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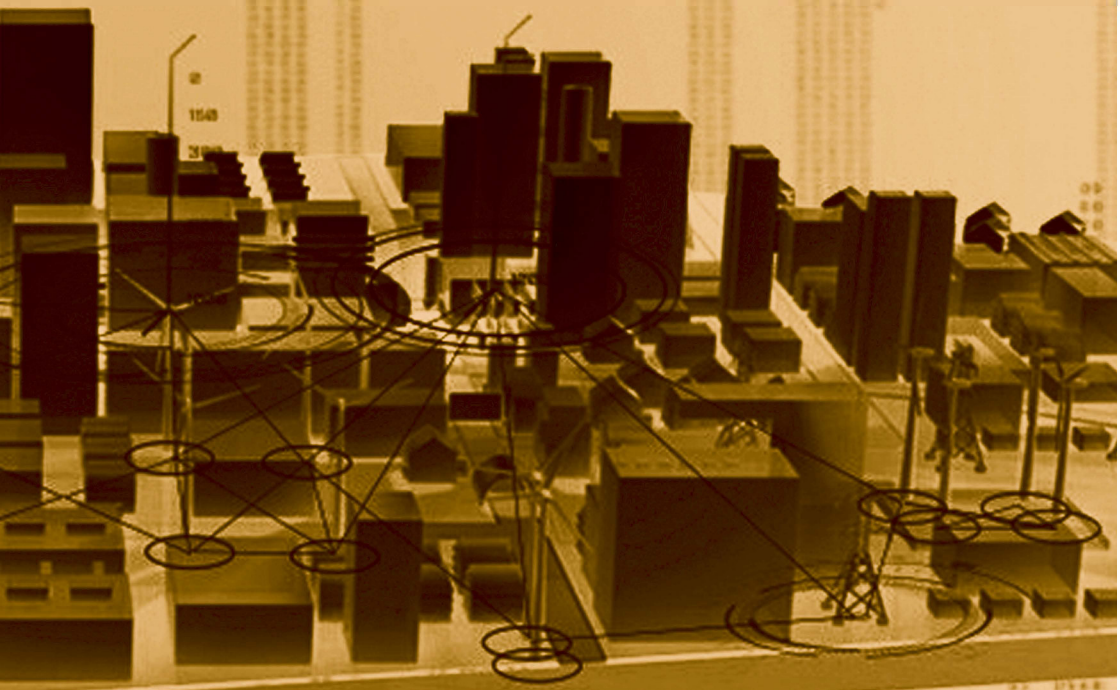

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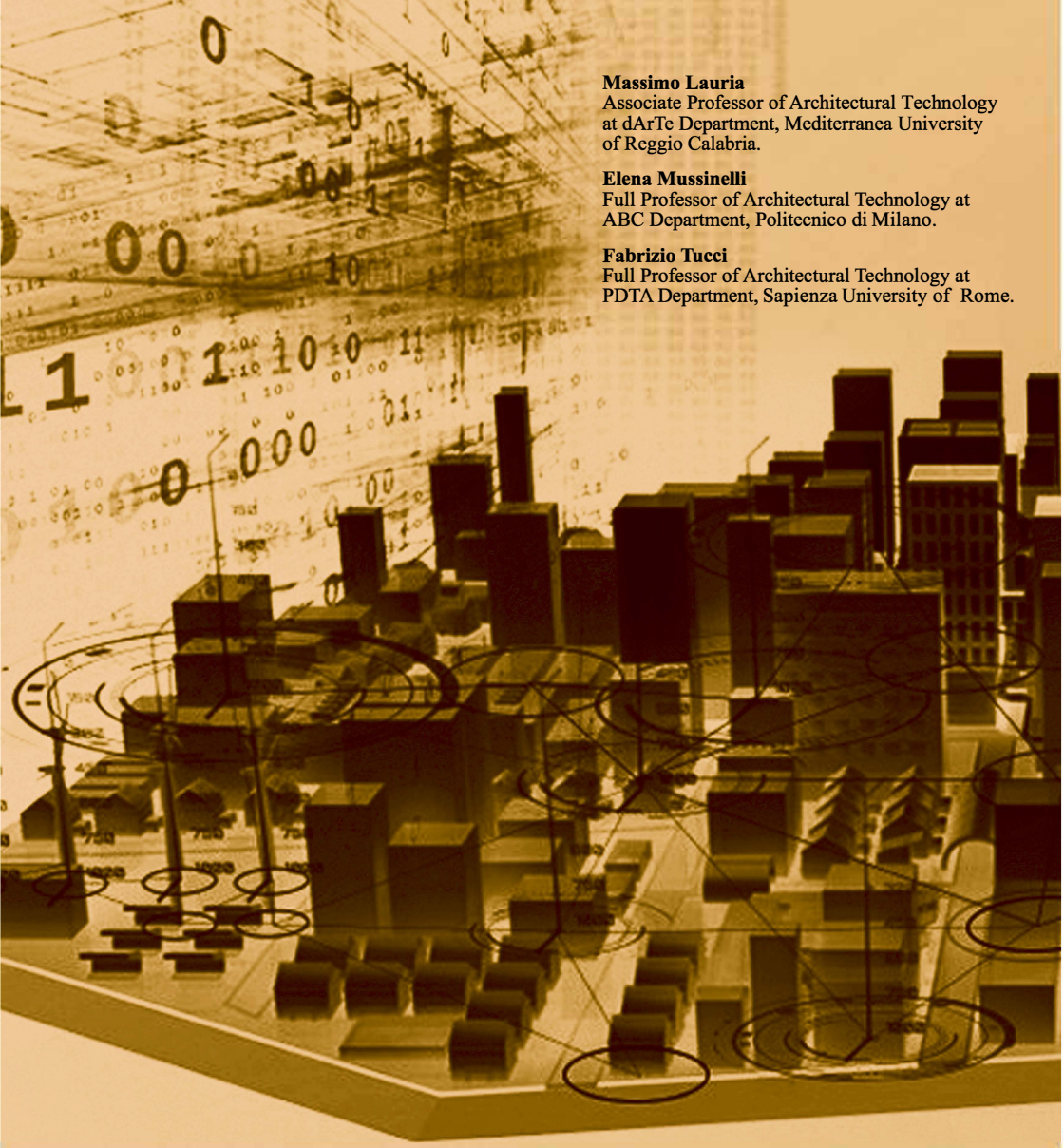

