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INDOOR FLEXIBILITY BY INDUSTRIALIZED METHODS: A WAY TO IMPROVE USE OF DWELLINGS

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ABSTRACT

This paper will examine flexibility and its relation to an Open Building Industrialization.
Flexibility means adaptability to the different ways of using buildings, easily and within short time.
Flexibility is suitable for both space planning, inside the building, or, the exterior envelope, the skin.
Inside Flexibility increases the options for using dwellings, as rooms can be resized and adapted easily to the different conditions dwellers live, indoor space is maximized without demolishing any of the dwelling.
Flexibility for office, commercial buildings, or factories has been always mandatory.
Flexibility improves the way space and functions are employed in different circumstances, taking into account the number and the needs of the dwellers; their age and requirements.
Flexibility and its value has been known during all 20$^{th.}$ Century, although it has not reached dwellings.
Tools for flexibility have not evolved as industry has, but we can evolve those tools providing light industry with products and instructions in a sort of Do It Yourself procedures.
Nowadays indoor flexibility could provide comfort and quality of life rather than only aesthetics or saving space solutions. Architecture must be useful for human needs, not only for economical proposals.

Keywords: Flexibility, dwelling, open building industrialization, acoustic, progressive habitation.

OBJETIVE OF RESEARCH: INDOOR FLEXIBILITY, A CHARACTERISTIC TO BE ACHIEVED AT SOCIAL DWELLING

Flexible, is becoming a common adjective when describing qualities and progress of dwelling.

Flexible, as happens with industrialized or ecological, is been used mainly as an adjective for commercial purposes; just because these qualities can make look better a product to be sold.

In order to avoid indoor flexibility as a commercial purpose, with no true value, we should know what it is, why it is worthy, when main examples happened, why it is not often used for social dwelling, and how we can make indoor flexibility as a useful characteristic of dwellings without repeating those common mistakes indoor flexibility has shown.

With all that information we can face to industrialize a low cost indoor flexibility as an evolution for social dwelling.

WHAT IS A FLEXIBLE DWELLING? OUTSIDE - INSIDE FLEXIBILITY

Flexible is the ability to adapt to the different conditions and needs.

Flexibility is seeing in advance what are the possible evolution and improving of the building, keeping them open for the incoming future, while maintaining comfort and quality of life; all over the different stages that users and dwellings will pass together.

Flexibility allows dwellings to adapt themselves easily to users needs.

Outside Flexibility (flexibility at envelopes)

Conditions Outside the building depend on weather (natural issue) or pollutants (artificial issue).

Weather, as natural issue, involves day & night, summer & winter, rain & sun, snow & storm. Pollutants can be from different nature: toxic, light, noise; even we humans are pollutants.

Outside flexibility needs innovative bioclimatic envelopes ready to adapt themselves to the different conditions, so they can match efficiency i.e. summer and winter; day and night conditions. Those envelopes will need to be improved during the life of the building.

Outside flexibility it is not a longer matter at this text.

Inside Flexibility (indoor flexibility, floor planning flexibility)

Inside flexibility is the ability of changing and improving spaces easily to the different needs and conditions. Conditions inside dwelling depends on human beings, our needs and desires.

Indoor flexibility, as architecture, should provide comfort and quality of life. Inside flexibility adapts dwelling to allow and enrich human being needs as it maximizes floor planning.

Inside flexibility does not mean the indeterminacy of empty rooms; as it is seen frequently when flexibility is just only for commercial purpose.

WHY INSIDE FLEXIBILITY MUST BE TAKEN INTO ACCOUNT?

Dwellings are supposed to be made to accomplish the needs of the users, human beings.

We, human beings, are social beings with economical, medical or other limitations.

Social being involves friendship and family. And living together, alone or however.

Spanish home market is rather static: property and renting relationship is approximately 5:1. A family uses the same dwelling for a long period of time: 15, 25 years or even more than one live. Emancipation, marriage, birth, childhood, divorce, emancipation, ageing, sickness, death, etc. Those can be used as the main words that describe the enormous variability of a standard family.

The traditional concept of dwellings based on corridors, rooms and doors can not face the evolution of homes that, by the other side, flexibility allows; in order to satisfy users' needs.

ARE FLEXIBILITY OR INDUSTRIALIZATION NEW WORDS AT ARCHITECTURE?

Nevertheless, flexibility and industrialization were together at the early XX century.

