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Componentes inteligentes en 3D
Smart 3D-components

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***Resumen*— La fabricación de componentes 3D a través de la línea de ensamblaje implica un alto grado de valor agregado, entre los cuales se incluyen características inteligentes. Las funciones inteligentes nos permiten reconfigurar rápida y fácilmente el espacio donde están instaladas. Este tipo de propiedades suelen estar relacionadas con la comodidad del habitante y las instalaciones (iluminación, sonido, acondicionamiento térmico ...), pero también con la configuración del espacio. Por esta razón, para facilitar su movimiento o reemplazo, su peso y tamaño se convierten en un factor muy importante. Dentro de los componentes 3D, los más adecuados para cumplir estas funciones son los pods 3D y los compactos 3D. El dB alFA-G.100 sirve como fuente de las muestras más importantes del tipo de componentes que se están revisando en este documento, sus propiedades y características se nombran, definen y comparan. Para finalizar, se demuestra cómo las redes de suministros generales son la guía principal para organizar las relaciones espaciales entre los componentes inteligentes 3D (y cuáles son los más utilizados), pudiendo no solo obtener una nomenclatura de componentes inteligentes 3D y su clasificación, sino también incluir las reglas de sintaxis entre ellas que admiten configurar el espacio en ellas**

Palabras Clave— Componentes 3D; Pod 3D; Cabina 3D; Compacto en 3D; funciones inteligentes; espacio flexible; sistema de objetos.

***Abstract*—Manufacturing 3D-components through assembly line implies a high grade of added value, among which smart features are included. Smart features allow us to reconfigure quickly and easily the space where they are installed. This kind of properties are usually related to the comfort of the inhabitant and the facilities (lighting, sound, thermal conditioning ...), but also to the configuration of the space. For this reason, in order to facilitate its movement or replacement, their weight and size become a very important factor. Within 3D-components, the most suitable to fulfill these functions are the 3D-pods and the 3D-compacts. The dB alFA-G.100 serves as a source of the most important samples of the kind of components that are being reviewed in this paper, their properties and characteristics are named, defined and compared. To end, it is proved how general supplies networks are the main guide to arrange the spatial relations among 3D smart components (and which are the most used), being able not only to obtain a 3D-smart components nomenclature and its classification, but also to syntax rules between them which support to configure the space into they are include**

Index Terms— 3D-components; 3D-pod; 3D-cabin; 3D-compact; smart functions; flexible space; objects system.

I. INTRODUCTION: REASONS AND BELONGING

The 3D-wagen added value consist they transport part of main structure, enclosures and applies of building they goes to configure (the 3 main and complementary subsystems of XX Century Architecture), but the 3D-pods and 3D-compact don't includes necessary the main structure, enclosures, or main fluids net. Thus, the supplies are the best contribution for the

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build they will configure. This reason reveals how the cases studies of smart-components from this assembly-line view point are really useful to contemporary buildings.

Precisely because: they have less size/weight, they are independent of the main structure of the building itself, and because they can transport very easily specific technologic functions to change the ambient conditions of the space they occupy.

Also, by this reasons, the flexible spatial potential of 3D-pods and 3D-compact are even higher than the one we can find in 3D-wg components (this article could be consider as 2nd part of "3D-Bonding Vocabulary" article where we can find the meaning of specific nomenclature used here, and the basic different among 3D-wagen, 3D-pod, and 3D-compact components [1].

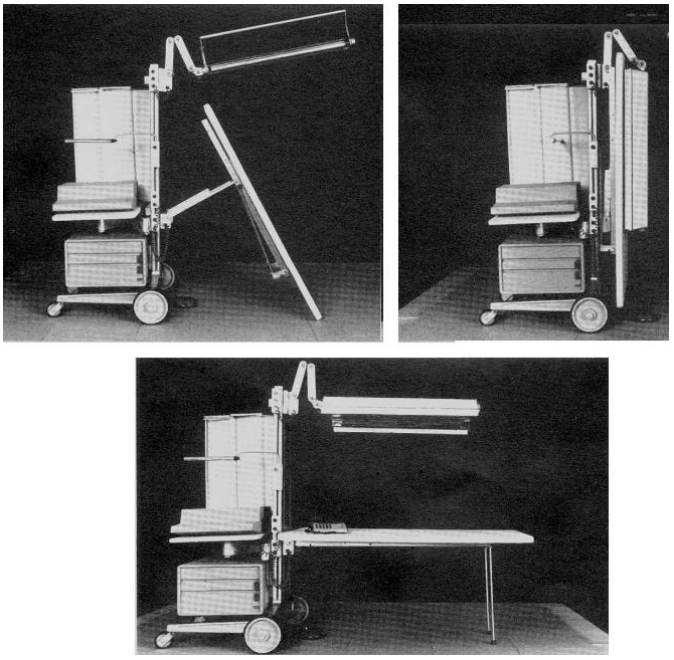
II. BACKGROUNDS: LOFTS AND LANDSCAPE OFFICES

The "existenzminimum" dwelling defined by A. Klein at 1929 Frankfurt CIAM, had a great influence in domestic Architecture of 20th Century. Those hiper-funcionalist ideas provoked great specialization over dwelling spaces, include service rooms (kitchen, bathroom, and toilette, mainly). This served to locate and get clear solution for this kind of zones, that along the time got to be named "humid zones" or "service zones". But in the same way, also those Architects got to tight dwellings for its inhabitants during all their life. Nevertheless, while this happened with social housing all over the world (mass-housing), the way running office towers and work manufacturing naves was another. Unlike these last types of buildings quickly took advantage of the new Technologies of the 20th Century to achieve spaces that were as flexible and transparent as possible.

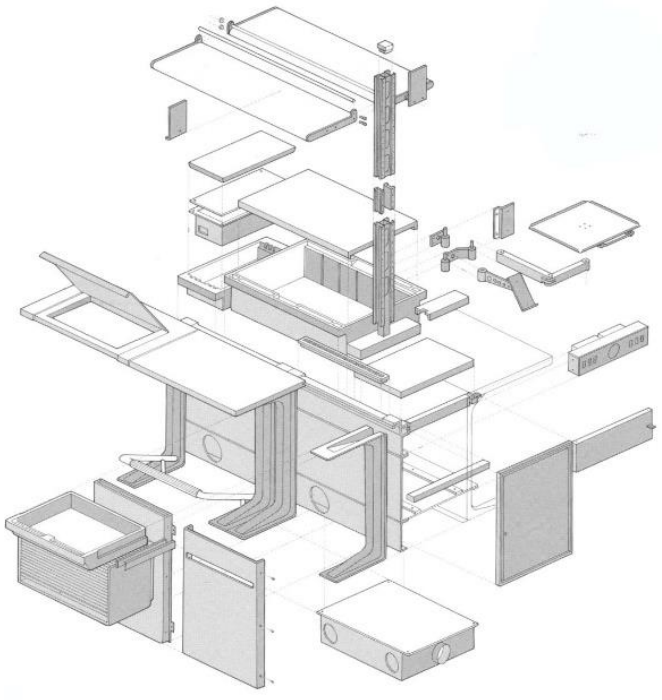
We can check this path if we simply remember the Theories from "Le Corbursier`s 5 points" (Maison domino, 1914) or M. van der Rohe`s "Universal Container" (Farnsworth House, 1945). Both claim for a greater spatial flexibility when they remove old structural walls (in first case the reticular concrete structure is born), and locate an core installation with vertical ventilation (as happens in the Seagram and skyscrapers of 3thd generation)

The combination of these 2 main Modern Architecture theoretical statements, immediately gave rise to what in the 50s was called "Landscape Office ", and in turn, the concept of "workstation" appeared little by little within this kind of space. This "workstation" has served as the basis to start generating furniture with various kinds of functions associated according to the tasks they bring assigned (Fig. 1a). After, this furniture was compacted more and more to respond to the needs for faster change and flexibility in these offices until we arrived at the transportable 3D-compact that is taught here. (Fig. 1b).