The transformations created about the design activity by the several challenges started by the economic crisis, climate change and environmental emergencies, together with the impact of the Web and ICT on social and productive systems, highlight many critical issues, but also significant prospects for 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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2.14 LIGHT RESOURCE BUILDING APPROACHES FOR ECO INNOVATION OF BUILDING PROCESSES

Martino Milardi[*]

Abstract

The subject matter is collocated in the scenario where the emergence of approaches with a strong green or circular connotation is becoming more evident, i.e. new ways that cross production chains and implementation practices, often becoming significant drivers. The profound revision of the statutes of the design processes due to the fallout of the economic situation and to the need for substantial innovation has generated a fertile field of opportunity where the project can direct new efforts of its practices. Among the various strategic spheres that arise from it, the architectural project finds a field of action in eco-innovation and in the modalities that with this specific theme define the assumptions of the "Resource-Efficient Building" (Light Resource Building).

Keywords: Design, Efficient Resource, Materials, Construction, Eco-Innovation

The "resource-efficient construction" approach: an alternative vision of building production

The need to "Dwell" and the consequent construction as well as being the natural founding characteristics of human life, are recognized as genetic bases of European culture.

However, the construction sector, and construction in particular, are the subject of more study in more fields of knowledge as considered among the determining causes of both economic situations and "new" environmental impacts such as climate change.

The "efficient resource" approach, promoted at European level and shared internationally, expresses the need to use less natural resources to achieve the same or better product/output, thus internalizing the concept that the performance of transformative processes could increase efficiency levels with the result of finally getting "the more with less" (AMEC, 2013).

For the sector, it means not only employing resources more efficiently to realize, or restructure artefacts but also to reduce the amount of resources necessary for their operation.

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This performance would not only tend to improve the environmental performance of the processes, but at the same time would yield greater economic returns.

It is too known that the construction sector is the largest consumer of raw materials in the EU; construction and demolition activities make up about 34% of the waste produced each year (EEA, 2016).

At the same time, for some years European funds offer incentives that allow companies to renew their processes in order to reduce their environmental burden; such aid is framed in the logic that the most efficient use of resources and recycling of waste/waste would significantly reduce the Total Material Requirements (TMR) of European companies.

The same logic combines the concept of "environmental incentive" (deriving from the desire to promulgate green culture in production models), to the economic one, where reducing material inputs could actually reduce the costs.

Therefore, a more systemic and global approach to construction and restructuring actions seems necessary, such as to understand how energy and materials can be used efficiently, considering overlaps and compromises between them. This broadening of perspective on efficient resources could contribute to a better realization of environmental goals of established communities and models of development, also because in its foundations this perspective internalizes the dimensions, social, environmental and economic (Bringezu, 2009).

Ultimately, resource-efficient construction is not just "transforming" more efficiently (i.e.: reducing waste streams), but also finding new ways to achieve the same (or even superior) functionality, with a minor use of resource-intensive materials, new technologies and new approaches to design.

The construction material requirements for the "light-resource" building

It is now established that awareness of the excessive and uncontrolled consumption of resources is contributing to the formation of one of the greatest environmental challenges of the 21st century.

