Producing Project

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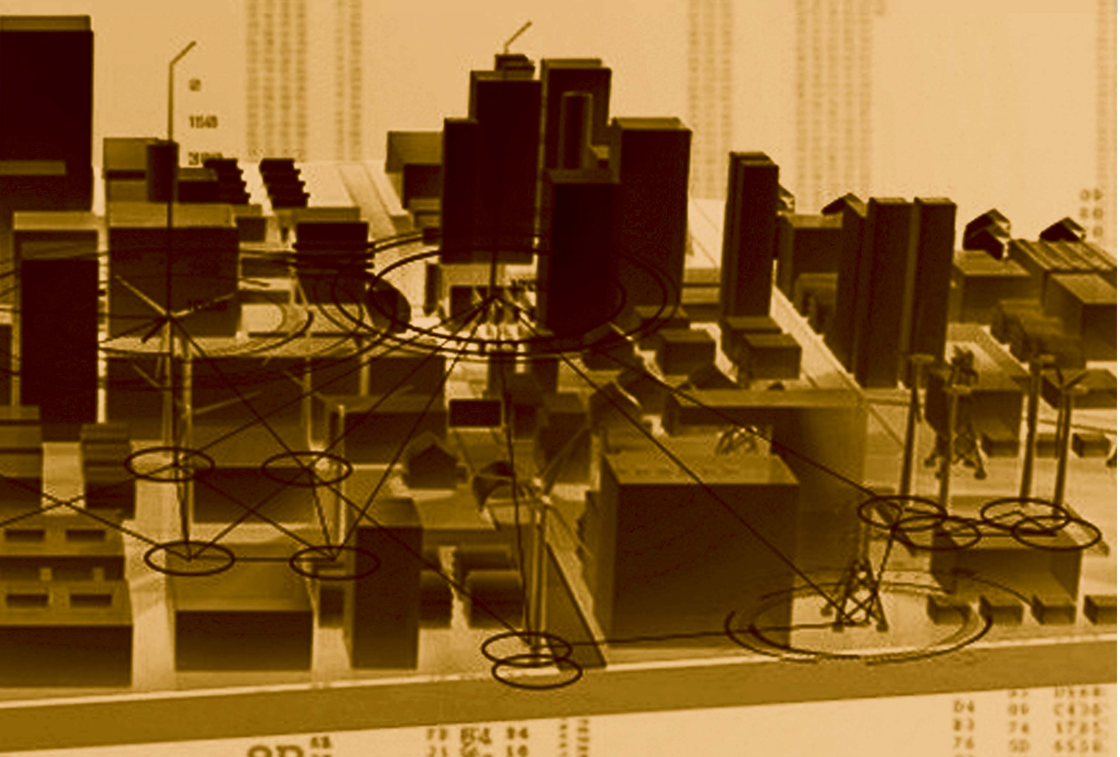

