Integrating Active Technologies into Housing-Block Designing

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Summary

Current technological developments allow us to consider how devices intended for compensating functional loss to a certain part of the body not only facilitate the activity's development but may also act as a specific substitute. ACTIVE technologies act on behalf of persons but require an exterior energy supply to be able to perform their substitute work.

Before we can integrate such technologies into housing blocks we need to answer two basic questions

- What construction and design provisions must be made for integrating active-technology providing installations into housing blocks?
- What possibilities and limitations do they have in improving personal autonomy, by controlling the immediate environment of the housing location?

To answer the first, we need to make provisions in our designs for every type of energy source and supply, such as where that supply is to be connected, how it is to be transported, where it is to be consumed and how its waste products are to be dispensed with. In answering the second, we need to identify the system's principal components, note the range of features the system can offer, and study the limitations that it currently presents.

1. Technologies for accessibility: active and passive

Current technological developments allow us to consider how devices intended to compensate the loss of functionality to a certain part of the body (or merely to improve comfort) not only facilitate the activity's development but may also act as a substitute for specific tasks. From this point of view, it might be said that technologies fall into two groups:

- PASSIVE, which improve the possibilities of environmental use without substituting human body actions. Slip-resistant ramp pavings, prostheses that aid walking, "Braille" writing systems, anatomical doorknobs or mixer taps, to give a few examples.
- ACTIVE, which operate on behalf of the person. A lift, an electric wheel-chair, doors which automatically open as people walk up to them or water which is released from a tap when hands are drawn near to it.

Both "types" of technologies need to be combined for improving environmental accessibility. For professionals working in construction, it is not hard to come across the following reflections: instead of adapting buildings and the urban environment, would it not be better to develop wheel-chairs which can negotiate stairs? The answer seems obvious: both need to be done at the same time; just as improvements to transport vehicles (cars, trains, etc.,) occur in parallel with improvements to infrastructures (roads, railway routes, etc., so progress in accessibility must employ both "active" and "passive" technologies.

2. Using active technologies in housing

Introducing accessibility resources into buildings has been principally based on incorporating passive technologies, although there are some notable exceptions such as mechanical lifts.

Such primacy in passive technologies, in comparison with active ones, is even more striking in housing blocks, where technology is usually exploited much less frequently than in buildings designed for public use; as a consequence, provisions for incorporating active technologies into housing blocks have always lagged behind requirements. We need only recall the serious difficulties we are presently faced with in installing lifts in a great number of buildings constructed during the recent decades of the '60s, '70s and '80s or how up to very recent times telephone systems were superimposed on building facades, even newly-constructed ones, in an anarchic and even shameless manner.

In short, there are two principal advantages in using active technologies for housing automation:

- They significantly reduce the capabilities required for using various tools and mechanisms: pressing a lift button instead of having to walk up stairs,

placing one's hands near a tap instead of having to handle it or activating blinds or shutters electronically instead of having to use manual elements.

- They automatically enable many daily-life activities: regulating environmental temperature, switching light sources on or off and adjusting light intensity or activating security systems.

and as a consequence, they facilitate an independent living and increase personal autonomy for disabled users.

At a time when the market is bursting with products and systems for "home domotics" or "environmental control", it might be a good idea to carry out a comprehensive study on active technologies applied to housing blocks and attempt to answer the following two questions:

- How may a building be prepared for a problem-free incorporation of active technologies? In other words, what construction and design provisions ought to be made for integrating installations into housing blocks which provide active technologies?
- What contributions do active technologies make to improve accessibility to the physical environment? What are their applied fields, what are the possibilities they offer and what are the limitations or deficiencies they present?

3. Integrated design criteria for service-supply installations[1]

To start with, it could be asserted that every active technology requires an energy supply for carrying out the work it is supposed to do for us and that this energy is channelled within buildings through what we generically refer to as "installations". It would therefore be convenient to analyse which facilities become incorporated into housing-block designs and construction, and under what conditions, and what the current deficiencies are and options for the future.

There are currently four basic supply types (although they are not found everywhere): gas, water, electricity and telecommunications. In designing these installations we should single out two clearly differentiated sections:

a) Installations outside the building, for which the respective supplier companies are responsible up to the point of connection.
b) Installations within the building, for which first the agents participating in its construction are responsible and later, once constructed, the final users. It is interesting to distinguish between those sections that are communal and those that are exclusive to each residence.