In this way, the flat that is inside offices towers is transformed in a fully fluid and open space, a kind of space helped by the installations applied on ceilings and floors that leave to change very fastly functions and organitations inside it. And consecutive, we can see how this solutions are extrapolated to apartments flats, but with significant economics restrictions.



(a)



(b)

Fig. 1. (a) Lloyd`s of London deployed work station; (b) Lloyd`s of London integral work station.

On the other hand, also the services core in these office towers have direct relation with “humid zones” from CIAM housing. In this sense, R.B. Fuller get to anticipate from the Farnsworth-House service core, when he designs dymaxion-house (1928-38) and proposes a stainless-steel 3D-capsule, which is then stacked vertically to challenge first Manhatthan´s skyscrapers (Fig.2).

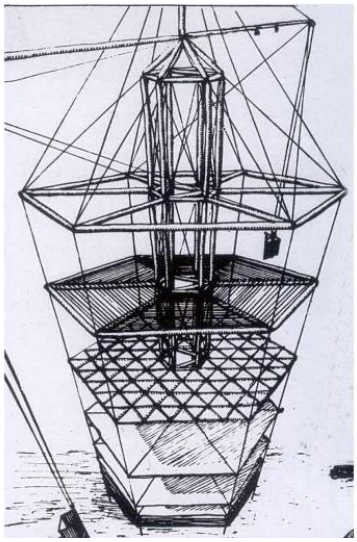


Fig. 2. 4D -time + dymaxion pod., B.Fuller 1929-37.

With this we can advance the idea of 3D-pod for domestic functions, which during 60`s leads to plug-in technology, and which the archigram plug-in City (1967 fully represents exceeding all expected expectations of acceptance within the world of art and design. Pop-art, associated with the Space Age and the first astronautic or submarine capsules, leaves a trail of industrial design where ergonomics and spaces, adjusted to very specific functions, are the "lead-motive" that will mark the character of those years. Something that is fully reflected in the "Visiona" MoMA exhibition (1969) with pieces by J. Colombo among others authors (Fig.3).

If we add to all the above-mentioned, the parallel trajectory of the great voids for industrial manufacture (from the train stations to the hangars of the II WW, then we find the M. van der Rohe "universal container" theory that is stated in the Crown-Hall" (1950) and the "Convention Palace" (1953) (immediately surpassed by Fuller's geodesic domes: S. Louis Greenhouse, 1960 / Manhattan Midtown Shelter, 1960 / biosphere-1, Montreal 1967: which are also launched from MoMA Expo, 1959). These super-shell (at same time envelop and structure) get total mechanical and environmental freedom to its inside space, so that space was previously limited by the horizontal flats (from LCorbusier`s 5 points), now it is turn in an ambient free and controlled where we can site very easily 3D-pod and 3D-compact with more possibilities for its sizes and heights.

Fig. 3. Visiona exhibit, Colombo 1969.

In this way, the landscape office of the 60 becomes the Climatroffice building (Fuller & Foster, 1984), and the R. Banham 3D-compact with the standard-of-living package, 1965 (Fig. 4), under any class of dome and size, What gives rise to the emergence of the Loft as a favorite place for artists and cool people to celebrate their events and multi-occupation vitality both in the Manhattan of the 70's and 80's and in the rest of the World under their influence (another 1985 exhibition MoMA dedicated to industrial environments found the "High-tech" name to this kind of architecture under the auspices of E. Ambasz).

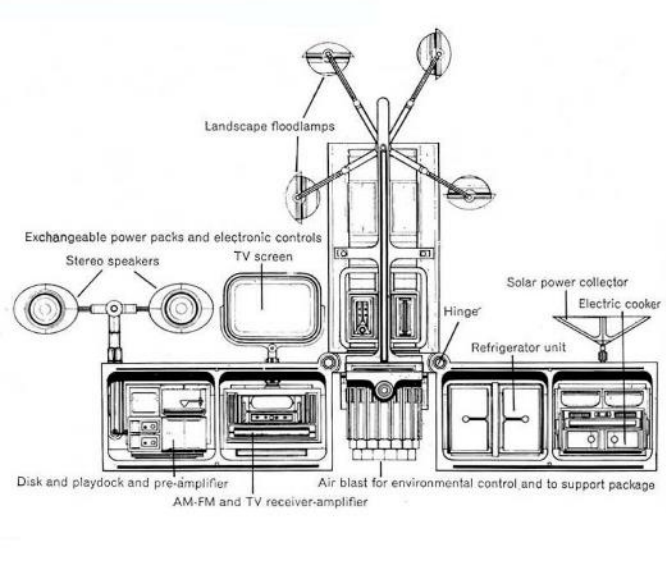


Fig. 4. Standard of living package R. Banham 1965.

As we can see, the worlds of large empty spaces and office towers are in full harmony with the technology of their time

(which gives them great breadth and adaptability), but nevertheless, this is not happening in the housing sector by economic and cultural reasons, that exceed the objective of this article.

III. TAXONOMY: 3D-POD AND 3D-COMPACT COMPONENTS

Consulting dB alfa-G.100 [2], and checking all concepts and spatial ideas shown in before point, all of this kind of components could be classification as follow (by its shape, manufacturing, and spatial situation):

. 3D-pod components (+ 3D-cabin):

INSIDE of flats [that they can be configuring: vertical cores of supplies or as loose units]

INSIDE of loft [that they can be set: in spatial reticule, or rolling and by stacking]

PLUG-IN at vertical spine

PLUG-IN at horizontal band

Exterior [stacking or over spatial reticule]

. 3D-compact components:

INSIDE of flats [that they can be applied at vertical networks cores or individually over floor]

INSIDE of loft that they can be set: over stereo-grid, or by stacking]