While this consumption does not manifest itself as a clear and visible problem, such as pollution or toxicity, it actually contributes to greater environmental pressure and problems of "effect mobility", for example by shifting the negative impacts of production to abroad, so that these are not seen by consumers in the countries of consumption (OECD, 2013).

The planet has reached its points of no return for a certain "number" of environmental systems, beyond which the fear of collapse becomes relevant (Meadows et al., 2004, Rockström et al., 2009, EEA, 2010).

Recognized as the largest "resource consumer", the construction sector is critical to the trend of this trend, but there is great potential to reduce material consumption through "efficient resource construction".

Other data concern the share of minerals in Domestic Material Consumption (DMC) of UE (27 State) is about 52%[1].

Of this percentage, only a small part cannot be used in the construction sector, while the majority is, making the consumption of material in the construction sector a factor of "intense and maximum demand". A useful example of intense material consists of stone aggregates, since, while they do not seem to contribute "visibly" to environmental emergencies; they actually constitute evident environmental pressures. The aggregates are granular materials, such as sand, gravel and crushed stone. They are, for example, the main ingredient of ready-mix concrete and include the vast majority of construction minerals (BGS, 2010). In 2009, the total demand for European aggregates was around 3 billion tonnes, produced mainly by small and medium-sized enterprises on 22.000 sites across Europe (UEPG, 2010). The construction of a new average building uses up to 400 tons of aggregates, as well as the construction of 1 km of motorway uses up to 30.000 tons (Bleischwitz, Bahn Walkowiak, 2007). Throughout the life cycle, environmental problems[2] are always "present", especially in the extraction phase (change in land use for mines and quarries, variation in groundwater levels, etc.). However, at the same time the environmental pressures also play an important role. Firstly, the extraction of aggregates really contributes to the depletion of resources. To mitigate this connection, a useful measure could be to hinder the absolute decoupling of PIL from the DMC. In their use phase, aggregates are used to produce concrete, releasing large amounts of CO_2, thus contributing to the "sealing" of the fertile soil layer for the purpose of new portions of built environment. At the end of their use, aggregates are disposed of or recycled and, to date, the percentage of construction and demolition waste (C&D) is high, given 33% of the waste produced each year in the European Union (EEA, 2010). That witness how much requalification and demolition of buildings generate large quantities of materials that can be recycled (Geibler et al., 2010).

- the creation of more efficient methods to recycle aggregates, finalizing the supply chain to their reuse both as an "input" constituting a new value of the real estate;
- to contribute to new constructive modalities that reduce the need for aggregates through their material substitution;
- pursuing "light-resource" building.

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[1] This percentage is very different between European countries. From over 70% in Portugal and Ireland to around 30% in the Netherlands and Greece. Between 2000 and 2007, this percentage rose in the EU-27 (from about 49 to 52% of the DMC). Trends are very different between countries. Comparing the years 2000 and 2007, the total amount of mineral consumption decreased in Italy, Germany, the Netherlands and the UK. While it increased in Spain (31% more in 2007 than in 2000), the Ireland (consume 40% more) Greece (consuming 42% more) and Bulgaria, Lithuania, Romania, Estonia and Latvia (with an increase of over 50%).

[2] In reference to the alterations and qualitative impairments of Environmental Compartments: Air, Water and Soil; or anyway, the problems concerning the Bio and the Geosphere.

Industrial policies play a key role in reducing impacts on the use of resources and on the environment, through more efficient production processes, a different project of energy flows, and the dematerialization of production cycles, preventive strategies, cleaner production technologies and procedures.

"Clean production", as well as a review of product life cycles to minimize waste production, play a key role in reducing impacts on the use of resources and on the environment (OECD, 2010).

The concept of cleaner production was introduced by the Office of Industry and Environment of the United Nations Environmental Program (UNEP-IE) in 1989 and recognized by the Ministerial Conference organized by UNIDO on ecologically sustainable industrial development (Copenhagen, 1991).

Clean production consists of the continuous application of an integrated preventive environmental management strategy, applied to processes, products and services, to increase eco-efficiency and minimize risks to health and the environment.

It can be applied to production processes (saving raw materials and energy, eliminating toxic and dangerous raw materials and reducing the quantity and toxicity of all emissions and waste), to products (reducing the negative impacts during the entire life cycle, from extraction of raw materials at the disposal stage) and to services (incorporating environmental concerns into the design and provision of services).

The implementation of this concept presupposes a cultural change. Requires defining a new approach to the industry relationship; requires responsible environmental management, the creation of a suitable national political environment and the assessment of technological options. Furthermore, eco-efficiency represents a life-cycle perspective that follows products from the extraction of raw materials to final disposal stages; it is therefore an extension of the Total Quality Management process.