3.1. Installations outside the building

There are significant differences between one type of supplier and another. We shall try to focus on those aspects that may affect users the most, in particular where users have some form of disability which they attempt to overcome by using an active technology, something which will make them more dependent on and vulnerable to any eventuality affecting the service's supply.

Companies (although they may be other agents) essentially have the concession for a certain product which:

a) They create or convert
   It is this process that will ultimately determine the quality of the final product reaching users and consequently its features.
b) They transport
   At this stage speed and reliability are essential for the product arriving in suitable circumstances and at the appropriate time.
c) They supply
   The quantity which the user theoretically requires.
d) They manage
   And draw highlight, on account of its importance, the price they set for the service they provide.

All these factors clearly affect each of the products' use as a source of accessibility. While electricity and telecommunications certainly offer great possibilities with regard to accessibility, it is also the case that expensive, low grade supplies that lack reliable services minimize such possibilities.

3.2. Installations inside the building

It is here that reflection on the criteria to be taken into account for the correct integration of housing-block installations takes on its full meaning - as much for enabling their future incorporation where they do not form part of the original supplies (gas, for example, is not mandatory nor are certain telecommunications either, although they must be provided for) as for enabling the ready repair, maintenance, alteration or extension of those already in place.

There are four main issues to be resolved:

a) Outside connections
   Gas and water are practically always piped underground, below a public high way, for which reason the connection will be made in the subsoil in accordance with existing regulations and the supplier company's standard practices.

[1] This article does not discuss alternative energy sources in this development, such as solar or wind, which not depend on supplier companies.

Electric power lines tend to be placed underground although it is still taken for granted that two types of connection can still be made, overhead or below ground. Existing regulations too, supplemented by the supplier companies' discretional practices, clearly define the construction provisions to be taken into account.

Telecommunications prove to be more complex in that they may be received either through cable (telephone, fibre optics, etc.,) or by radio-wave (mobile telephone, television, radio, etc.). Both options must be considered, so that a connection can be made either underground, from the public highway, or overhead, from the building's roof. Regulation for all this is recent (the legislation dates from 1999) and its impact is therefore still limited.

b) Transport via the building's interior to residences or private entities.

Fluids (gas and water) are transported through pipes whereas electricity and telecommunications (if they are not overhead) are delivered by cables.

This subject is especially important from both the construction and the management points of view. If the installation does not run in its entirety through common, inspectable elements, with room that provides for possible extensions, etc., it will be difficult to adapt it to needs that change over time. These construction aspects aside, account also should be taken of the fact that modification of any communal element must be jointly agreed on by all the building's property owners, and this does not always turn out to be straightforward. Therefore while provisions for construction are essential, they are not sufficient in their own right without a consensus among communal property owners.

There are legal regulations and complementary practices for supplier companies managing installations which connect the outside supply points to each of the housing units. It is logical enough for them to take certain criteria into account when guaranteeing their repair, maintenance, alteration or extension although the range of potential circumstances to bear in mind is extremely wide and on-site situations vary greatly. It is because of all this that the designer's role is critical. It has already been stated here that regulatory regime regarding telecommunications is recent and its effects consequently still rudimentary. On the other hand, this regulatory regime has been granted more generous provision than those of the other supplies.

c) Consumption points

In general fluid supplies have a localized use: in the case of gas, this is limited to the kitchen and its ancillary premises (laundry room, lumber room, etc.); in the case of water, this includes hygiene facilities, whereas cable supplies (electricity and telecommunications) are extensively used throughout the entire housing block.

Deciding on the location of the consumption points and on their features is important and at the same time complex since it presupposes having knowledge of the final user's personal details (interests, habits, physical capabilities, etc.) for enabling the positioning of consumption points in a suitable venue and with the most appropriate design. Furthermore, elements for use in installations are subject to a technological process of constant modification and improvement (boilers, thermostats, programmers, switches, etc.) which further complicates the matter.

Difficult as it already is, as regards passive technologies, to define how the interior of a housing block ought to be, so that it can prove useful to children, the young, the old, the blind, wheel-chair users, people with impaired hearing, etc., the field of active technologies turns out to be even more complex. This difficulty is counteracted by the user having a greater capacity for modifying the interior of the housing block he or she lives in.