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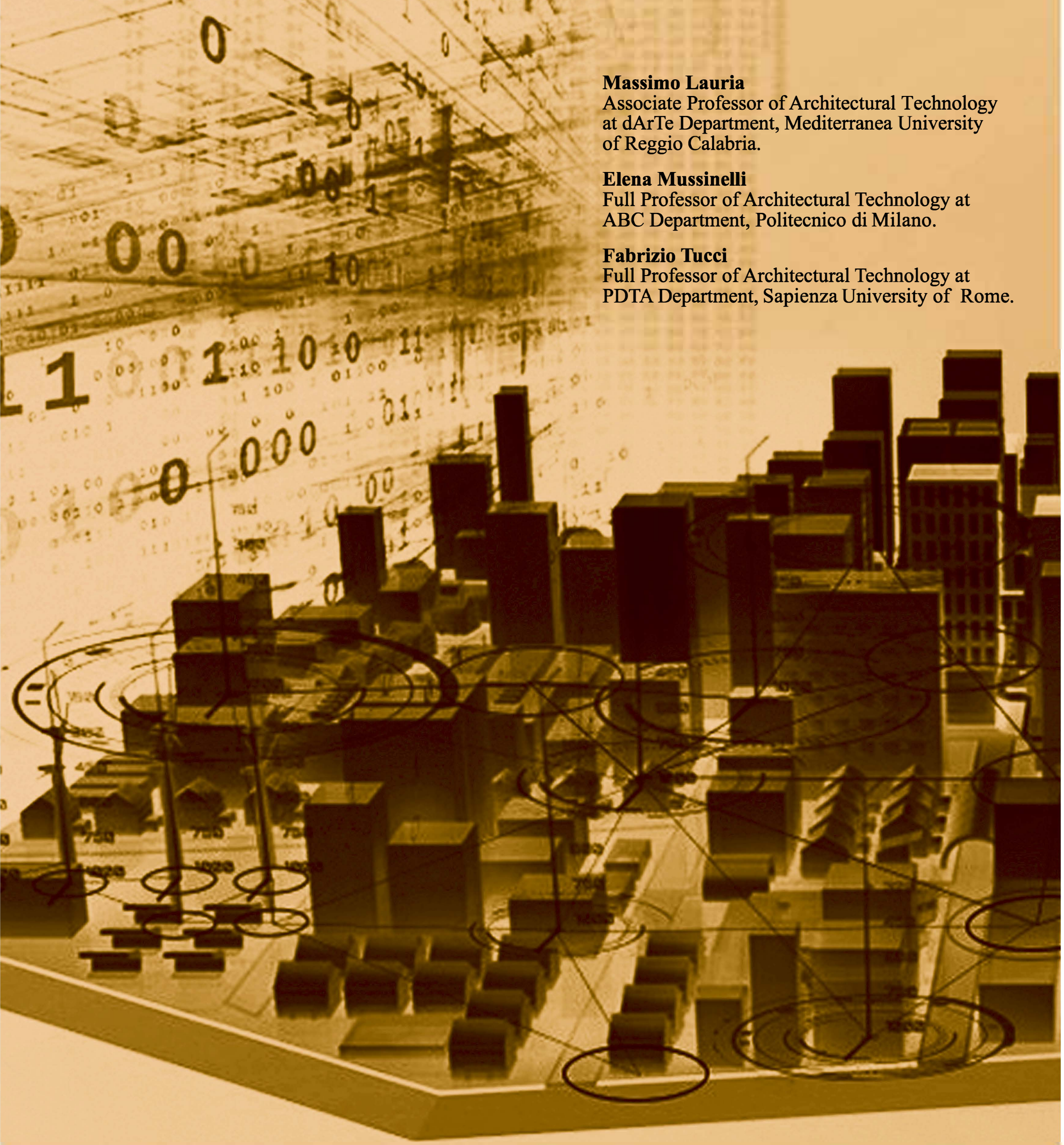

The transformations created about the design activity by the several challenges started by the economic crisis, climate change and environmental emergencies, together with the impact of the Web and ICT on social and productive systems, highlight many critical issues, but also significant prospects for updating concerning places, forms, contents and operating methods of "making architecture", at all levels and scales.
In this context, the cultural tradition and disciplinary identity of Architectural Technology provide visions and effective operating practices characterized by new ways of managing and controlling the process with the definition of roles, skills and contents related to the production chains of the circular economy/green and to real and virtual performance simulations.
The volume collects the results of the remarks and research and experimentation work of members of SIT*d*A - Italian Society of Architectural Technology, outlining scenarios of change useful for orienting the future of research concerning the raising of the quality of the project and of the construction.

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1.13 THE INNOVATION WITHIN BUILDING DESIGN AND MANAGEMENT PROCESSES

Valentina Frighi[*]

Abstract

The everyday modifications caused by the advancements introduced by the 4th Industrial Revolution determined a lot of changes even within the built environment, making a large part of the existing stock inadequate towards current standards.
In order to reduce its vulnerabilities, a sustainable strategy could be aimed at implementing the performance of existing buildings through interventions aimed at giving them the ability to "adapt" to the unique context in which we operate. Therefore, this contribution aims at defining, in its general features, a design and management strategy for the existing stock, to be applied during its entire life cycle, underlining the potential role that new technologies play in this process.