PLUG-IN at horizontal band

PLUG-IN at vertical pole

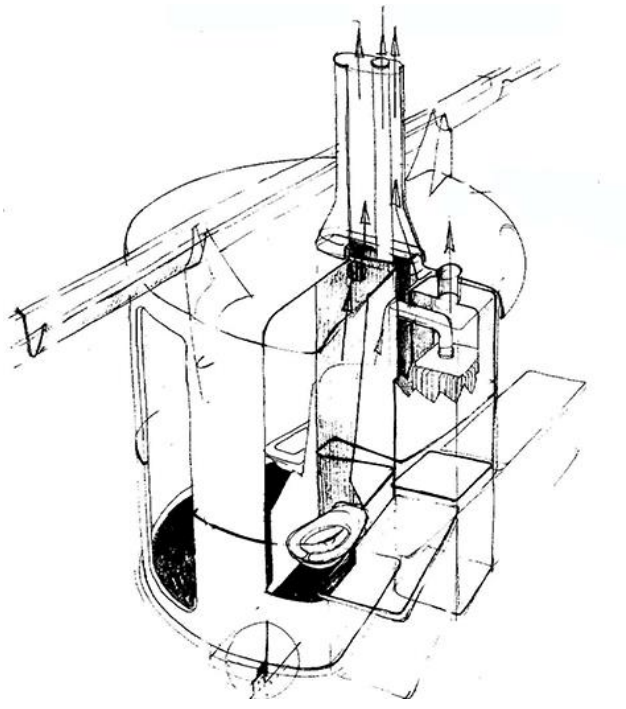


Fig. 5. Maison for Abbye Pierre, J. Prouve 1957.

As we can see, this naming system partially matches with the bonding naming system for 3D-wg shown in the article that is referred in the beginning of this pages, but it is not used in same way (“stacking”, “single”, and “deployed” are include at "inside" case, but this didn´t happen because their sizes, structural functions and isolation, which are not the same before and now).

This nomenclature and classification can be clarified with the following examples:

3D-pod “inside of flats”,

Shaping verticals cores of supplies:

Maison Abby Pierre (J. Prouve, 1955), Fig.5

J. Prouve manufactures and assembles this central supply core on the banks of the Seine for a prototype of a social home for unemployed families, with the possibility of changing it to any place when family conditions may change. The 3D metal pods work as a structure and have a bathroom and toilet + compact kitchen with all the pipes and cables installed from the factory.

In addition to this historical example, we have included here the dymaxion house mentioned above.

3D-pod “inside of flats” loose:

Home 1990 (archigram 1967) Fig.6

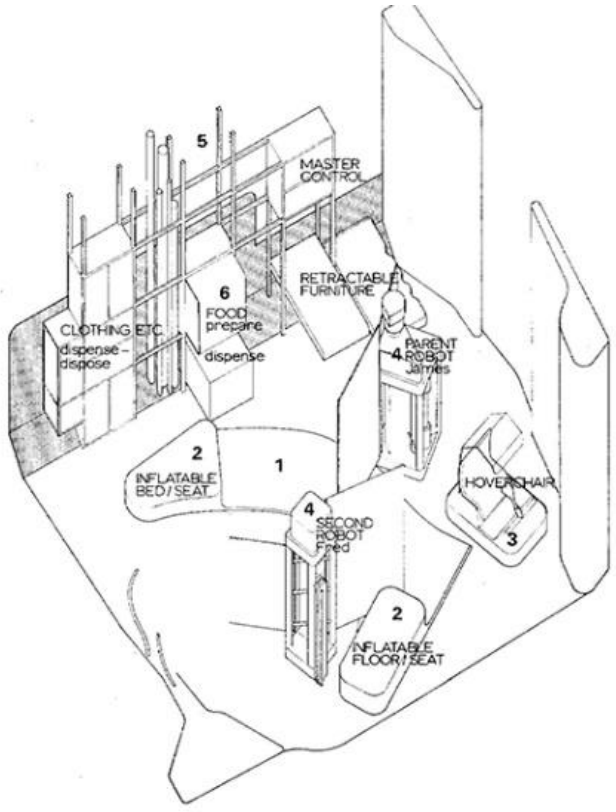


Fig. 6. 1990-House, archigram. 1967.

We can see how almost all the services of this floor are solved with 1 3D-compact component. Only the toilet and the shower appear as robotic pods that slide on the floor of the flat. This section also includes resting pods, used nowdays in Tokyo hotels for short stays and those inside train carriages, ship cabins, or air fuselages for wc.

3D-pod "inside of loft" (stacked and rolling):
Robo-house (R. Herron, 1987) Fig.7

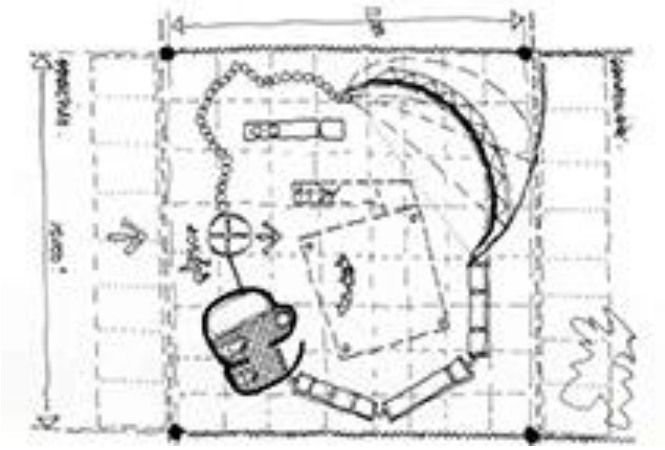


Fig. 7. Robo–House, R.Herron, 1987.

We can find all kinds of 3D components inside this double height nave to plenty a set to generate very different environments in relation to the feelings and demands of its inhabitants. All these 3D components can automatically slide on the floor. The component fleet includes two 3D-pods stacked on 2 levels to serve where the user prefers, and they are very similar to dimaxion pod.

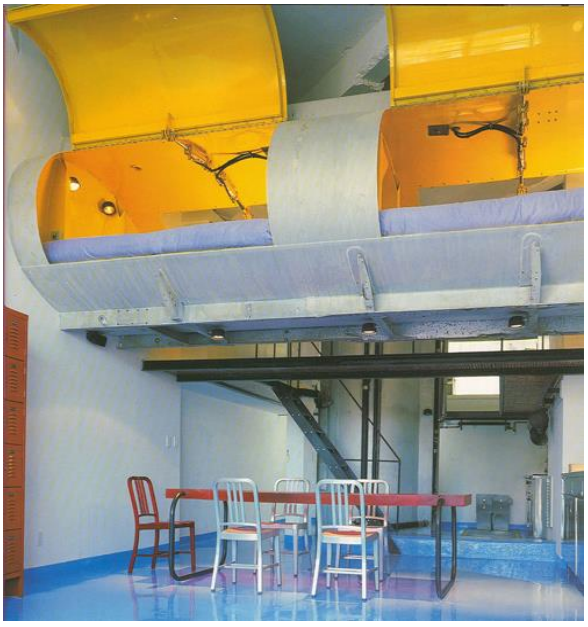


Fig. 8. Loft in Manhattan, lot-ek, 2007.