R. Buckminster Fuller, proposes at 1927 both Dimaxion house, and its industrialized 12 floor dwelling building: 45 tons of steel, glass and aluminium alloy to be Zeppelin transported.

Le Corbusier "*la habitation en série*": A structural grid where multiple floor plans can fit.

Gio Ponti teaches some great inside flexibility examples ("uniambient home for 4 people", DOMUS magazine, 1956. "la casa adatta" Eurodomus 3, Milán 1969).

John Habraken's work at S.A.R., during the 60´s and 70´s, shows again and compiles how important porticated and industrialized systems are for dwellings and flexibility.

Joe Colombo's short life was full of interesting works for improving dwellings trough industrial possibilities like : "Eurodomus 3" Milan 1969 and "Total Furnishing Unit" MOMA N.Y. 1972.

More Recently: Abalos y Herreros ("habitatje y ciutat" contest 1990 Barcelona), Alan Wexler (Crate House, New York 1991), Aranguren y Gallegos (Bentaberri home contest, Donostia, 1993), Josep Bohigas ("Espai Elastic" at CONSTRUMAT Barcelona 2007).

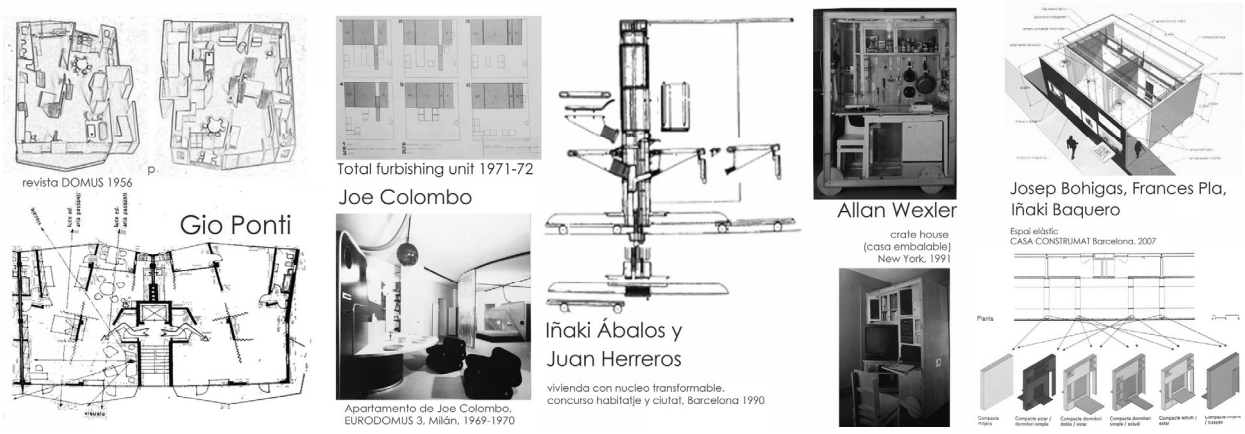

Figure 1: *State of art of indoor flexibility. Left to right: 1956, 69-70-71, 90, 91, 2007.*

WHAT ARE PEOPLE´S REQUIREMENTS FOR DWELLINGS? COMFORT AND QUALITY OF LIFE (C. & Q.L)

We need quality of life at our homes. We, as users and inhabitants of dwellings, need a place to develop ourselves at multiple situations: rest, clean ourselves, feed, joy, increase our culture, raise a family, work, study, communicate and feel like a useful human being.

C.& Q.L. do not depend on having the best technology gadgets; although it can help.

C.& Q.L. can be fitted at five easy and primary requirements: private life, roomy indoor, customize, and a low cost to maintain the dwelling; mother earth and human respect is assumed.

Private life: sense privacy.

Homes must provide privacy, not only from the outside but, from neighbours and flatmates.

A lack of privacy disables comfort and quality of life.

Noise is the origin of most of dwellers complaints.

Acoustic and visual isolation allows privacy, which is one of the most important needs of human behaviour. Privacy allows us to use the home for work, leisure, study or whatsoever.

Roomy indoor: spacious, organized and ready for multi-purpose resizeable rooms.

Human needs tools. They are very useful things for our life, like clothes, cleaning kits, electronic appliances, kitchen or hardware stuff, etc. An organized storage makes tools ready to use, if not, any search for tools includes wasting time. Wardrobes are useful.

Inside flexibility organizes and evolves space and tools to accomplish easily the needs of users.