Keywords: Smart Buildings, ICT, Internet of Things, Innovation, Technological design

Architects are nowadays facing a radical change whose causes are multiple and only partially determined by the current social and economic conjuncture.

Triggered by the blast of the real estate "bubble" in the already far 2008 and still evolving according to often unpredictable dynamics, the resulting crisis seems never-ending. In this scenario, the evolution of the relationship among professionals and inhabitants cannot be neglected, influenced by the presence of other figures – more or less expert – who are variously allowed to intervene on building environment in operations that should be prerogative of competent technicians. To this, it has to be added the regulative framework, which should be considered as a reference for practicing profession but that actually seems at least murky. In the context outlined above, the challenges that design activity deals with, can no longer leave the operating conditions introduced by the "Industry 4.0" out of consideration: the digitalization effects indeed, today more than tangible, significantly influenced the organizational setups of construction processes, modifying their design actions in terms of roles, expertise and contents. In this new building cycle, in which, contrarily to previous ones – generally marked out by quantitative additions – we'll have to face the need to reduce soil consumption in view of the urgency to act sustainable process of re-

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generation of existing buildings, the new technologies introduced by the advancements of technological progress play a key role in the integrated and sutainable management of the existing stock.

Right in 2016, R. Del Nord stated that the ongoing digitalization process would be destined «to radically influence the design processes, both in contents and in processing methods as well» (Perriccioli, 2016). It cannot be denied indeed, that these technologies came over all areas of everyday life, including architecture (Neuckermans, 2017), forcing it to face this change. In the same way it is undeniable the fact that these technological scenarios are endowed with significant consequences on the economy of the country: the global IoT market, and more in general, of ICTs for buildings, is one of the main drivers for the economic growth of construction sector. Among others, Navigant Research[1] estimates, over a ten-year period, a growth for this market equal to over 15 billion dollars. In 2020, a shorter-term goal, the well-known agencies Gartner and ABI Research predict that the number of network-connected objects will be among 26 and 30 billion dollars (Baldi, 2016); the so-called Smart Buildings, born through the applications of Building Automation technologies to edifices with the aim of reducing construction, monitoring and management costs[2], are fully part of this ever-expanding market. Thus, even in architecture, the signs of the digital disruption[3], are more than evident, determined by the introduction within such sector of systems and components with high technological innovation to face modern needs of change. The energetic and environmental question as well as the radical transformation of project's demand (Mussinelli, 2016), made the number of buildings inadequate towards contemporary needs constantly increasing. So that this innovation can become vehicle to achieving higher levels of architectural quality (Campioli, 2011), then providing an operational response able to find a balance between performance to be guaranteed and regulations to be respected, a double change of perspective, by all the actors of this process, is needed.

First of all, designers must accept the loss of their privileged status as repositories of specialized know-how, limited to a very specific area, while they have to acquire awareness about the strategic role they play in this new context,

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1 From 6,3 billion dollars in 2017 to over 22 billion in 2020. Navigant Research, "The Global Market for IoT for Intelligent Buildings is Expected to Exceed $22 Billion in 2026", available at: https://www.navigantresearch.com/newsroom/the-global-market-for-iot-for-intelligent-buildings-is-expected-to-exceed-22-billion-in-2026 (accessed: 3 July 2018).

2 Talon and Strother (2017) expected that the adoption of BATs/BACSs would allow to obtain, within 2028, the savings of more than 150 billion TEP/years, correspondent to about the 22% of consumption of the entire building sector and to about the 9% of the total energy consumption of the European Union.

3 Term with positive meaning introduced in 1997 by Clayton Christensen in his "The innovator's dilemma: when new technologies cause great firms to fail" to define a disruptive change, intended as the moment in which the advent of a new technology brings a change in manners, thus determining the complete modification of the previous model.

thanks to their dialogue-oriented aptitude, on many levels, intrinsic in the architect's education, capable of being translated into an unequalled ability to become promoters of such innovation (Sinopoli, Tatano, 2002).