3D-pod "inside of loft", on stereo-grid:
Loft en Manhattan (lot-ek, 2007) Fig.8

In this case, the function of pod is to rest, but the components do not come from the factory directly, as happen in the hotels in Japan that have been seen before. Lot-ek uses a recycled tank for liquids to get the desired component: the larger size takes us from the flats to the loft, and to set up the tank on the second floor, a steel reticule helps to reach this. In addition, Lot-ek obtains a result similar to Herron's in the robo-house with 2 identical pods using another vertical tank to place a bath in each level.

3D-pod "plug-in" at vertical espine:
"Plug-in city" silos (archigram 1967) Fig.9

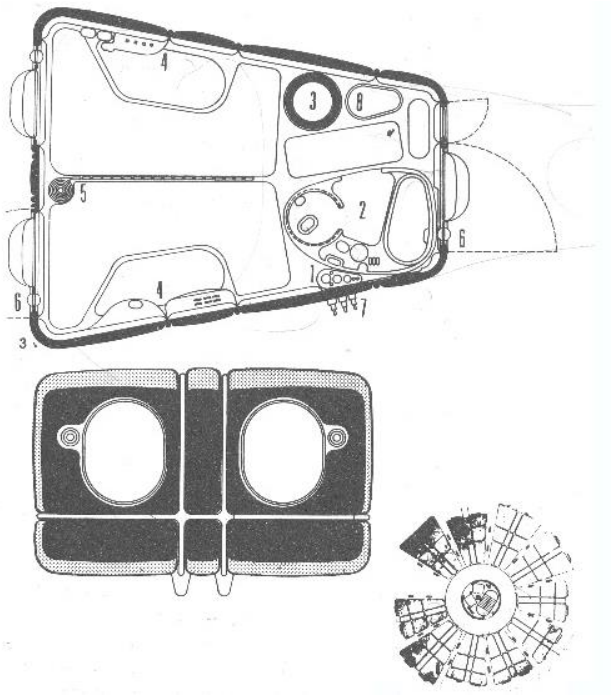


Fig. 9. "Plug-in city" silos, archigram 1967.

This is one of the most popular archigram´s proposals, and it represents very well how to get a vertical housing complex where the sizes and functions of the apartments are obtained through the adhesion of 3D-pods components both horizontally and vertically. The pods (metals or PVC) has circular sector shape around the supplies and circulations vertical column. Then, this kind of towers generate by this plug-in procedure has high grade of spatial flexibility.

3D-pod "plug-in" at horizontal spine:
Set-urban (R. Herron, 1982) fig.10

In these dates archigram-group activity was very diluted, and the technological euphoria of 60`s had decayed very much. This reasons made Herron´s proposal leave the Megaestructures and

takes more affordable scales. The building volume is spread on the site like a camping set, and relation between nature and technology is very symbiotic. This time fluids spine is horizontal and 3D plug-in let inhabit very free to reconfiguring total set

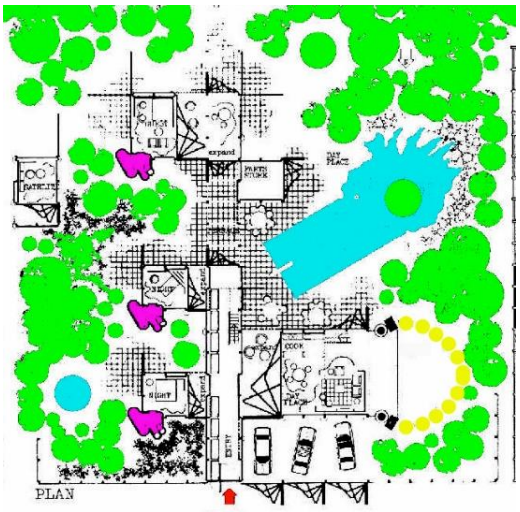


Fig. 10. Set-urban, R. Herron, 1982.

3D-pod exterior on stereo-grid:
Spatial-city, (K. Kurokawa, 1970) Fig.11

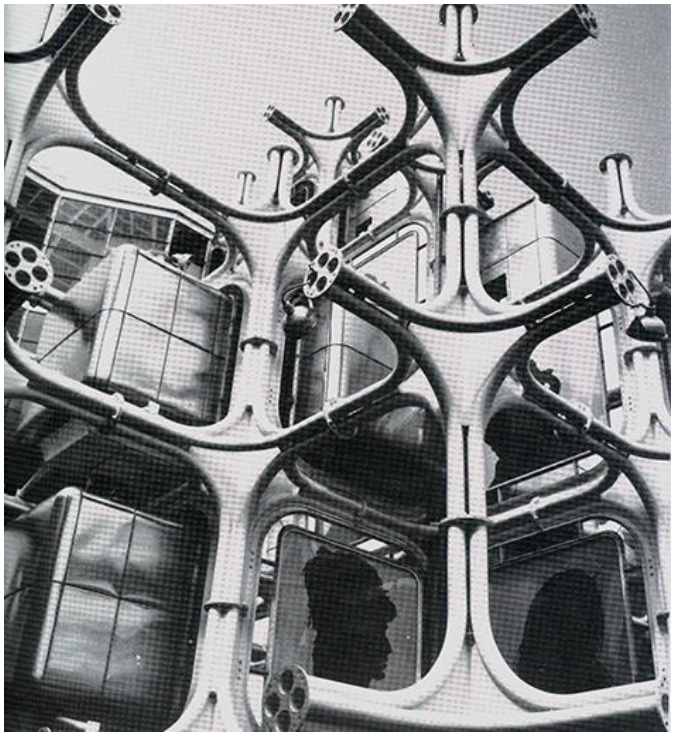


Fig. 11. Spatial-city, K. Kurokawa, 1970.

Osaka expo is the “zenith performance” for the young pop architects. Thus, Kurokawa manages to build an habitation prototype which has all characteristics of this aesthetic and spatial current: standardization, flexibility, plug-in. An complete Manifest to show the kinds of spaces we can get through these procedures, but also expose everything: all economics and energetic handicaps that are transported in these modular-matrix proposals.

3D-pod exterior stacked:
PVC pods W. Döering, 1972

Following the same matrix way of case before, but without stereo-reticule and using another materials (paperboard or PVC) this case is more cheap. This cancel partially the plug-in possibility, and the spatial flexibility getting by other ways and in less grade.

By reviewing all these examples, their authors, their dates and their accomplishments, we easily detect how most of them belong to the decade of pop, and how they have not been built either (except for those that used recycled support or come from the transport brands: trains, ships, aeronautics), and, for the most part, the cases were proposed, verified and discriminated against by the archigram members. All of this is easy to understand only knowing how locomotion sector is fully industrialized in front of building sector, and then how there is firstly the mobility concept, and architecture have to be sure and inert “per seculam seculorum” (from the eyes of Ancient Culture).