As in so many fields that relate to accessibility, two aspects will need to be dealt with at the same time. One of these involves attempts to ensure that new products appearing on the market and intended for large-scale use provide the greatest possible features as to accessibility. In this regard it is interesting to note that a development is taking place towards integrating every service using wiring as a medium (electricity and telecommunications) into a single range of products. Consequently, the main companies that manufacture electronic appliances are offering new products with more features in their catalogues, so that traditional appliances like switches can now be automated (switching themselves on when they detect a person's presence) or capable of adjusting brightness (by dimming or increasing light intensity at will) while room-temperature thermostats are time-programmable chronothermostats; in addition, devices are now included (anti-theft alarms, sound diffusion systems, etc.,) which previously only specialist companies would offer, gadgets are added (smoke detectors, water or gas-leak detectors, etc.) which provide new features and integrate into communication systems (electronic porters, video porters, telephony, etc.) The fact that these features are accessible guarantees disabled people the availability of reliable technologies at reasonable prices.

The other entails the creation of specific products or adaptation of existing ones for disabled people

who have no immediate or direct access to what is offered on the market. All in all, it will always be necessary for a limited group of "made-to-measure" users to allow the housing block's immediate environment to be used in the most autonomous way possible. It is interesting to see that a burgeoning company market has been developing which offers domotics or automated adaptations to housing for disabled persons.

All supplies have specific guidelines for managing a housing block's interior installations and which, on the whole, are sufficient to guarantee a basic consumption; for example, sectorizations and inspections that are essential for allowing repairs or modifications, determine the minimum number of connection points, capacity margins for enabling consumption expansion, etc.

In view of such great complexity and diversity, it would be difficult to incorporate useful accessibility criteria for every type of user - beyond what is already established by the guidelines themselves for the supply in question - unless it is known to the final user beforehand (in the case of constructing or repairing the housing block itself or the residential units that are sold or allocated before their completion).

d) Waste removal

Any form of energy use produces waste which needs to be removed. Gas will require ventilation holes and shafts, water a whole drainage system, electricity an earthing installation with its appropriate safety features, telecommunications, which dissipate via the air, the necessary sound proofing between premises to avoid disturbing neighbours.

The regulatory regime is diverse and, on the whole, less demanding than those applying to the other three points discussed. Thus, problems may be caused over positioning an appliance in the housing block that consumes gas and requires a conduit leading to the exterior (boiler, drier, etc.), over modifying a bathroom and replacing the bath with a shower unit, where this operation affects the drainage system's general installation, over placing an electronic technical aid inside a room with running water where it is not possible to implement a series of safety measures or over carrying out night-time telework, without disturbing neighbours, which requires audio-visual media.

3.3. Summary outline

It might be useful to draw up a summary outline for active technologies associated with housing blocks which depend on an outside supply. With regard to outside installations, there are four sources currently available (gas, water, electricity and telecommunications): those aspects most notable for ensuring the supply's maximum possible accessibility are shown. Regarding interior installations, four key questions arise over guaranteeing the operating capacity of each of the supplies: Where is the connection to be made? How is it to be transported? Where is it to be consumed? How are the waste products to be removed?

ACTIVE TECHNOLOGIES ASSOCIATED WITH THE HOUSING BLOCKS					
require: energy		which creates: work			
EXTERIOR INSTALLATION		INTERIOR INSTALLATION			
SOURCE	SUPPLIER	WHERE IT CONNECTS	HOW IT IS TRANSPORTED	WHERE IT IS CONSUMED	HOW IT IS DISPENSED WITH
GAS	COMPANIES •CREATE quality accessability •TRANSPORT speed reliability •PROVIDE quantity •MANAGE prices	PUBLIC WAY underground	PIPES	KITCHEN	VENTILATION SHAFTS AND HOLES
WATER		PUBLIC WAY underground	PIPES	KITCHEN BATHROOM	DRAINAGE
ELECTRICITY		PUBLIC WAY underground/ overhead	CABLES	THROUGHOUT THE HOUSING BLOCK	EARTHING
TELECOMMUNICATIONS		ROOF, PUBLIC WAY underground/overhead	CABLES	THROUGHOUT THE HOUSING BLOCK	AIR (sound proofing)

Table 1. Active Technologies associated with the housing blocks

4. Possibilities and limitations in active technologies in improving personal autonomy through environmental control

Integrating the different active technologies into a domotics system which enables the housing block's environmental control and communication with the outside is, without doubt, the main objective in increasing personal autonomy and facilitating independent living for disabled people.

There are three issues that may be of interest: identifying the principal components of the system, noting the range of features it can offer, and studying the limitations it currently presents.