Similarly, end users, free from the passive role they performed in the past as common buyers, have now acquired an active role in this transformation process. Encouraged by the dissemination of information through new channels accessible to all, they have become *prosumers*[4], aware and evolved users equipped with decision-making independence and interested in consumption management, control and monitoring, energy saving and home automation; to resume their attitude in a word: they have been involved in the smart management of the built, becoming self-media[5] (Cloutier, 1975) able to actively participate in the creation and management of buildings during their entire life cycle.

Therefore, to face the needs of this new liquid society (Bauman, Bordoni, 2015), new reference tools are needed: Cloud Computing, new business models, development of wireless networks and intelligence, Key Enabling Technologies and Information Technologies which applied to project and construction provide new perspectives of update for forms, contents and operative architecture's manners, in response to the appearance of changed reference frameworks on which design activity is based on.

From this reasoning, arises the will to wonder about how the new possibilities offered by the impact of the Web and ICTs on social and productive systems stand in relationship to these issues, and, in particular, how they can concretely contribute in generating buildings able to respond to current needs, not only in performance terms but also adapting and transforming themselves according to external stresses or factors (exogenous or endogenous) that can modify their characteristics of use, reducing vulnerabilities of construction systems of which they are part of, thus restoring the balance condition that allows their proper function in time and space within which they are inserted, though their progressive adaptation. Getting back on what D'Ambrosio[6] (2017) on the twofold characterization of the adaptation concept, it's interesting the distinction made between what was defined "incremental adaptation", that means a requalification process precisely carried out though strategies definable adaptive, and what was instead defined "transformative adaptation", intended as a rethinking of the design approach towards a systemic planning of building process through mitigation strategies.

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4 Term obtained from the merging of "producer" and "consumer" words, introduced for the first time from Marshall M. and Barrington N. (1972) in *Take Today: The Executive as Drop-out, Harcourt Brace Jovanovich*, University of Michigan (USA).

5 No more recipient of messages, previously established from producers and suppliers, but now able to deliver messages and to influence the creation of tailor-made buildings.

6 V. D'Ambrosio (2017), "La progettazione ambientale per i sistemi urbani resilienti", in M.T. Lucarelli, V. D'Ambrosio, M. Milardi, *Resilienza e adattamento dell'ambiente costruito* (op. cit.).

Therefore, in order to propose a sustainable strategy for the achievement of the aforementioned objective, a possibility could be aimed at developing a multi-scale strategy (that takes into account the specific features of each application scales), defining requirements and performance to be achieved.

First of all, in order to implement effective strategies, it is necessary to understand the behaviour of different building systems over time; the step further will instead be aimed at defining homogeneous terms of comparison among materials, components and systems that could be completely different.

Then, a following phase will be aimed at identifying the requirements, function of the showed up current needs that buildings must have, trying to predict their possible evolution over time thus determining any variables that could compromise their operation.

Given the complexity of the typological and technological characteristics of the existing building stock (above all, their being unique for geographical, temporal and operational features) (Norsa, 2005), a first step towards the definition of the aforementioned requirements could be reached through the classification of buildings by virtue of their geographical application context, as well as for their macro typological and technological characteristics; hence, the following interventions to be implemented will descend from such classification, according to distinctive and peculiar features of each cluster identified, in a direct relationship. The different classes of intervention can be established by making a parallel with the current regulation on energy efficiency[7], establishing for each level identified certain actions to be undertaken.

The types of intervention can then be distinguished according to whether they are carried out on new buildings or on the existing stock, including, in the first case, all demolition and reconstruction actions for which the supposed design choices must necessarily take into account the whole buildings' life cycle as well as the durability over time of the materials and components used.

On the other hand, in the second case, the predicted actions, whether they involve a deep renovation (first or second level) or energy efficiency interventions, should aim at extending buildings' useful life, with the goal of improving its performance response. Clearly, the increasing levels of complexity that are function of buildings' features, will be less manageable in all those cases in which interventions to be done are simultaneous to actions needed to maintain the components' efficiency over the whole useful life.