But the 3D-pod idea was changed by 3D-cabin, while makers reaching towards through assembly line process. The first idea is very attractive from cultural point and ergonomic character but in the second one, the results and built cases were widely increased; thereby designers lose the technology transfer directly from transport sector (super-technological pods), to substitute 3D-pods by another components are manufacturing like the 3D-wag analyzed in previous "

3D-bonding vocabulary" article, so the structure and infill are referred to 3D-wagon but size and functions came from 3D-caps (they have specialized space, bur with less ergonomic character than those).

3D-cabin “inside of flats” shaping verticals cores of supplies: 3x3x3 (CRL, 2008) Fig.12.

This cubic core is part of the general system configured by a steel grid with 3x3x3 m bars, which generates a housing construction with 6 height levels with flexible dwelling around each core. Each 3D-cabin includes a kitchen wall and a gray water recycling process. Also, the space system has complementary spaces on the opposite sides for natural climate regulation (greenhouse / terrace on the south side and ventilation chimney on the north). Unfortunately, the construction company imposed a new "technological criterion"

during the construction process and the cabins, and now its structure is only autonomous, not part of the main structure.

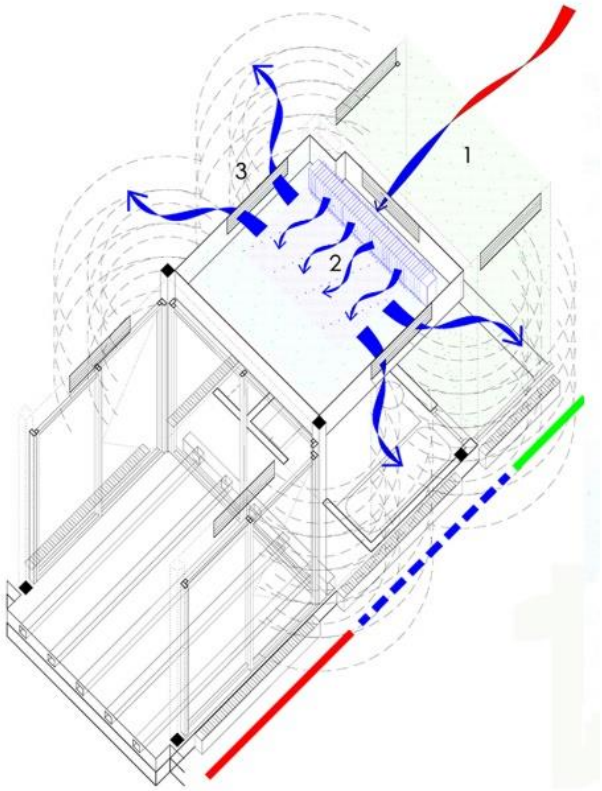


Fig. 12. 3x3x3, CRL 2008.

3D-cab "inside of flats" loose: Medialab unit, MIT 2012+ Total Furnishing Unit, Colombo 1972 (Figs.13 y 14)

Fig. 13. Medialab unit, MIT 2012.

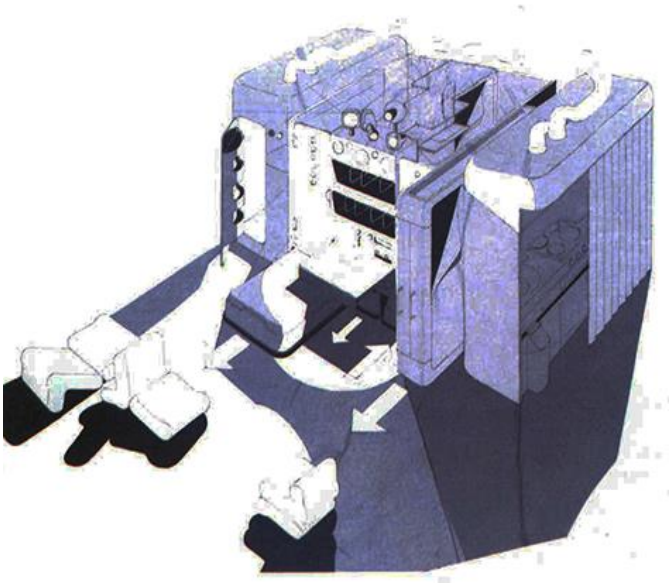


Fig. 14. Total Furnishing Unit, J. Colombo 1972.

This 3D-unit with several compact functions (kitchen, rest, work) come to reproduce "total furnituring unit" wich Colombo designed in 1972. We can check the step from pod to cabin, but also as Medialab unit is equiped with a spectre of domotic dispositives. With this dispositives the unit is transformed into a robot which moving parts follow the user spatial needs. This model currently for sale in market to equip flats in several USA cities.

3D- cab "inside of loft" rolling: Strijp-S Eindhoven (2013) + Loft at Ghent Port, (E. Lybeert, 1998) Figs.15 y 16

Fig. 15. Loft at Strijp-S, Eindhoven 2013.

Fig. 16. Loft at Ghent Port, (E. Lybeert,1998).

Part of old Philips Factory at Eindhoven has been retrofitted to get 700 loft apartments with 4.5 m high (put in several levels). The concrete structure grid leave important voids, so it is possible to site different kinds of equipped cabins at each apartment with plug-in network supplies. Each model of this wood 3D-cab configures the room type (in relation with access, and window). Units looks like they are locked, but they could move very easy with rolling and robotic because its weight and size (as Medilab MIT and Robo-house tell us). This way, the leisure and rest unit placed at Ghent Port have rolling, so it can change its surrounding spatial conditions. Also it show us how the associate function to this kind of 3D-unit is not only bath-kitchen.

3D- cab "inside of loft" into stereo-grid:
Strijp-S Eindhoven (2013) Fig.17

Fig. 17. Loft at Strijp-S, Eindhoven (2013).

At same Strijp-S complex we seen in previous section there is too cases of loft-apartment has 3D-cab into stereo-grid, to get unit up-level. Then 3D-unit function is usually to relax or special leisure.

3D-cab plug-in at vertical espine:
Nagakin Hotel, Tokyo (K.Kurokawa, 1972) Fig.18

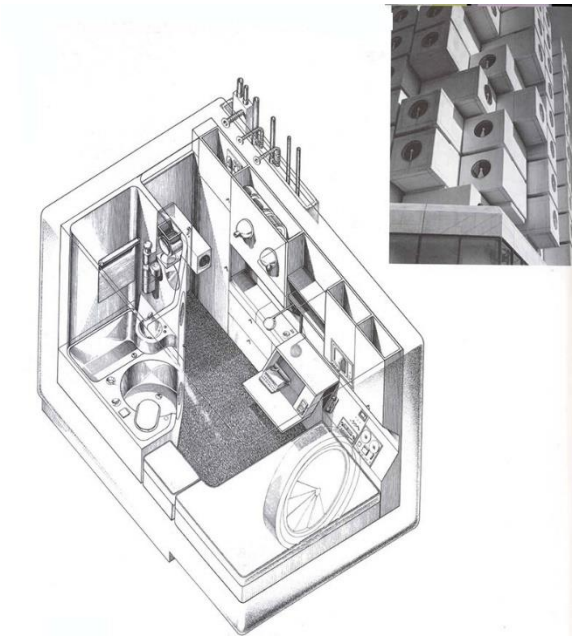


Fig. 18. Nagakin Hotel, K.Kurokawa 1972.

