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► **To cite this version:**

Elizabeth Mortamais. What Is an Intelligent Building?. Organizing Smart Buildings and Cities Promoting Innovation and Participation, 2021. <hal-03781236>

HAL Id: hal-03781236

<https://hal.science/hal-03781236v1>

Submitted on 20 Sep 2022

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What Is an Intelligent Building?

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Abstract

The word *intelligent* to talk about a city, building and so on, is so overused today that one carefully avoids delimiting its contours. We admit the existence of varied and variable intelligences based on our knowledge, requirements, and necessities. Among living beings confronted with the environment, some have a more efficient form of intelligence than others. We refer to three concepts as developed by Gilbert Simondon: associated *milieu* (2005a, 2005b); concretization (1958); *mécanologiques* generations (2005a); invention (2008). After a very short analysis of the today's French Thermic Regulation we note the difficulties to exceed the question of standards, and be able to go beyond the addition of technical devices to respond to the question. To go further we need to abandon the concept of environment and rethink the whole complex systemic problem using the concepts of *milieu* and associated *milieu*. The presentation of the different generations of technical objects (Lafitte in *Réflexions sur la science des machines*. Paris, 1932) helps us to locate today's main challenge. The reasoning from the *milieu*, enables us to reach the concretization of apparatus and obtain intelligent solutions gathering several co-actors interacting in the same network: the external *milieu*, the inner one (*stricto sensus* building), the apparatus, and the inhabitants, sharing information.

Keywords

Concretization
Information
Interaction
Milieu
Memory

Network

Operation

In the present text the French quotations are translated in english by the author herself.

1. Hypothesis

Let us start from the following definitional hypothesis, which will consider the intelligence of a building as the faculty of what I will call “an artificial device” to solve a set of complex problems. For these elements have to be organized to communicate in a network system, with memory, a certain capacity of analysis and expertise relative to the complexity of the problems to treat. This set will be able to propose solutions, in interaction with the occupants integrating an internal *milieu*, and the external one formed by the natural, anthropogenic, and entropic conditions.

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2. What Is the Problematic Context?

To meet, in particular, the requirements of the current RT 2018 (RT for Thermal Regulation), the insulation of buildings must be carried out according to the inevitable norms, that of the so-called passive house.

RT 2020 website clarifies:

... by additionally including elements of energy production such as ventilation with heat recovery on stale air, enhanced thermal insulation, passive solar energy capture passively, windows of high quality, limitation of energy consumption of household appliances, rainwater recovery. (2016)

And so, the passive house will even become “house with positive energy” from 2020. [5] ...

Current normative solutions respond to declared emergencies. Yet they are not without problems. In fact, we qualify them as willingly prosthetics. The building remains designed as a structure and an inert volume, around which are installed prosthetic futures. This is a common attitude of adding elements, each, in its own specialization area, responding to the request, even if their additions don't really redetermine the whole system.

In the name of performance, we see intervening, for each technical field, a set of professions and engineering offices. This tends to transform the building into a sum of technical devices, each of them assigned to handle and fix specific problems.

What Gilbert Simondon [9] would call abstract technical object, or even, sometimes, hypertelic.

The criterion of performance, the desire to characterize the technical activity by the yield cannot lead to a resolution of the problem; the yield, in relation to the technical activity, is very abstract and does not allow to enter this activity to see its essence; several very different technical schemes can lead to identical yields; a number does not express a scheme; the study of yields and the means of improving them leaves the obscurity of the technical zone as completely as the hylemorphic schema; it can only contribute to confusing the theoretical problems, even if it plays a practical role in the current structures.(p. 254)

The technique, in its most prosthetic forms, is precisely summoned in the name of this performance (can we see a translation of the practical technical dichotomy versus theoretical technique according to the Simondonian model above?). Add to that, each device or set of devices is controlled to ensure its performative abilities. Thus, the temperature standards inside a building are defined and applied. But they do not take into account changes in outside temperature, or perceptions of users moving from an outside at minus 5 degrees to an interior at +19 degrees or from +30 outside to +19 inside. They define a state that refers only to itself. Far from the very logic of ecology that develops a systemic reasoning (including living, non-living and atmospheres).

The control can go as far as preventing the opening of the windows, in order to maintain a constant temperature, requiring an extraction of stale air (with double flow), whereas the open window obeys natural behaviors and other spontaneous goals such as talking to someone in the street, breathing outside air, listening to the song of a bird, watching and listening to children in the garden, etc.

Prostheses are therefore also restraints that define and impose specific behaviors.