Accepted standards which measures human activities, like Neufert bauentwurfslehre, can only be used as minimum measures.

Low cost of maintenance: energy consumption, repairing and transforming the dwelling.

More than 60% of energy consumption is used in thermal comfort.

Although transforming the dwelling is rarely applied, fixing or repairing it locally will happen more often. All these can be very expensive if dwelling is not designed and built for.

Sustainability is a relationship between produced and consumed energy and materia.

Customize.

Human being needs to feel useful and different one from each other.

Customize needs compatibility between products from an open and smart industrialization.

Dwellings, as computers, can be made ready to face plug in solutions. Customizing is also adapting to new incoming technologies.

ACHIEVING FLEXIBILITY:
SETTING THE BUILDING SHOULD NOT CONDEMN FLEXIBILITY.

Building can be made with set or unset parts depending whether they can or cannot change position during the life of the building.

A wrong chosen relationship between both of them can condemn options for indoor flexibility.

Set parts cannot change position: structure, drainage, venting, shared systems.

Set parts are immutable, they are always at the same position during the life of the building because the are usually shared between different users.

Structure, stairs, elevators, drainage and venting are the most important set parts of the building.

Set parts provide conditions for modifying floor planning. Set parts decide whether a building is flexible or not. Set parts can condemn flexibility.

Indoor flexibility for the XXI century ask set parts to allow multiple choices, in order to attach the unset parts when changing position.

A structure that allows evolution: Anchorage decision.

Structure must prevail different stages of the building according to the evolution of the envelopes, the installation systems, or indoor evolution.

Structure is defined by the anchorage system that is used. Anchorages decide how quick, easy, resistant and thought for the future the structure is. Anchorages decide how the building is made.

During the life of a building, structure, envelopes, systems, the building itself, will be under inspection, it could be evolved or repaired too. It can also be dismounted and rebuilt at another site. A correct decision for the anchorage system will prepare us for the future; at a low cost.

Flexibility associates with big spans, but floor vibrations can be uncomfortably felt by dwellers.

Plumbing, venting, and other shared systems must become multiple choice plug-in.

Installations are needed to supply water, heat, electricity, communications, etc. They are needed for venting. They are necessary to drain out used and wasted water, they can be very noisy and must run vertical across the building. Among entire life of the building.

We must think about using multiple choice, changeable, plug-in solutions for needed systems.

We can find at Europe many industrialized solutions made in some valuable technical polymers.

Service wall panels, which are useful, should be designed again according to nowadays principles of flexibility i.e. an easy access to allow multiple choice along the life of the building.

Unset parts can be moved: partitions, equipment, furniture, individual systems.

Unset parts can change position whenever the dweller decide to pay for it, i.e.: ceilings, indoor partitions, furniture, individual systems, even non structural envelopes should be taken as unset.

Attachment of unset parts should be prepared in advance, flexibility concerned, so dwelling will be prepared to admit easily any option user decide.

Flexibility asks unset parts to be versatile, easy to change, we ask them to be plug and play.

INDOOR FLEXIBILITY'S
TWO METHODS FOR EVOLVING THE DWELLING

First of all, flexible is thinking dwelling for being improvable since the first moment.

Dwellings can be improved, through inside flexibility, by 2 related methods: modifying the dimensions of indoor spaces, or improving systems and equipment to face more uses.

Modifying the dimensions of interior spaces (rooms)

Nowadays at traditional dwellings, function is adequate to the room; rooms are adequate to laws and economical possibilities. By the opposite, flexibility adequates room to its function.

A bigger room means that another one must be made smaller or joined together in order to have a big indoor space. That big indoor space can be useful for many things.

A human being can not use two rooms at the same time, but a family can. Due to the multiplicity of activities a logical planning, according to users' needs, must be taken into consideration.

According to the human being needs, the equipment that gives function to that space should be plug & play and easy to store when unused or when redistributing indoor space.

As we will see next, there are some tool types like i.e. panel walls or big sliding doors, that can face modifying dimensions of indoor spaces in a few time and with no cost.

Improving installations, systems and equipment. Adapting to new technologies.

This means evolving and improving water or heat net, electric, communication or other systems.

One of the main problems when evolving a building is to adequate and improve those systems to face the requirements of new times or a new floor planning. Those systems are made static and hard to evolve; even when we know they will need to be repaired during the life of the building.

Compatibility and multiplicity is needed to improve access and evolution of systems and nets.