The archigram´s vertical silos become real if we change only manufacturing process and its geometry. One tight room with all necessary cabinets inside of one side wall, and big oculus in order to get the user projected to the exterior chosen orientation. Two circulation and supply columns serve to plug- in each 3D-cab in preset positions, then we could substitute or interchange units if necessary.

3D-cab plug-in at horizontal espine: d21_system (ETSAM+reyesJM, 2oo4) + Hamburg offices.

One central nave with several levels serve to receive at its both sides one catalogue with 21 different cabins.

This cabins configure and conditioning the spaces and uses they leave among both parallel bands. 21 models include not only kitchens and baths, balconies and lookouts are key components too, if we want to control the exterior relation for each dwelling. This space typology have great flexible grade, and correspondence with its background is not hide: (Demain-1985; Vivienda filtro-1987; Urbanautas-1989; Habitaclon-1993); but most different between d21_system and those is the plug-in available technology fully functional (as happen at Hamburg offices.

3D-cab exterior into stereo-grid: d21_systems (2004)

This case is not easy to find. It has the same handicap that Kurokawa´s spatial City at Osaka; d21_system use it because of a similar reason. This prototype was designed to mount it very quick at IFEMA Fair. So stability reason does steel structure must be reinforced. But in another timing

circumstances cubes could be hanging directly from central have, then double steel sheet would not have been necessary

3D-cab exterior stacking: cassa-nova (H&H 1974) Fig.19

Fig. 19. Cassa-nova, Hübner &Huster 1974.

This case is very rare. It have same handicaps that Döring`s PVC capsules, but it is possible if is made with another technology. This example belong to 60´s organic modular fever, and finally it used as exhibition pavilion or for retail.

With this 3D-cabs cases review we prove how all item of above 3D-pod classification are infill, and here they had been examples classification, we can find as follow:

3D-comp inside of flat at supply core:
Plug-in counter / insert / deployed (Fig.20)

Fig. 20. Apartment at Paris, Kalhöfer 2001.

One of most used 3D-compact is kitchen counter as island, but if we have vertical supply columns where plug-in it, then it is very easy moving it rolling. We can see how in Kalhöfer apartment wires and pipes are naked, thus they let several operations around. Urbanauten 3D-leissure&relax is very similar: they arrive to the flat through vertical chimney, and after they remain associated to this mast (fig. 29). Nevertheless, 1990-House don't have plug-in components, but some functional devices are deployable. Also, in other cases seen above have inserted the counter kitchen in the 3D-pod as side-compact: "Maisson Abbye Pierre" (1955); "Total furnishing-unit" (1967); 3x3x3 (2oo8); MIT medialab (2012); Strijp-S (2014). Some of those have deployable devices to rest, work, or storing (Colombo-TFU and MIT-medialab).

3D-comp "inside of flat" loose on floor:
Zip-up House (Rogers+partners 1968) + others (Fig. 22)

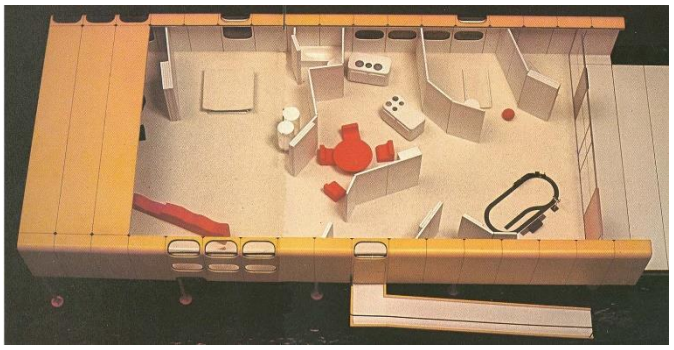


Fig. 22. Zip-up House, Rogers+partners 1968.

Zip-up house is one shell made with sandwich panel without structural obstacle under it. The floor is elevated by micro-pilots and this is space serve to network supplies circulation If habitant need install one 3D-comp at any point, he can made a hole very easy with a drill to drive the conduits, and after cover it if the 3D-comp is retired. Result is directly refered to the "landscape-office", and the prototype is applied for this program at one London penthouse. Rogers design after this a rolling station-desk set on technical floor for Lloyd´s of London which project images, also several info-pole to be displaced very easy.

A&H proposal for BCN Diagonal (1987) take same concept of the last case to kitchen and bath functions (like "CLEI deployed Kitchen", "vertical-home", "all I own house" (packman), last compacts haven´t pipes and they are for work, leisure, rest, or storing: "big wood closets" with size and weight, easier to slide on wheels that the 3D-cabs inside loft.

3D-comp "inside of loft" stacked on floor:
Standard-of- living package (1965) + robo-H. (Figs. 4 and 7)

Maybe this item content the most famous manifest for the 3D-compacts: "standard-of- living package" published by R. Banham. One multimedia appliance with air conditioner give

us necessary to survival under “fuller´s geodesic” (this time pneumatics structure). Scale change that pull us to change the material, to change from collective space to another individual, and also from 3D-wg under Price´s ceilings to the 3D-comp to customize and conditioning the own space. And, in middle point: The Robo-House. Same reference to same spatial concept, this time transformed into a loft which host 3D-caps, but also 3D-comp for cooking, storing, and control the inner environment (air-light-sound)…

3D-comp “inside of loft” into stereo-grid:
Superchair (Ken Issac´s grids, 1966) (Fig. 23)

Fig. 23. Superchair, Ken Issac 1966).

Here, the Robo-house admits under its cover a compact into one reticule, this time for rest (like giant bunk). But in this thinking line the K. Isaac´s grids have more functions associated to this kind of stereo microstructures. So, we can find in only one 3D-component: leisure, rest, and storing functions. Sometimes they using sliders layers to get the compacts deployed (as above cases).

3D-comp plug-in at vertical-pole:
Instant-city (archigram 1967) (Fig. 24)

This multimedia-pole was designed by archigram for their famous Instant-City. One nomad city which transport Culture and leisure anywhere along British coast. Just in parallel time first rocks-concerts starts, and finally we can find this realization on the stages of most famous pop-bands. This time 3D-comp has all kinds of multimedia devices: display speakers, spotlights... the same repertory there is in Robo-house, but using a different scale. Here we can detect clearly the technological transfer form Blackpoole-Park to Carnaby Street and its theory trail.

Fig. 24. Instant-city media pole, archigram 1967.

3D-comp plug-in at horizontal band: INVISO system (G+T, Guardiola. 2oo8) (Fig. 25)

In this case, the 3D-comp are hanging at the exterior of the building edge just where the inhabitant needs them (like "exterior-closets"). And, as the same way happen with plug-in pod and plug-in cabin, the inner space which they complement is transformed from the conditions added functions at the edges. The result we can get about flexibility and possibilities is more or less the same that then, but here the velocity and agility for any change is very much greater. Best prove of this is the win prize granted by INVISO (industrialization for sustainable dwelling), Research Team hosted in CSIC (Spain High Council for Scientific Researchs).