3. The Notion of *Milieu Associé*

The thermal standard is considered one of the most efficient to adapt what is called “built environment” to the environmental requirements. When we say environment, we think we have said everything about what really interests us in nature.

Dominique Lecourt quotes Georges Canguilhem [7]:

Living is radiating, it is to organize the *milieu* from a reference center which cannot itself be referred without losing its meaning. (p. 83)

4. Let's Start by Talking About *Milieu* Rather Than Environment

The environment is, in our opinion, a dogmatic translation (and a reduction) of Nature, according to certain types of knowledge. The environment, in a way, is a performative decoding of Nature for the use of the human species. But in this decoding, there is obviously loss of information and a gap between the subject we are and what surrounds us.

Hence, we prefer the concept of *milieu*, which makes the general “bath” prevail and does not detach the elements from the context.

For Uexküll [14], the characteristic of the living is to “make oneself” one’s *milieu*; the *milieu* is relative to the living who dominates and accommodates it.

Canguilhem [7], in turn, clarifies his conception of the relation of the Being with the *milieu*:

So, he says:

From the biological point of view, it must be understood that between the organism and the environment, there is the same relationship as between the parts and the whole within the organism itself. The individuality of living-beings does not stop at its ectodermal borders, nor does it begin at the cell. The biological relation between a being and its *milieu* is a functional, and consequently mobile relation, the terms of which successively exchange their role. The cell is a medium for subcellular elements, it lives itself in an internal “milieu” with dimensions sometimes of the organ and sometimes of the organism, which the organism itself lives in a *milieu*. (as cited in [7], p. 184)

There is here a form of adjusted conciliation and cooperation between “objects” (including living beings on all scales) and the «milieu». The simple distinction between natural and artificial does not provide any understanding of what is happening. It is ineffective to describe and construct such situations.

In the words of Gilbert Simondon [10]:

Recourse to the notion of the associated *milieu* to think the technical object makes it possible to confer on the latter a kind of autonomy and remarkable power, since it is said that it conditions itself precisely by its relation to its associated *milieu*, which is conditioned by it at the same time as it conditions it. (p. 25)

And also [9]:

The associated *milieu* mediates the relationship between the technical elements manufactured and the natural elements in which the technical being functions. (p. 57)

Even better, for the philosopher [9] the categories are hybridizing:

On the contrary, by technical concretization, the object, originally artificial, becomes more and more similar to the natural object. (p. 47)

The artifice spends its time borrowing from Nature as its associated *milieu* (also medium). Without Nature, there is no concrete technical object. The technical scheme originates in its relation to the *milieu*. It may be argued that the *milieu*, (and so medium), is the language by which Nature is expressed in the schema of the technical object. Here, we accept the word schema as defined by Jean Piaget [8]:

... not constituting an object of thought but reducing itself to the internal structure of actions, while the concept is manipulated by representation and language. (p. 22)

The question of intelligence is not beyond reach.

5. The Concretization of the Technical Object According to Simondon

Let's go through the concept of concretization of the technical object according to Gilbert Simondon [10]: the technical object appears in a phylogenetic line where each step corresponds to the resolution of an identified problem. The lineage makes it possible to think of the technical object in an evolution from the abstract to the concrete. Jean-Yves Chateau [2] recalls that according to Gilbert Simondon:

A particular thing is a technical object only by its relation to a lineage, i.e. a series (lineage) of objects that are more and more concrete, in so far as they solve, in a more and more integrated way, their problems of working: in a lineage, the primitive technical object is more abstract, it is close to the logical diagram of assembly of elementary structures realizing each one a proper function (...); (when) the technical object becomes concrete, it progresses simultaneously with the progress of the convergence of functions in a central unit, the overdetermination of the functions of the organs, which makes the entity more and more coherent with itself. (p. 80)

This, in our opinion, constitutes an important key to understanding the criticisms we formulated above, and the obstacles we encounter in apprehending the problems posed by normative practices.

To illustrate very briefly the phenomenon of concretization, let's look at the phone we have today. It contains complex functions around integrated devices: technically a 4G device connection is fourth generation of standards for mobile telephony corresponding to a high data transmission rate, as well as a reception and transmission device. It is therefore this specific transmission device that is the heart of a device that has become hyper-communicative. For the user, in practical terms, the current mobile phone is translated into a small flat box mainly comprising, on one of its faces, a touch screen that can activate a keyboard letters and numbers, but also images, sounds. It is both a simple phone, but also a receiver and emitter of emails, word processor, small calculator, calendar, data manager (health for instance), receivers and transmitters of multiple data for very extensive activities from simple GPS consultation to buying goods, transferring money, etc. The communication has spread to very wide activities from a device whose shape has been singularly simplified, compacted into a flat object, rectangular in shape, essentially equipped with a multi-functional touch screen. We can describe this object as a "concrete" one in the lineage that connects it to (and distinguishes it from) the ancient wall phone (so-called abstract), or even to the telegraph, in so far as