INDUSTRIALIZED TOOL TYPES THAT CAN BE USED TO ACHIEVE INDOOR FLEXIBILITY BY MODYFING THE DIMENSIONS OF INTERIOR SPACES.

There are 4 tool types to allow flexibility at floor planning, according to a 1976 classification made by Joaquín Grau Enguix: Capsules or boxes, screens, wall panels and wardrobes.

Designing a flexible and industrialized building concerns knowing the possibilities of the tools which can be acquired and of those which can be designed and industrialized for first time.

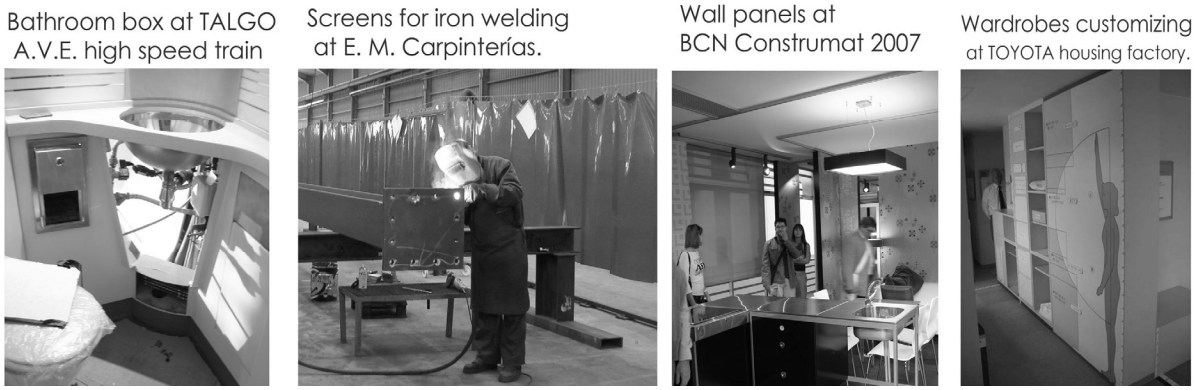

Figure 2: *Tools for flexibility. Boxes, screens, wall panels, wardrobes.*

Capsules or boxes.

Capsules are 3D medium size components which can include technical systems. They are fixed at dwelling to form i.e. kitchens, bathrooms or any other option designed for being repeated.

Nowadays this tool is not often used at dwelling, although big capsules as full bathroom boxes are commonly used at hotels due to its economical repetition and the great value of factory built quality, luxury equipment and quick installation. These boxes should be designed for comfort.

Screens.

Screens are 2D easy movable components that can help if only visual privacy is needed.

A great and affordable aesthetic performance should be completed with other requirements.

Wall panels.

Wall panels are 2D movable components that can close and divide, visual and acoustically, spaces into rooms. They can perform a great aesthetic value due to the election of outside layers.

They are hanged from a substructure deployed at a technical ceiling. So we must add the cost of the ceiling to the high cost of the panels themselves.

Wall panel most expensive parts are magnetic connection within panels and the mechanisms which press and seal panels against floor and ceiling.

Wardrobes.

Wardrobes can store clothes, hardware or tools for living; Wardrobes are essential to a home.

Joe Colombo's machines for living demonstrate what can be done within boxes and wardrobes.

Allan Wexler's 1991 remembered “arts&crafts wood resources” and “do it yourself” procedures with a smart an easy storage solution.

Most of big sale furniture stores provide multiple easy to apply storage solutions.

MAIN FAILURES WHILE TRYING TO INTRODUCE INSIDE FLEXIBILITY.

Flexibility and its value has been known during all 20$^{th.}$ Century; but it has not reached dwellings. Dwellers have seen flexibility as a way to reduce the cost of building, instead of a set of tools that can make life easier. They think they would receive empty small dwellings, without rooms or walls, without acoustic requirements to be achieved. No comfort, nor quality of life; but the same expensive prices.

The main failures of flexibility are: Space planning for the minimum, the high cost of industrialized tools for flexibility and, last but not least, acoustic transmission.

Space planning for the minimum:

Minimum space planning comes from economical limitation.

Municipal laws, according to human activities standardization, were pulled to protect users against too small rooms. But these laws are thought for static dwellings, based on separated and different rooms, not for indoor flexible and multiple choice planning.

Measured standards for human activities are constantly increasing.

Spanish social dwelling standards take care about number of rooms and surface; not comfort.

High cost of the industrialized solutions for flexibility.