4.1. Domotics-system components in housing blocks

We could summarily say that a home domotics system consists of the following components

- Emitters: these are the devices which emit the operation order.

  They can be automatic (by hourly or level regulation, etc.), sensory (temperature, light, water or gas-leakage detecting, etc.) or responsive to a person's action, either directly or via an

external device (remote control, computer, mobile telephone, etc.)

- Receivers/Actuators: receive orders and then act on them.
  Practically all components need electric energy for the action to be carried out, whether for initiating, maintaining or completing the process. Functional automation therefore requires extending the electrical installation.
- Medium: through which the emitter's order passes.
  It may be through data-specific wiring, using the electrical wiring itself or via a wireless system as well (infrared, ultrasound, FM waves, etc.). Such wiring is mainly used in new, centralized installations. It has a high capacity and is very reliable, fast and safe, but it requires significant work. Using electric wiring reduces the number of features and increases the interference risk, although it does avoid double installation. Wireless systems are very versatile and do not require building-work, but its universal use is restricted by the incompatibility of their languages and protocols, by the differences in their features and ranges between systems and by security problems associated with hacking; without doubt their potentialities are enormous and their use is on the increase.
- Language/Protocol: which is used so that the order given by the emitter can be understood by the receiver and all the components within a complex system can understand one another.
  The lack of an internationally developed and accepted protocol, at the very least, is a serious deficiency and one of the principal obstacles to the extensive introduction of domotics systems in the home. Note the following, for example, which exist side by side: the **X10** (is very widespread throughout the world, in being the first standard created for domotics systems), **KONNEX / EIB** (an easily scalable, open European standard), **LONWORKS** (a private US standard directed towards industrial or large-scale applications) and others, in addition to numerous **Proprietary** systems (developed and used by specific companies).
- Controllers: which enable the control, running and operation of a complex system. For instance, a computer with its software (both that of the system's internal control and that of user dialogue), PDA, Tablet PC, mobile telephones, remote controls, etc.

4.2. Features of a domotics system in housing blocks

From the point of view of accessibility there are two aspects in a domotics system which are of most interest to the user: the possibilities of the environmental control it offers and the way of accessing it or the user-system interface.

These days the operational possibilities domotics systems offer are enormous. They can integrate, for example, functions such as:

- Security: intruder alarms, security cameras, personal alarms, technical alarms against fire, for detecting water or gas leakage and for locating electrical faults, etc. (fig. 1, 2 and 3)
- Communication facilities, telephony, internet access, local data network, etc.
- Automated control: shutters and awnings, doors and windows, locks, watering, electrical household appliances, etc.
- Multimedia network management: capturing, processing and distributing images and sound
- Energy management: Air conditioning, lighting, energy saving in general, etc.
- Personal mobility: fixed cranes, hydraulic lifts, adjustable beds, etc. (fig. 4 and 5)

this is a sector undergoing constant development and change.

Figure 1

Figure 2

Figure 3

Fig. 1, 2 and 3. Flats for the seriously disabled at the Centro Dato, Madrid. Safety features can be adjusted to specific needs such as detecting falls (movement

sensors on two levels which coordinate with one another) or uncontrolled water-flows (opened taps in showers, leaks, etc.)

Figure 4

Figure 5

Fig. 4 and 5. A flat adapted by ByJ Adaptaciones, Barcelona. Improving the autonomy and safe use of the housing block may require specific appliances such as conveyor-cranes for moving into the bath and a mobile chair for enabling shower and toilet use without any third-party assistance.

As for the method employed for accessing or user-system interfacing, this is fundamental to these activities' efficiency because it is this that links what the person understands and is able to do with what the machine understands and is able to do. The mains points to be considered are:

- Location
  It can be individual for each appliance, in the case of simple systems for activating specific elements by button or switch, via wiring or remotely, present in each room to enable the activation of remote controls or infrared devices or centralized in a single place within the housing block with the advantage of avoiding displacements but the disadvantage of being stuck with it (although there are mixed systems that offer a certain flexibility).
  Moreover, there must be a guarantee of in-range conditions (manual, visual or auditory) so that the disabled person can use it autonomously.
- Physical characteristics
  Suitable requirements for texture (physical contours which can be interpreted by the blind, fissures for facilitating keystrokes by persons with poor motor functions, etc.), colour (contrasted for visual impairments, which does not cause reflections, etc.) size (appropriate to each person's dexterity, strength, and visual acuteness, etc.), form (ergonomic, without ridges, etc.) and other features, are very much connected to the needs and capabilities of each individual: for this reason numerous individual adaptations have been developed which are tailored to specific needs. (fig. 6 and 7)

Figure 6

Figure 7

Fig. 6 and 7. Remote controls with large push-buttons, sharp colours, and no ridges, etc., and keys with contrasted letters, with Braille line etc., can facilitate interaction with many disabled users.