many functions of communication and processing of the information aggregated to the first function of audio communication, and converged into a single object. It incorporates a very large number of functions formerly handled by separate devices, to be melted into a powerful object of simple appearance, multiple affordances and user-friendly features, ensuring “overdetermination of organ functions, which makes the whole more and more coherent with itself” to use the words of J. Y. Chateau [2].

6. Mechanological Generations: To Understand the Current Situation of the Building in a Lineage and Its Different Phases of Development and Improvement

In his lessons [10], Gilbert Simondon, referring to Jacques Lafitte and his book [4], establishes 3 successive generations of machines.

6.1. Those of 1st Generation

Passive machines according to Lafitte, they are referred to as machines in steady state of equilibrium according to Gilbert Simondon. As such they are:

... pre-scientific inventions (...) the internal logic of the objects they have produced is the in-deformability, by primacy of stable equilibrium. (p. 232)

These machines depend on the medium in terms of stability. There is search for longevity.

Let us try to identify some devices present in the construction, or the architecture, such that they could translate a belonging to each of these generations, as Simondon ([10], pp. 160–161) tried himself, on occasion.

We can identify that of simple mechanical communication—search for stability— notion of adaptation in construction field:

- Trench + footing: exhaustive summary of the relation of the soil and the building.
- Framework + roof: exhaustive summary of the relation of the sky and the building.
- Please note that the current issue of research and invention is no longer

structural stability, well-acquired knowledge.

Traditionally buildings fall into this category of this first generation of machines: the first aim that motivates building is to provide a stable protection for people to be out of rain, cold, and wind, in a secured and strong place. The elemental wish is a maximum of inertia and stability for each housing. We can declare that the origin of any building is as simple as what is named here “machine of the first generation”. Roman architecture expresses this aim very well with massive walls and vaults as Viollet le Duc [17] explained.

6.2. Second Generation Machines

Lafitte considered them as “Active machines”. For Gilbert Simondon they are machines as assembly of tools with energy transformation, ideal of reversibility of the transformations (or control by negative feedback), maximum yield and indifferent state of equilibrium.

The active machine is, however, insensitive to the *milieu*, except for the removal of energy. It is characterized by a search for power. It is about keeping the machine in these intrinsic qualities, for a goal to accomplish. In these machines, there is a non-distinction between energy channel and information channel.

For this second generation we could identify:

binary mechanical system—reversibility of transformations - search for autocorrelation—existence of negative feedbacks to maintain homeostasis according to Norbert Wiener’s ([15], pp. 189–217) terms.

Gilbert Simondon [10] gives some examples:

... in some constructions, account is taken of unavoidable displacements (metal bridges resting on pebbles to allow the expansion, Eiffel tower resting on jacks allowing to maintain the verticality in spite of settlements of the ground. (p. 180)

If, overall, buildings stay in first generation category, were inserted little by little, more sophisticated technical apparatus, the building conception would move to second generation.

At the beginning, during the very first generation itself, we could consider chimney and hearth as self-correlated proto-system (control of the air intake). Later on, technical devices were developed for second generation machines, like the central heating with the boiler, the radiators and the thermostat: what constitutes really a system with thermal regulation and corresponds at the birth of a more complex set.

Natural ventilation devices, with manual closing and opening, are also proto-systems. Water networks, followed later on by electric ones, introduced other steps. The networks of ventilation and electric refrigeration constitute real machines for the thermal regulation.

In its way of designing, Modern architecture included other machines like elevators, a machine that establishes a relationship between two levels in a building. Modern architecture tried to promote the *Machine à habiter*, according to Le Corbusier [6] wordings (that suggested a way of living beyond technical devices, of course, but implied them).

It's reasonable to note that the current issue of research and invention is no longer a search for the now acquired functional efficiency of embedded devices. It is also clear that the energy autonomy directive requires going beyond this stage.

6.3. Third Generation: Corresponding to Reflex Machines According to Lafitte's Terms

Given the current technological evolution, I consider that there are, at least, two third generation stages.

The first stage is the one that Norbert Wiener [15] defines as having a positive feedback regulator (pp. 189–217), including the notions of servo and homeostasis. This means that it allows the amplification of a phenomenon, where the negative feedback machines are only intended to bring the machine back to its initial stage, by correcting defects or creating/making changes in the state generated by the very operation of the machine (simple self-correction).

