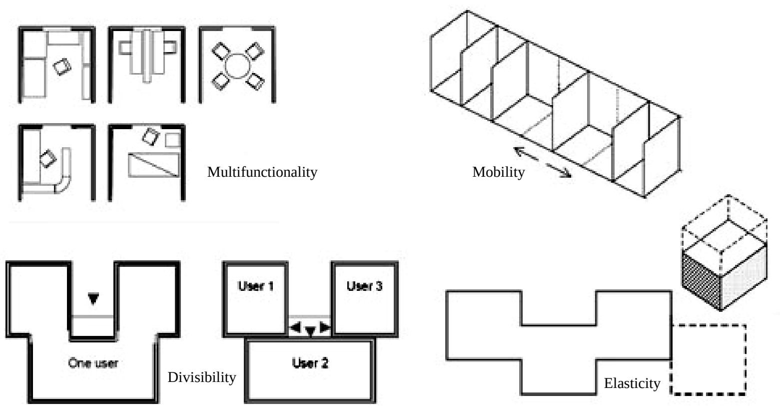

Figure 2: Multifunctionality, mobility, divisibility and elasticity (Blakstad, 2001)

- Optimize the space and its utilization: enhance the space density by multiplying the activities places without expending its topological dimension (e.g. Menger sponge), Fig (3). Take advantage of every millimetre of the space in height and area.

Figure 3: Space optimization according to 'Menger Sponge', the case of Sarphatistraat office building designed by Steven Holl (www.stevenholl.com)

- Use modularity to facilitate reconfiguration, subdivision and easy rearrangement of spaces. That guarantees evolution of the building through time according to the needs.

- Design spaces that are fluid and continuous and think carefully of the design of storage and its location.

- Include buffer zones allowing to absorb the overflowing caused by the frequent change of close spaces (which have important function and flow) and to avoid any encroach on the other spaces. The buffer spaces should have their own function which can change according to the needs.

- Design internal circulations routes as part of an overall architectural concept. They should be alive, animated, and interactive and should be able to host many activities. Avoid narrow and dead circulations of which the only function is moving from a place to another.

- Provide more than the minimum spatial areas and floor heights to facilitate space adaptation to others functions and conditions. Judicious estimation helps to avoid exaggeration.

- Spread out the design and construction of the building over different phases in order to better meet the progressive change and new needs, and therefore, keep coherence with the socio-cultural and economical conditions as well as technological advancement.

- Integrate the building into the surrounding environment. Design the building as intertwined spaces with the immediate natural and built environment in order to optimise their connection and interaction and enhance permeability and accessibility.

2.4 Structural guidelines

The building structure can also contribute in a number of significant ways to achieve the building adaptability. Thus, the following guidelines should be taken into consideration:

- Design foundations as to allow for potential expansion and extra loads. Reinforce also the lower slabs to bear the eventual supplementary loads resulted from the future functional and spatial modifications. A rational analysis should be made to determine a reasonable estimate.

- Design support structures to fulfill various long term changes and uses, and to accommodate a variety of technical services distribution schemes based on eventual future changes. Minimize the number of internal columns and bearing walls which could compromise building adaptability. Use a wide structural grid based on the multiplication of 7,2m and a generous floor-to-floor height.

- Make the support structure divisible, enabling future independence of compartments. Consider in the design, the separation of entrances, stairs and lifts.

- Use well adapted structural systems to local context, able to resist to major risks.

- Use dry connections with no male-female connections.
- Study carefully the installation of joints in order to avoid any differential settlements due to eventual extra loads.

2.5 Technical guidelines

Architectural adaptability cannot be achieved without a suitable adaptation of technical buildings components (Nakib, 2010b). Servicing and technical installations are considered as a key factor to adapt buildings (Kronenburg, 2007) and should be designed for longevity, expandability, disassembly, recyclability, maintainability, and energy and material efficiency. Therefore, the following guidelines which are based mainly on the work of Geraedts (2001, 2008), should be respected:

- Avoid embedded ducts and pipes in other buildings' systems (structure, walls, floors or ceiling).
- Ensure an easy access to technical components and installations by using dropped ceilings, raised floors, central cores, plenums, etc. That allows for easy maintenance and upgrading without disruption perturbation. Use generous and adaptable plenum systems (either overhead or under-floor) to meet space needs for future HVAC, power, lighting, and fire protection systems change.
- Make a distinction between collective and individual installations to facilitate maintenance and repair.
- Separate flexible components from inflexible ones, so as to enable change where it is valuable while preserving static elements that constitute the base of the building. Consider the distinction between long and short life cycles.
- Use pluggable connections (plug and play) such that installation components can be easily and safely disconnected, removed or repositioned while limiting the knock-on effect of changes. And Encourage use of wireless systems (low current, infra-red, etc) as they become commercially viable, to reduce problems related to distribution of cables and ducts.
- Locate strategically cables and ducts (backbone pathways) and ensure that the location of fixed services' rooms is chosen such that it doesn't compromise different configurations or uses in the future.
- Adopt prefabricated and standardized components, and encourage modular coordination (design and construction according to a fixed module) for easy replacement and recyclability, Fig (4). Use durable, recyclable and sustainable components.
- Over-measure energy to accommodate the growing and evolving demands and provide emergency power supply.

• Design installation systems as a modular and dividable system into several independent subsystems, and the interface between them must be reduced as often as possible, making easier to replace one of the subsystems by another one without affecting the system of the upper level nor the wholeness.

• Work out a precise description of different technical elements specifications (location, functioning, etc,) allowing feedback in case of future change.

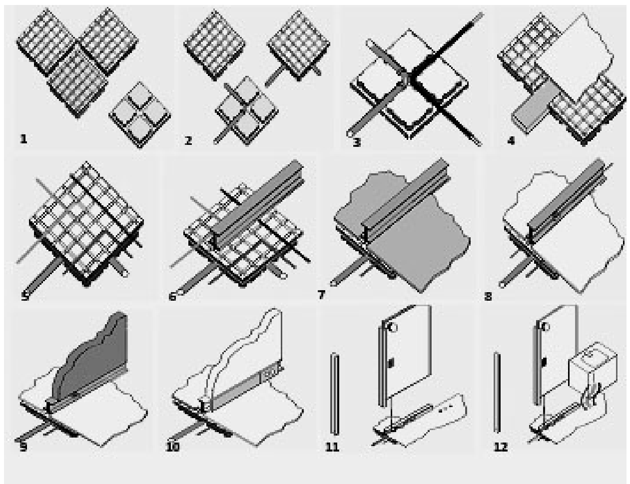

Figure 4: Modular and dividable technical systems. The case of Matura system developed by Habraken (www.habraken.com/html/downloads.html)

2.6 Façade guidelines

In order to allow easy interior changes as well as new technologies integration, we should consider the following in the facade design:

• Design a versatile envelop able to meet the building internal changes. Double façade when possible, to allow absorbing internal changes without affecting the exterior skin

• Make the building envelope independent of the structure and provide means for access (to the envelop system) from inside the building and from outside to facilitate maintenance and repair.

• Design sober facades and avoid overabundance of ornaments and extravagance while considering details. That allows easier adaptation to new uses. Choose materials that allow a building to weather beautifully and grow old gracefully.

• Base the façade design on a modular system to allow replacement, updating, integration of new technological features and suit of fashion. Base the modularity on a fractal composition in order to avoid monotony and uniformity while creating mixed, dynamic and personalized facades. Base the design of the façade on hierarchical scales with preferably a ratio of 2.7 between every two consecutive scales. This constant constitutes the base of natural logarithms and arises in the most successful and psychologically comfortable buildings (Salingaros, 2000).

- Increase the contact and exchange areas of the building by creating an irregular and meandering perimeter. That enable the building and its different parts to breathe, and interact as well as to be better ventilated and lit, etc. it also helps to enhance physical and visual accessibility and permeability (Nakib, 2010a)

3. Conclusion

Buildings should be designed with adaptability in mind to anticipate the accelerating rhythm of change, and absorb its consequent effects. Adaptability plays a major role to improve the sustainable attributes of the building in order to keep harmony with the natural environment and lie within the new imperatives of sustainable development.

This paper has shown that the building is a highly complex system which requires a systemic approach to achieve adaptability. It calls for a combination of many interrelated key factors: social, professional, economical, spatial, functional, technical, and structural as well as some aspects related the facade adaptability. A lack of consideration of one of these aspects may hinder the building adaptability.

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