In other words, the vision of eco efficiency is that of "producing more from less". Reducing waste and pollution and using less energy and raw materials is obviously positive for the environment, but it is also positive for the business world, as it cuts the costs of companies and avoids potential environmental responsibilities; it is therefore a prerequisite for the long-term sustainability of the production process.

Ernst Ulrick Von Weizsacker, refers to the need to operate an "efficiency revolution", that is to make possible the development, considered central for the improvement of living conditions, compatible with the environment by increasing the efficiency of production systems, settlements, of mobility (Weizsacker, 2009).

The new goal of the building design will be to respond to the problems of our planet and to a development that, to be sustainable, can only reduce the quantities involved through the optimization of use, the increase in efficiency, the limitation of consumption and tend to reuse and recycle.

The Building-Resource-Efficient

The Building-Resource-Efficient, considers building as a single functional unit, rather than consisting of separate components and expresses the need to use fewer natural resources to achieve the same - or better - "product/output" budget. Trying to optimize the functionality of the entire system, we intend to internalize the concept that the efficiency of transformative processes facilitates the increase of efficiency levels, with the result of "obtaining the most with less". This, however, requires the designer to have a deeper understanding of the object to build, the context conditions, the selection process of the materials, etc.

The focus is increasingly on "invisible technologies", with greater attention to design integrated, to the organization of the processes, to the control of the life cycle of the materials and where, the phases of management and decommissioning acquire a fundamental role for the sustainable dimension of the architectural project (Antonini et al., 2010).

It seems obvious, but it is very clear how much innovation (better if eco-innovation) is ever more necessary to achieve a truly sustainable development, in its concretization of the balancing of environmental and socio-economic objectives.

In the future, "compromises" and synergies will have to consider in a more comprehensive way, which means that instead of developing a new material to replace another material, innovation will have to "think" about how one component could replace multiple functionalities by meeting the needs of users also in different geographical areas.

Innovative technologies therefore, but a contemporary restructuring of governance processes will be necessary to review the sector and contribute to the creation of "sustainable companies".

To improve resource efficiency in the construction sector, a strategy is to replace resource-intensive materials with eco-materials. In this sense, the "*Resource-Light Construction*" seems to be a more complete approach because it considers the building as a single functional unit, rather than consisting of separate components, so it tries to optimize the functionality of the whole system. Moreover, being the functionality of the individual components a part of this approach, to realize and improve this functionality with less material input is the pinnacle of process innovation based on material flows (Milardi, 2015).

The *Resource-Light Construction* can be possible with eco-materials, as these are less resource intensive and less polluting than usual ones. This feature also includes revenues generated in the production process and the replacement of resource-intensive raw materials. However, we must recognize how the line of demarcation between what configures the "eco" or "not-eco" character of a material is not absolute, if not even blurred, in fact, a material can also satisfy ecological values by covering requirements from the characters different.

Among the challenges of the 21st century one of the biggest is probably the rational use of resources and especially the limited ones and this requires a necessary and pressing change to the building sector (EU Commission, 2011).

From the aerospace and automotive sectors, we know that a higher "weight" automatically means more energy "commitments".

Many studies have shown that even in construction, technologies and materials needed that make a building lighter, so that it has "consumed" less resources and energy.

However, lightweight construction has to be considered beyond the mere indication of using light materials or minimizing the use of material.

Resource-Light Construction refers more directly to the appropriate use of construction materials and techniques, providing the most effective response to the specific needs of a constructed object. In this case, also, the analysis method of material flow and the material intensity calculation are offered as useful tools.

Conclusions

Starting by the assumptions just described, the support of new organizational structures, process technologies, ICT systems, seems crucial to implement a massive (if not radical) system innovation, now unavoidable in the construction sector, thus contributing to growth based on the Resource-efficient construction and a truly sustainable economic development.

This can be supported by ICT logics, which, by developing new hardware and software, offer the possibility of "dematerializing" some production phases through simulation and virtualization of supply chains, processes, products, favouring a lean, light, adaptable and flexible industrial production.

However, it should be noted that, even if with different "speeds" compared to other sectors, even the building sector is following this change.

In fact, different "types" of eco-innovation are finding application in the European field, even if the sector experts believe that this must be much strengthened starting from the process level, at the same time hoping for a systemic change of the different elements of the sectors productive (EACI, 2013).

Furthermore, it is evident how many lines of research can be developed and how much these could offer the project contents, methodological apparatuses, operational tools and a real capacity for transdisciplinary management of the processes.

This succinct scenario seems to offer clear opportunities, where the Project can not only reposition itself to the desired centrality in the processes, but also acquire new dimensions of scale and scale that could form an effective managerial role in those production chains that have as their horizon the New Qualities requests to the architectural action of the future.

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