At the early phases of aforementioned stage of third generation machines, we could distinguish a category of technical objects with positive feedback but not interdependent, therefore, their positive feedback is limited.

So-called smart elevators (optimized management of the displacements) could be included in this category: there is positive feedback thus amplification but there is still servo loop (in the cybernetic sense).

And automatic closing of openings, according to criteria of normative comfort and energy saving for instance, or the coupling of the productions of hot water (electric and solar ...) could also be included in this category.

There is here a notion of amplification.

The current issue of research and invention is no longer a search for complex functional efficiency already acquired.

We can affirm this stage of fitted building does not belong to the smart building category, because it is still a set of assistant technical devices enrolled into the building, to answers separated standards.

The second stage: according to Gilbert Simondon [10], these more advanced machines are characterized by the sensitivity and importance of amplified signal transmission. There is a search for metastability responding to variations and hazards of the *milieu*. Here the machine is able to produce a close relationship between adaptation and self-correction.

The second-stage machines of this 3rd generation would be, if we use the terms of Gilbert Simondon, technical packages of reduced size or tending to be reduced for better reliability, better information output. This requires the search for signal fidelity. Here communication is not only exchange and transmission, it is original, it founds and constitutes—it translates the principal act of organization. This technical being is entirely understood as and in information, as origin and finality, element and totality.

In this configuration, it involves designing and setting up a network of communicating machines (transmit, receive, process, store, etc.) between themselves and with the *milieu*-medium ...

It is therefore the advent of a coextensive network in the world.

On this topic, the philosopher [10] mentions:

... in its last stage, the technicality of the networks concretely finds the *milieu* by becoming coextensive with the world, while the human operator is only in

contact with the terminals, which are also initials. The medium is technicized.
(p. 86)

and also:

... By taking the dimension of networks, the technical reality returns at the end of evolution towards the “milieu” that it modifies and structures (or rather textures). (p. 101).

Autocorrelation is then intrinsic, since the language of transmission, of positive regulation, and even of co-evolution, is entirely that of information - not information that would dominate matter (hylemorphic and/or dialectical conceptions) but an integrative information that can be (and manifested in) matter, movement, or temporality.

If we go back to the beginning of our remarks, we could say that the most emblematic current issue, as it is advocated, is that of energy stability. Nevertheless, if we translate it into Simondonian terms, what would be relevant would be to speak of energy metastability for this second step of the third generation to respond to variations and uncertainties, through a close relationship between adaptation and self-correction, a productive relationship with the *milieu*.

In this case (second step of 3rd generation) the operation ratio is carried out with the complex and technicized medium—one could advance the notion of global cross-linking. This would mean that parts of the same building communicate to produce, distribute, regulate energy for instance. But it also means better distribution and minimization through communicating with the inside and the outside (i.e. Producing and circulating information that can involve energy management). We must also consider the communication between the different uses of specialized spaces according to user needs, as well as the communication between specialized spaces and indeterminate spaces. Relying on the demands of the occupants in real time, providing varied conditions for non-standardized situations, considering more widely than any inhabited place is immersed in a *milieu*, associated with it, but that it is itself an associated *milieu* for users. In this frame “intelligent” means able to provide answers, not only to standards, but able to interact with *milieu* and occupants. This supposes intricate and immediate situations and answers. Let us insist that this remark is valid not only for the building but for any place occupied,

inhabited, borrowed, crossed, whether it is precise and surrounded or wide and open.

In this sense, we could go further by following the words of the architect Toyo Ito [3], who said:

If as McLuhan said, clothing and architecture are both extensions of our skin functioning as mechanisms for controlling energy and protecting us from the world outside, then their function as membranes would certainly be very important.

(...) This epidermis (...) must operate as a highly efficient sensor capable of detecting the flow of electrons.

(...) Rather than being rigid and dense like a wall, architecture as epidermis must be pliant and supple like our skin and be able to exchange information with the world outside. It would be more appropriate to call architecture clad in such a membrane a media suit. (pp. 123–124)

The energetic and ambient issue is typically behind the invention of this generation of beings-objects; they are not treated with static matter, because they cannot be constituted with machines of pure control: we must consider them as emission and reception flux, realizing kinds of emulsions, and metastable states. We must now think of them as being complex backgrounds, wholly understood as and in information as origin and finality, element and totality. Here, the form is only the result of a relational process and complex tensioning as Gilbert Simondon [13] claimed.