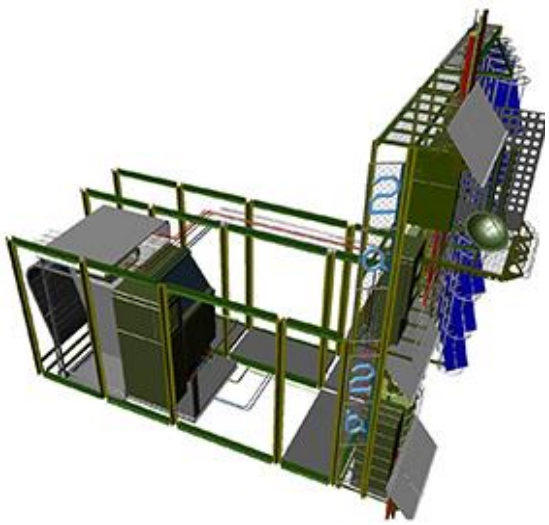


Fig. 25. Compact plug-in at general BUS of INVISO, GTG, 2007.

IV. COMPARISONS OF ITEMS AND CASES

We can see how 3D-pod and 3D-cab cases always are immobile (locked) when configuring vertical network cores (dymaxion, M Abbie Pierre, 3x3x3, All I own house), their prototypes have always been built and how there are trademarks in E.U. for this demand (Conspace, M. Jumilla, Norac, BDS…). And for other hand, how when this kind of components lose the vertical of previous column, then they admit displacement over floor. This has led to think about its motorization, and so it goes from the "Total furniture unit" to "MIT Media Lab unit", both are very similar as they are thinking for the same functions within any apartment, but the last one, allows changes and movements very easy through the home automation interface. The single 3D-pod case are also fabricated and sold, but they are used usually in locomotion sector (toilets cabins for Talgo, Boing, Yachts…). The "capsule hotel" of Kurokawa in Tokyo is a clear case of technology transfer, where the bunks of any standard yacht have been moved to other place.

We can also check how when 3D-cab is inside of loft, then the movement demanded by the projects using 3D-pod (Robo-house) becomes real (loft in Ghent Port). Mostly of them transport bath-toilet function (+ kitchen compact) but not always: if they get moving, then they lose vertical supply network, so they can transport another functions as rest, leisure, or storing (when cabin is inside of loft, this functions could be also on cabin top).

But, if we change from 3D-pods/cabs at inside situation to plug-in, then this latter case goes to building edge (exterior situation). This means, the spatial conditions of service zones leaves the inner space free, they can be a “plug-in” connected from exterior just exactly where we need them, and the flexible quality of the project increase very much. If we apply plug-in by horizontal bands, then functions are usually very specific: toilets, kitchen (urbanautas, set-urban, habitaclon), but there is also other cases with another different functions: relax, bow windows, balconys (d21_systems, Hamburg offices). Nevertheless, if plug-in component is applied to a vertical network spine, then functions usually are mixed and can be combined with each other: fully device-equippied rooms (Nagakin Hotel, Plug-in City).

When we do the same with 3D-compact, we can see how its functions are also associated with different uses (cooking, relax, leisure, work, storing ...). When function of component is not kitchen, they usually appear as deployed pieces of the compact (Lloyds rolling desk, towers at diagonal A & H, survival-unit-kit), but if they are for cooking, then deployed is produced by conjunction of 2 depending and mobile counters (robo-House, Kalhöfer in Paris, Casa-Barcelona), or one of them is locked to the cabin and the other loose as dining table (TFU, MIT, CRL, 1990-H, All I own house). Like in previous point, there is also trademarks to reply to this kind of demand (bulthaup, Fagor, CLEI,..). When we play with thin parallelepipeds, the use of rails or the slide over floor is key to get very flexible spaces.

So, we can prove how those supplies only used for landscape-offices (power and communications) were transformed into another kinds of services fully matching with any domestic standard program. But no only this, if application of the plug-in is realized along exterior building edge, then the spatial flexibility for served space is more versatile and operative (as we seen before with the 3D-pod). The INVISO case or the proposal of "Q21_architecture" for “puertochico” retrofitting at Madrid show this clearly (Fig. 26).

Fig. 26. Puertochico on moving, Q21_arquitectura 2009.

With all the above, we can state that plug-in technology makes it very easy to change the service areas from one site to another, and therefore very easily increases the degree of flexibility of any type of architecture in which it is applied (homes, offices or multiple spaces).

V. SMART COMPONENTS (EQUIPMENT, SIZE, AND ROBOTIC)

If we facilitate the mobility of all the components seen up to here, then we get spatial flexibility on the architecture on which they are applied. But its features are usually not only mechanical (lighting, sound-acoustic, thermal regulation ...) curtains, gates, and internal divisions, but also essential to keep the comfort of any ambient (and its mechanical characteristics, affect their control).

Therefore, when the 3D-compact and the 3D-cab crawl behind all this kind of benefits due to their possible movement / displacement (doors-light-sound-stairs or data, water supply or air) they become true smart objects (smart-components) that

give an interactive response to the inhabitant that controls them, and to the adaptive space that he needs to reconfigure.

And, if these displacements are motorized they will be more domotic (smart)

We can review the examples shown in this article with this criterion, and identify which are projected with this last objective (not built yet), which are existing intelligent components (built and with applied automation), and which are still only manual, but immediately possible motorization:

3D-comp with movements and adaptations projected with home automation: inside (1990-house; Robo-house; C. del Paraíso); exterior plug-in through cranes (plug-in city, urban-sets, urbanautas, INVISO, puertochicosemueve (fig.30)).

Really constructed 3D components with moves and home automation adaptations: inside (MediaLab MIT unit, Loft in NYC); exterior plug-in through cranes (d21_system; offices at Hamburg) (Fig. 27).

Fig. 27. Retrofit offices at Hamburg, 1999.

3D-comp has manual movement with immediate motorization: inside (Total Furniture Unit, loft at Ghent Port, Strijp-S Lofts, Kalhöfer apartment in Paris, vertical Home, All I own House: enorme-studio).

We check how only inside 3D-pod and cabs configuring supply cores remain as static components; and also how weigh and size are determinants to evaluate the properties and moving possibilities of this kind of components: The INVISO 3D-compact is most operative of all plug-in exterior units examined, and the rest interior components are moving very easy only transforming it from 3D-cab to 3D-compact (like Kalhöfer kitchen at Paris flat).

VI. OBJECTS SYSTEMS : SPATIAL TOPOLOGIES

One of most relevant out-put from this cases study is to have determinated the way that this components configure the space where they are included. Thus, from this idea, we can enunciate the space as "the out-put of established relations among different kind of objects". In other words, by one hand we have all market brands that are able the supply of 3D-components as individual objects (Conspace, MJumilla, Norac, Bulthaup, Gerberit, CLEI…), but by the other hand, we also have enough habitation examples to prove how this objects are distributed and related itself to define its corresponding types of spaces: its own syntax (as Structurist Philosopher M. Focault said us) (Focault, 1966).