Therefore, in this context, it is necessary to resort to tools able to predict and manage this complexity, according to an integrated approach that can be implemented from the very early stages of designing and planning the overall work. Hence, technologies introduced by the 4th Industrial Revolution certainly represent a useful tool for the management of the abovementioned reference framework, thanks to the presence of integrated and interoperable systems.

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[7] Decree "Requisiti Minimi", 26 June 2015.

The techniques brought in, capable of digitizing the operations that contribute to the creation of an architectural work (such as BIM systems), help in solving criticalities intrinsic in this process through, for example, the detection of geometric interferences between heterogeneous components (clash detection) or the check for consistency with rule and constraints (rule checking), or, again, they allow, thanks to home automation devices, the collection, elaboration and analysis of different types of data, providing an operational support for actions of logistic fine-tuning, energy management and control and monitoring.

Currently on-the-market-available systems present various levels of automation, from the basic level to systems equipped with integration and interoperability capacity, even among different devices.

In literature, automation systems for smart buildings are distinguished in first, second and third operation devices; buildings in which multiple autonomous and self-regulating devices are installed, able to independently operate each other – such as security systems and automated systems for mechanized compartment ventilation (HVAC) – are considered first generation.

The second category instead includes systems connected to each other through networks that allow remote control, even operating from a single central unit, such as lighting control systems depending on occupants' behaviour.

Finally, third-generation systems are those able to adapt their functioning – in terms of monitoring and control – to boundary conditions, varying it according to the context. This last systems' generation, although still in an early stage of development, is clearly the most promising.

The existing components that operate within a smart system, able to adapt to the surroundings, not only through intelligent actions but as part of a real "network", collecting data, communicating and transmitting them – even after further elaborations – would allow to open new and very interesting possibilities for controlling and implementing building materials and components performance. In this process, even new building materials, the so-called smart materials, equipped with original performance, often variable, controllable and selectable, play a very important role. In the same way, even innovative construction methods, recently developed, such as, for instance, 3D printing technologies, thanks to the possibility they offer to reduce costs and construction time increasing at the same time quality and safety on site.

Last but not least, the development of off-site building production approaches, able to fine-tune times and resources, favouring the specialization of all the manufacturing along the supply chain.

Although indeed, about the 80% of all construction works is still an on site production, the interest towards new off site attitudes, aimed at increasing the predictability, uniformity and repeatability of works is exponentially growing, both because to a lesser extent of working spaces in construction areas, as well as due to the progressive loss of skilled labour and to the increasing rigidity of safety and environmental standards.

The possibilities offered by the integration of ICTs in constructions' design and management processes would make buildings real UCG (User-Generated Content), guaranteeing their functionality over time and, above all, their compliance with the ever-changing needs of their occupants, making them (inter)active and interoperable structures thanks to the introduction of the aforementioned technological innovations, as element of mediation among multiple instances, sometimes juxtaposed but essentially interconnected.

So, design in digital ages, must necessarily confront itself with less recent but still current challenges related to the reduction of environmental impact, enhancing the existing building stock while respecting safety and wellness conditions of users, becoming at the same time investor of new demands, recognizing the new material culture linked to new digital technologies and enriching itself from the contributions that technological innovations provide to meet new quality standards and ever-changing needs (Losasso, 2017).

In conclusion, in order to achieve such ambitious goal, a reconsideration of the current way of designing is needed, moving towards the production of architectures not only capable of rediscovering and adopting technical and design solutions able to deal with the context, exploiting available passive resources, but above all, designed to be equipped with adaptive and recovery capacities, effective at all the scales that mark out building process.

Certainly the abovementioned technological resources, capable of allowing an on-demand control by end users, as well as to obtain return data on such functioning, significantly contribute to progress in this direction, allowing to gather useful information on the operation of devices and components to further calibrate, during the whole building life cycle, the interventions needed to avoid a decay, even localized, of its performance response.

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