The ways of thinking about design are shifting from the classical and modern projective method to a processual elaboration, where time as flow is imposed on space as a stable support.

Of course, the invention of these *machines-beings-milieu* is not isolated from the previous stakes (static structure, operation of embedded “machines”). But this tends to re-define their relationships, from the moment we admit the interlocking and the interaction of different beings and their associated *milieux*.

And Gilbert Simondon [12] explains the characteristics of invention:

The invention provides a wave of condensation, concretizations that simplify the object by loading each structure of a plurality of functions; not only are the

old functions preserved and better fulfilled, but the concretization brings in addition new properties, complementary functions that were not sought after, and that could be called superabundant functions, constituting the class of a real advent of possibilities in addition to the expected properties of the object. (p. 171)

We will come back to this point later.

It should be noted that Gilbert Simondon [10] himself does not envisage watertight categories, particularly as he regards buildings:

It is difficult to declare without reservation that buildings are passive machines, they are not all the same degree of individualized technical objects. (...) the passive machine is above all an irreversible machine made up of elements that maintain and adhere to each other, the real estate character of the building lies especially in the irreversibility of its genesis, if the buildings became movable and dismountable, they would have the main characters of active machines, which are open, admit repairs, changes in rooms (...) architecture integrates and propagates a cultural barrier (distinction of land and furniture) that a technological deepening can lead to revocation. (p. 182)

7. To Deepen More Precisely What Building Intelligence Is, Let's Go Through the Notion of Operation

Mechanologie is not a pure science, it is for Gilbert Simondon (1958): "... a science of correlations and transformations ...” (p. 48).

He uses the concept of *operation*. According to Gilbert Simondon [11], thinking the word relation is relative to the essential notion of tension, to that of communication—especially between medium and object—in particular in the situation of invention (p. 29).

In the passive object, first generation, the operation relation is simple and finished (closed)

In the active object, the operation relation is binary (open or closed)

In the “intelligent” object, the operation relation is the very definition of the object (permanent computation).

Could it not be said that this is a report of operations requiring otherness, interaction and relationship?

This operation relation is a framework, or structure, or beacon, if you will, the path towards a clearer definition of the notion of intelligence associated with the building.

To understand this point, you have to stop for a moment on the elements of this operation relation:

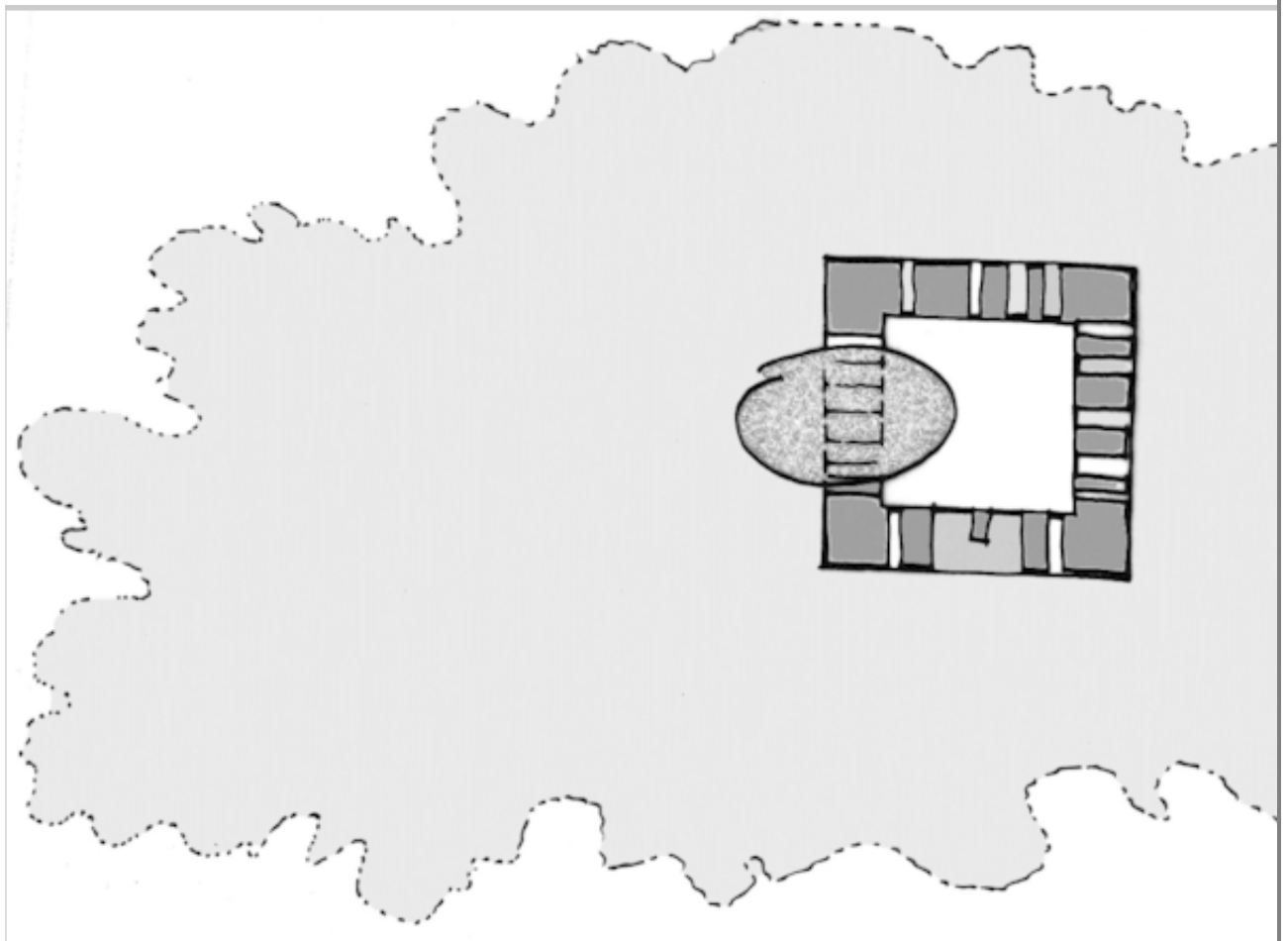
We can establish four types of actors:

1. users
2. The outside *milieu*
3. The indoor *milieu*
4. to which is added a set of technical devices: informational and effectors (Fig. 1)

Fig. 1

Outer milieu: light grey—internal milieu: white—user: granite—buildings apparatus: dark grey

(Source Author's diagram)



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In the diagram above, elements of the general situation are shown:

An external *milieu* of definition and complex composition, with fluctuating contours because the conditions that make it exist are multiple, not fixed. Thus, climatic conditions, living elements such as plants and animals, fluid elements such as air and water are not stable or static; entropic data in perpetual evolution continuously modify the state of the outer *milieu*.

An internal *milieu*, whose stability we will seek, is the very purpose of the building: to create a controlled interior *milieu*. One could consider it “stable” in a first-generation version of mechanics. However, it will be called “metastable” in a contemporary search for “intelligent building”.

A set of more or less sophisticated technical devices, making up what we will call the building, which encompasses and “protects” or rather makes this internal *milieu* exist. A roof, a window, a chimney, a central heating, the electric light, are part of these devices that appeared over the generations of building (lineage).

The user, with his or her demands, vital requirements, or more elaborately taking into account the social, economic and today contexts, is the “key” actor of this system.

What is the operation relation that connects them?

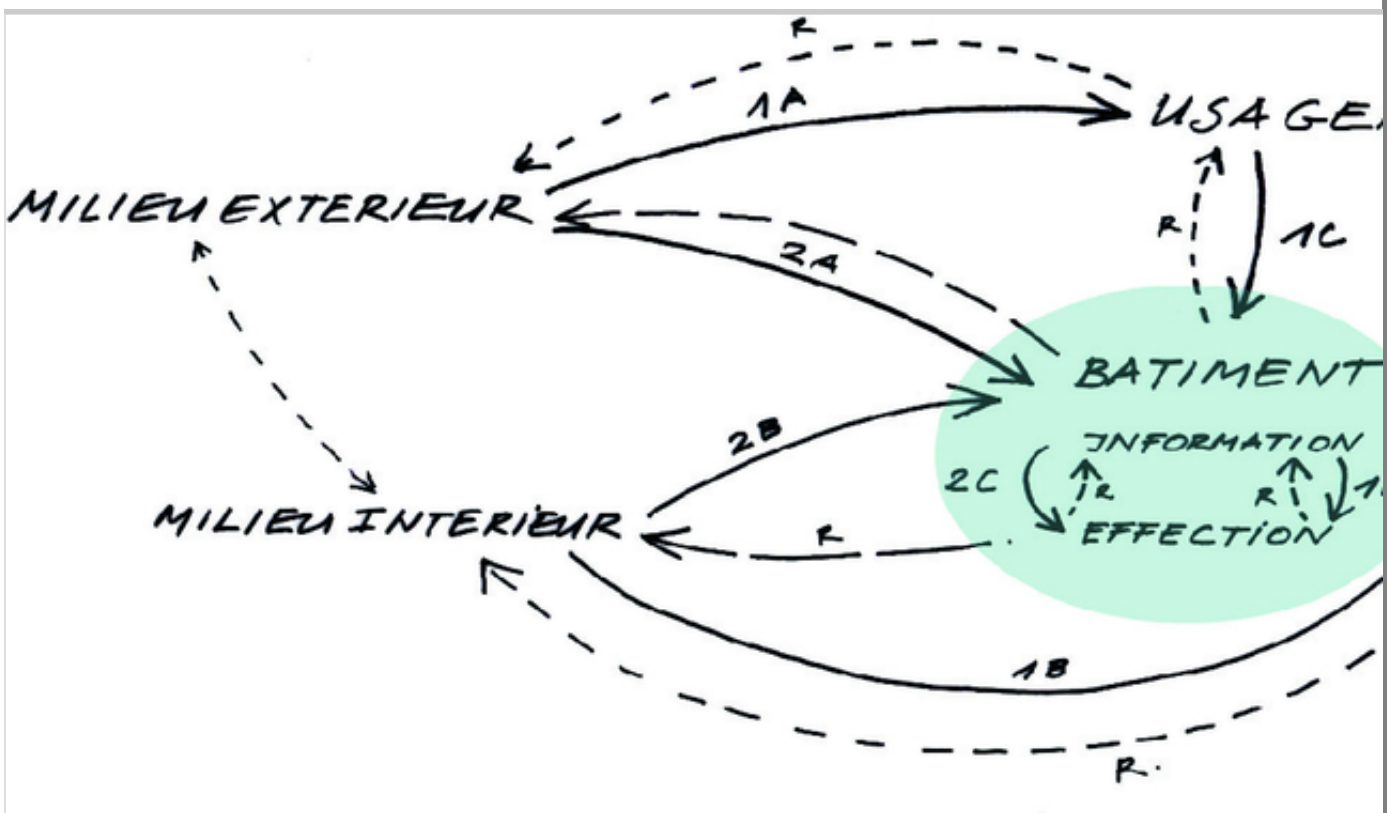
In a simple context the scheme is clear:

The external *milieu* acts directly on the building: gravity, wind, rain, sun, lift of the ground, the function of the building is to resist without feedback.

The external *milieu* also acts on the user (perception, sensations of comfort, embarrassment, etc.) which will in turn affect some of the elements of the technical device of the building: open a window, turn on the light, turn on the heat, and thus retain certain desired qualities of the inner *milieu*. This is a negative feedback system to maintain internal stability (Fig. 2).

Fig. 2

Author's diagram



The diagram above shows a more ambitious operation relation:

The *milieu* is connected to devices that respond to the programmed demand of the users or to their request in real time (even remotely) by processing the information and sending it to effectors who make corrections or new operations and return the information. In this scheme, there is also stored processed data and past actions that are also returned to indoor *milieu* detection devices.