- Conditions of use
  This is the most important aspect for people with a severe impairment and, in particular, where there are multidisabilities.
  Combining the type of action necessary for activating a device (pressure, breathing, eye-movement, voice, mere presence) (fig. 8, 9, 10 and 11) with the software developed to control complex actions through simple operations (touch-screen selection, sequence and chain programming, voice-command responses, process automation etc.,) (fig. 12 and 13) offers a variety of possibilities for increasing people's autonomy and independent living by adjusting to each user's different needs and possibilities.

Figure 8

Figure 9

Fig. 8 and 9. Chin and lever switches, large and chromatically contrasted, are examples of adaptations to different conditions of use.

Figure 10

Figure 11

Fig. 10 and 11. Interactive systems based exclusively on eye-movement have been developed for people with serious mobility impairments. Codified cards enable safety and privacy conditions to be reached in the access control by the mere detection of the person's presence.

Figure 12

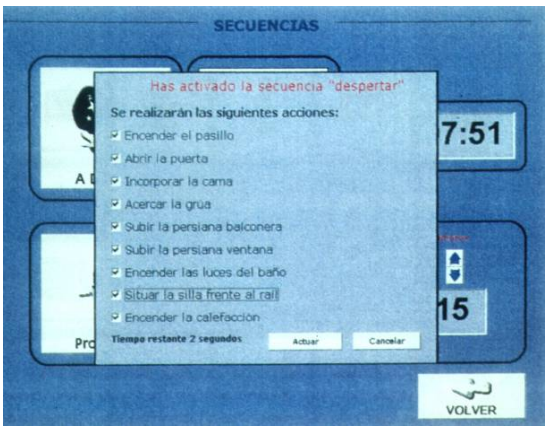

Figure 13

Fig. 12 and 13. Touch-selection and sequential chain orders linked to daily actions are examples of the possibilities which the software offers for facilitating the autonomy of persons with serious functional impairments.

- Systems for verifying results
  People with sensory impairments are those who may have most problems in establishing whether or not the command given to the interface has been performed or whether or not a set tool is functioning. Including visual and audio devices which allow the operation's verification or which indicate whether a set device or facility is functioning, enhances usage and offers security against incorrect handling.

4.3 Limitations to domotics systems in housing blocks

Domotics systems still present many problems which hamper their wide-spread introduction. For example

- Price
  Even though prices for a installation's principal components are rapidly dropping they are still significantly costly, in particular those which, because they are specific adaptations, are barely established and enjoy very limited production.
  Many elements can be installed with hardly any work or installation costs, particularly if radio signals are used instead of wiring for their inter-connection, but some sill require an extension to the electrical installation (up to the actuator), modifications of certain elements (for automating, for example, shutters or blinds) or expensive installations (such as conveyor-cranes fixed to ceilings for allowing movement from the bedroom to the bathroom).
- Reliability and maintenance
  In view of the embryonic development of certain elements and the complexity of widespread environmental control systems, a specialist may be required (which means additional costs) for the installation's regular maintenance and guarantee of operational performance and for modifying or adding features. Therefore, both the components' robustness against mistakes and the systems' flexibility, which will have to devised as modules that are adaptable to the users' developing needs, need to be improved
- Ease of use
  This is required by simple, clear user interfaces that are adapted to the needs of the disabled. As in so many other fields, the industry offers elements that can be used by people who are not disabled while adjustments can be subsequently made for minority groups.
  The software that programmes and modifies the systems operations also need to be easy to use for users themselves or their friends and family.
- Systems compatibility
  There are numerous "proprietary" systems which are company-specific and so incompatible with anything else, whereas systems that are meant to be "open" can crash through problems relating to the proliferation of different languages. Systems ought to be available as standards; however, the lack in a unified protocol or language hampers the ability of the distinct components made by different manufacturers to exchange necessary information.
- User awareness
  Most potential users are not aware of the benefits that come from using these technologies. These days it is possible to set up very simple systems, which carry out basic functions suitable to an individual person's needs and possibilities, whose installation costs are very little or nil, which are easy to operate and which can be extended in the future.

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