In this sense, we have to highlight how, they really behave by configuring certain zoning and combine as follows (although these components acquire a certain degree of free movement): most cases examined (object systems= space) have correspondence with the 4 standard topologies defined in "The Fates of four Games" (Mairea, 2009): (E) comb; (0) basilica; (I) spine; (H) with central supply core. (Fig. 28).

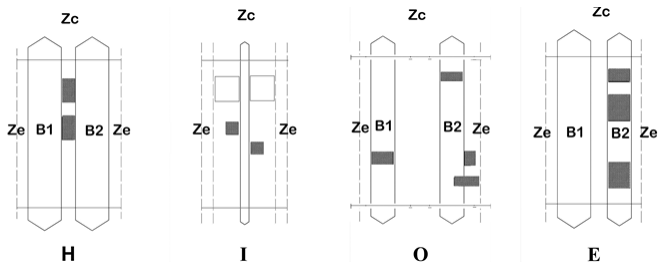


Fig. 28. Four main spatial topologies for flexible standard dwellings extracted from dB alFA-G.100 (Mairea, 2009)

1990-house, Robo-house, C del Paraíso, ALL I own house, INVISO, of. at Hamburg, MIT Medialab, Strijp-S, organize its 3D-components as comb (E) topology: they configure a space with 2 very defined parallel bands where one of this takes all specialized smart-components and the other, remain very free of services and objects. Thus, we can see clearly: one band with "serve spaces" (with very special functions), and other with served spaces" (polyvalent depending from its serve components). This provoke that the adjusted spaces and sizes of 3D-pod and 3D-compact are in contrast beside other parallel complementary space with large and spacious properties.

d21_system, Urbanautas, Habitaclon and Demain, organize its 3D-components as basilical (0) topology: this time 2 parallel bands with specialized uses determine between them one central area (Zc) more polyvalent. The plug-in technology of both cases (E.0) (3D-components combinatory) is applied in horizontal bands, and allows high flexibility in spaces determined by the system.

Plug-in city, Nagakin Hotel, urban-sets, instant-city pole, organize its 3D-components as spine (I) topology:

Here 3D-components are applied right at the vertical supply column or horizontal supply corridor (Zc). We need in all this cases crane or fingers-lifts to set components in the predefined places. System offer flexibility through substitution or permutation of 3D-units and the adjacent combinatory. This typology complements the spaces of service with service spaces when the designer reserves unplugged segments along the spine for the latest spaces. This way, system generates alveolus inside it, that brings us the polyvalent complementary spaces in corresponding with specials spaces.

M. Abbye Pierre, 3x3x3, Loft at NYC, respond to (H) topology. Here the 3D components are locked and structural, and the polyvalent complementary space happens around the central core. This case usually has no compacts in this space crown, and the divisions and cabinets define the resulting rooms. Only when central core is inside loft there is enough space to include relax or leisure compact into reticular structures set on crown (as happen with K. Isaac structures, or Lot-ek loft at NYC). When the core is transformed into a thin vertical supplies column, then 3D-compacts of kitchen, bath, or toilet, turn around this pole configuring the corresponding polyvalent crown.

Lastly, only certain spatial reticular organizations could generate other kinds of topologies (as perhaps under the archizoom large voids). But if we carefully analyze the variations produced in these interior spaces, we can detect systems of objects that reproduce the 4 topologies mentioned above in different scales.

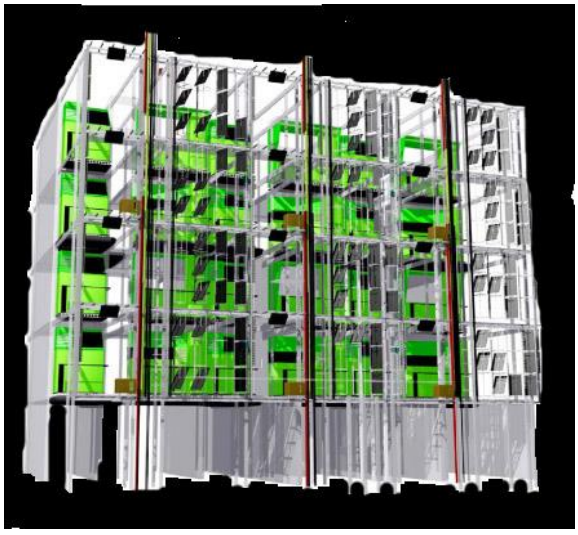


Fig. 29. BUS elevation for INVISO 3D-comp system.

This proves how all spatial potential associated to smart components (with plug-in properties) are subordinates to certain relational laws to get domestic habitable spaces: the necessary syntax to objects can generate systems with sense. And also, how these spatial laws are subordinated by the layout of the general supply networks traces, which they serve shaping the space (working like an omniBUS connector (Fig. 29) as named above: only one horizontal band beside building (E: comb); 2 parallel bands each building sides (0: basilical); horizontal central (I: corridors/spines); vertical supply cores (H); (usually this last are the cheapest, therefore, the most used).

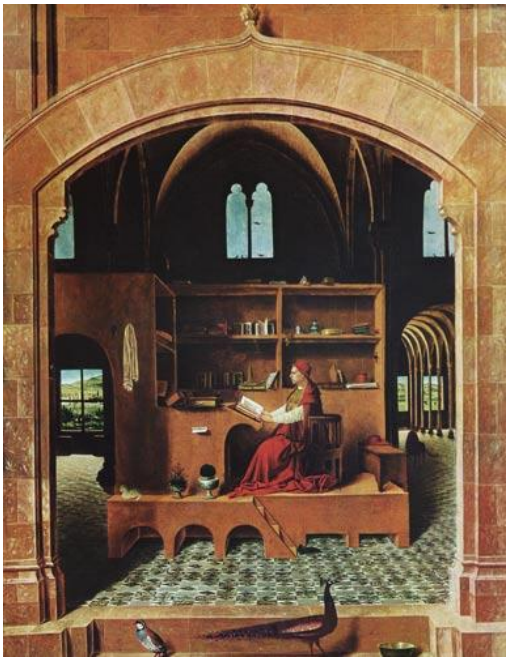


Fig. 30. "San Jeronimus in his studio" (A. da Messina, S.XV).

Finally, we can remember the famous painting "San Jeronimus in his studio" (A. da Messina, S.XV) (Fig. 30), where we can see how the Saint reads and writes very comfortably in a 3D wooden-cabin that works as a spatial complement in relation with the total space of its corresponding container, a spatial complement to control the surrounding environment and obtain a real domestic space.

Thinking this key, we can forget the very specialized "existenzminimum" CIAM home to recover rooms with real spaciousness qualities that only needs to be equipped with a basic smart-component set, corresponding with each inhabit definition.

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