The relation of operation interior *milieu* and apparatus of the building makes it possible to constitute a memory, an intelligence by learning, from already produced situations which will have been correctly analyzed and translated into algorithms. The notion of feedback plays a strategic role.

This complex system with positive feedback is then considered between all partners at different scales of time and space. Thus, the external *milieu* and the building (understood as a set of artificial technical devices in interface with the interior and the external *milieu*) can collaborate to co-produce (for instance ambiances, energy, information) to the user's address or directly towards the inner *milieu*.

The internal *milieu*, the external one and the user interact, via the elaborate devices that form a "building".

The connectionist model and the contributions of AI and *Enaction* (Varela et al. [16]) could be very useful to deal with these complex interactions. This would need to be developed in another paper.

AQ3

In order for the building to be truly intelligent, all the devices that surround the interior *milieu* and serve as interface with the external one, must be able to solve all the problems: i.e. both the primary questions (functions of the older devices in the building) but "at the same time" is able to respond to problems in more recent areas where the requirement has arisen—in the manner of a current telephone capable of responding to a problem, through a multitude of functions from a coded data transmission/reception device.

We will argue here that the complex interface between the indoor *milieu* and the external one, together with the increasing demands of the user (for instance in terms of energy production or more generally comfort), requires rethinking the building as a whole in analogy with the cell membrane that receives information, treats it, activates substances and mechanisms that regulate the

relationship between the inside and the outside of the cell to maintain homeostasis.

Intelligent building would therefore be, in our opinion, a concrete set in the sense developed above, which would consist of all the devices gathered and self-correlated to produce the desired relations, in real time, or almost, between interior and exterior with reference analogue to the membrane.