This makes the choice of flexibility only for those who can afford it, although flexibility is much more suitable for people of lower income, as flexibility maximizes floor planning.

When industrialized solutions are not achievable Do It Yourself (D.I.Y.) procedures happens.

D.I.Y. procedures uses both industrial products within arts and crafts concepts. It diminish the cost because as an arts and craft it has not need to pay patents nor industrial rights. But it does not take into consideration the hours to implement the proposals; because you don't pay yourself.

Acoustic transmission, a common problem.

Flexibility examples seem unable to answer people needs due to the unsolved problem of acoustic transmission; there are not being used proper sound barriers nor gaskets for gaps.

Sound barriers must be made with multiple layers of different composition, heavy and light weight, in order to interact with different wave lengths, improving sound absorbency and isolation, and minimizing redundancy phenomena.

The gaps within moving parts of a building (i.e. doors, or moving walls) or within sound barriers must be sealed to avoid air transmitted sound. It is not all about hermetic spaces or rooms, but to reduce the movement within air particles.

Although the non soundproof gaps is a common problem in flexibility, there are multiple options for sealing gaps which allow movement. Most of them deal with the compression of the moving parts against the surfaces they move around. There are gaskets with GreenGuard certification.

INDOOR FLEXIBILITY AND INDUSTRIALIZATON.

Industrialization needs to produce repeated series to match investment and to reach low cost. Customizing is often made through finishes; a slight surface variation.

Industrialized tools for flexibility, like wall panels, are nowadays expensive, although they have not evolved as expected; except for aesthetic value.

The most expensive they are, the less they are sold. So there are less benefits, and less money to invest in new designs or new production concepts that would help to decrease the price of those tools for indoor flexibility. This seems a circle that we, architects and industrial designers, can break in order to provide a low cost but full versatile indoor flexibility.

New industrial designs needs hand made models, like those made by Do IT Yourself procedures, to test the viability of the new designs. D.I.Y. procedures can be a start for new industrialization.

Light industry should be ready to industrialize and customize a smart, open and multiple choice industrialization, beneath “ 0 stock ”, or Lean production environment.

PROGRESSIVE INHABITATION, A GREAT FEATURE FOR XXI CENTURY SOCIAL DWELLING.

Life means change. Homes, where life happens must change too.

A progressive home, is never dead as it can change to adapt easily to the different conditions.

Progressive inhabitation means that a home can progress according to the evolution of its inhabitants, as those users can increase or decrease on number, age, needs or money income.

In order to decrease the cost of that home, a progressive home starts with the minimum necessary, including the multiple choice for future systems, equipment, spaces or rooms.

Users improve their homes whenever they need, they can, or want to.

The most important characteristic of progressive inhabitation is that all possible evolution of the home is thought to be easily achieved. The evolution can be made through different options that exist at stock, or as light industrial options to be produced specifically. Lean production must be considered, as when well applied, is the most effective industrial production environment.

All those options must be compatible, ready to be customized plug and play, etc., avoiding monopolies or a reluctant and no interesting choice for the user that would cause a monotonous life.

Furniture and building industry should be concerned of the possibilities of dwelling indoor equipment and systems.

CONCLUSION

There are many examples of industrialized components since the XX century; almost any kind of building activity has been industrialized in order to obtain profit.

There are many examples of indoor flexibility that can guide us to design flexible dwellings.

There are many tools for flexibility too, but because of they are not evolving as desire, we, architects, industrial designers, engineers, and any others can match industrial products and processes, new technologies and easy applying techniques for evolving tools for flexibility.

Many industrial designs include Do It Yourself procedures. They will be the first step in order to evolve industrialized indoor flexibility components or tools.

We will need to provide local industry with instructions and materials in order to face a proper execution of desired indoor flexibility tools.

We must design tools for flexibility again in order to achieve better comfort and quality of life standards, according to sustainability and low V.O.C. emission, low energy consumption, or other green concepts with the final objective of reducing the cost of those solutions.

Lean industrial production must be taken into account to acquire variability, compatibility and low cost. New materials and related processes should be used to reduce production costs.

Many industrial products, thought for other purposes, can be used to progress indoor flexibility.

We must be flexible to adapt to new technologies which can progress comfort and quality of life.

Industry should lead for an OPEN and SMART INDUSTRIALIZATION.

Users should be provided with the tools for a MULTIPLE CHOICE FLEXIBILITY.

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