8. This 2nd Phase of 3rd Generation, Will Be Named *Eco-Mechano-Logique*

According to G. Simondon [13]:

Communication between technical objects and *milieu* is of ecological nature. (p. 85)

If we go back to the beginning of our remarks, we can say that the most emblematic current issue, as it is advocated, is that of energy stability. Nevertheless, if we translate it into *mechanistic* terms, it becomes relevant to emphasize on energy metastability for such a 2nd phase of the 3rd generation to respond to variations and uncertainties, through a close relationship between adaptation and self-correction, creating a productive relationship with the milieu.

8.1. About Invention

A few words—this part would be to develop:

The invention is here too and is not an addition. The invention creates both the object and its associated *milieu* and it is precisely the consciousness of the separation of the two, their coupling produces the invention according to Simondon [10].

The invention makes a new being happen, comments J. Y. Chateau [2]. To think of the invention as a process and a complex *being-milieu* in tension is perhaps what could solve the problem of the moral antagonism between a building and its environment, between artifice and nature, between the norm and the realization of a concrete device, allowing the formation of an eco-mechanical milieu (thermal, domestic etc.)

Simondon explains [12]:

In every age, normative inventions make a finding of compatibility for modes of existence that did not have a meaning or point of insertion in the preceding normative structures. (p. 158)

For the philosopher [12] this process also involves an author (or a team of authors) and the tension between the latter and his problem (the object and his environment to be constituted) which is considered to be at the same time the origin and the result, the beginning and the end of the process.

The problem is solved when a communication is established between the system of action of the subject for whom the problem arises and the regime of reality of the result; the subject is part of the order of reality in which the problem is posed; it is not part of that of the imagined result; Invention is the discovery of mediation between these two orders, mediation by which the action system of the subject may have taken over the production of the result by an ordered action. (p. 141).

Solving the problem by formalization creates an artificial object with properties that go beyond the problem (p. 173).

All scientific explanations do not overcome the invention. A particularly special dimension characterizes it. If invention produces a new being, an artifact that is both the origin and the fulfillment of itself, holding both a unique existence and total dependence, both being and middle associated *milieu*, then, from my point of view, the invention is here necessary to produce intelligent building.

8.2. Adaptive = Intelligent and Vice Versa

Our aim to define intelligent building was constructed on several steps. At the end of this tour, we may admit that passive houses and even houses with positive energy (additionally including elements of energy production as we recalled on the first page) as required by RT2020 French norm are not satisfying answers responding to the word *intelligent*. At best, we consider the second generation of machines, may be also the first stage of 3rd generation, as set of tools for energy transformation, ideal of reversibility of the transformations, control by negative feedback and indifferent state of equilibrium. Standards and norms stay coercive, due to low level of responsiveness to the diversity and richness of situations and needs. Intelligence is precisely what is missing.

The ambition for an intelligent building, if we accept the definition built above borrowing a lot to Gilbert Simondon philosophy of technics, requires to solve the problem of a steady dialog between indoor and outdoor building with the milieu and mainly the users. Therefore, it needs to build smart technical devices as a network able to produce, share and record information, acting in and with the *milieu* and the inhabitants. Of course, the recent developments of AI to treat big Data could be able to solve a part of this complexity. However, we shouldn't forget the two actors (users and milieu) are the key to go over standards and pure technical answers, introducing complexity, systemic design in relationship with social, behavioral, individual and even intuitive demands.

Beyond technical approach, Gilbert Simondon [11] searched for human being. He redeemed technics as a part of *individuation*. Intelligence supposes human being as main aim. It's why an approach of intelligent building as a part of human intelligence is a source of inspiration.

To answer to these intricate aims, or inventions as we present the term are needed. The building would become adaptive, an intelligent complex apparatus, where human being and milieu are the main actors. In the today's phase of technical and architectural evolution, adaptive building could be the definition of intelligent building. A step into lineage.

As Mario Borillo [1] mentions: After all, no matter the ontology that we assign to it, isn't an "intelligent" system primarily a program? (p. 16)

The advent of information techno-sciences in general, as invasive technologies, hybridizing and reorganizing all others in a network of data processing, storage and dissemination, undoubtedly allow the initiation of this technology.

The complete machine (self-regulating in the sense of Lafitte), this adaptive system that Gilbert Simondon described as the stage of the technique he saw emerge, is yet to be produced. It requires a greater co-operation between the different actors and researchers in the built *milieu*, beyond the prostheses produced today.

If we consider the complexity of the city, in the light of the concept of milieu, and compare it to a simple building, we can realize the magnitude of the task we face.

As we see, to establish this program, much remains to be done.

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