

Lecture Notes in Networks and Systems 482

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# New Metropolitan Perspectives

Post COVID Dynamics: Green and Digital Transition, between Metropolitan and Return to Villages Perspectives

 Springer

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Francesco Calabrò · Lucia Della Spina ·  
María José Piñeira Mantiñán  
Editors

# New Metropolitan Perspectives

Post COVID Dynamics: Green and Digital  
Transition, between Metropolitan and Return  
to Villages Perspectives

 Springer

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# Preface

This volume contains the proceedings for the fifth International “NEW METROPOLITAN PERSPECTIVES. Post COVID Dynamics: Green and Digital Transition, between Metropolitan and Return to Villages’ Perspectives”, scheduled from May 25–27, 2022, in Reggio Calabria, Italy.

The symposium was promoted by LaborEst (Evaluation and Economic Appraisal Lab) of the PAU Department, Mediterranea University of Reggio Calabria, Italy, in partnership with a qualified international network of academic institution and scientific societies.

The fifth edition of “NEW METROPOLITAN PERSPECTIVES”, like the previous ones, aimed to deepen those factors which contribute to increase cities and territories attractiveness, both with theoretical studies and tangible applications.

This fifth edition coincides with what is most likely the end of the COVID pandemic that began in 2020. The global health emergency, despite having been a phenomenon limited in time, has acted as an accelerator of some changes in behavior and in the organization of activities associated with the ever-increasing spread of ICT.

The phenomena are too recent and still ongoing to fully understand the implications they will have on settlement systems, but the conclusion reached at the previous edition of New Metropolitan Perspectives seems to be confirmed: from many of the works presented at the Symposium, a reduction in the relevance of the localization factor emerges with ever greater clarity, at least in the ways known so far from the times of the Industrial Revolution, bringing to light more and more a paradigm shift in the center-periphery dualism.

In fact, the phenomenon that in the past led to the birth of the modern city, the need to concentrate people and activities in small areas, seems to be decreasing: the progressive spread of smart working and the digital modality for the provision of services (just think, e.g., of the digital services of the Public Administration or online commerce) significantly reduces the gaps in terms of accessibility to goods and services between metropolitan cities and marginalized areas, such as inland areas.

But this edition of the symposium also coincides with the start of a new phase for European policies, guided toward the green and digital transition, for the period 2021-27, by the European Green Deal, especially through the tool of the Next Generation EU.

The links between new technologies and sustainability tend to focus on the role played and that can play the city at EU level in fighting climate change.

Many of the contributions collected in this volume address the issue of the green transition through multidisciplinary points of view, dealing with very different issues such as, for example: infrastructures and mobility systems, green buildings and energy communities, ecosystem services and the consumption of soil, providing interesting information on the main trends in progress.

The changes in individual behavior and social organization, associated with the digital transition, are illustrated by the contributions that have addressed the issue of rules and of social innovation practices that are prefiguring new forms of governance for the regeneration of settlement systems. In this context, the issues of the new declinations of the concept of citizenship were also addressed, also with reference to the need to create favorable contexts for individual initiative and entrepreneurship, especially for young people, as a possible response to the challenge of employability for the new generations.

In this context, territorial information systems take on a leading role, together with apps capable of making territories increasingly smart.

The substantial investments planned by the EU to support the green and digital transition in the coming years require multidimensional evaluation systems, capable of supporting decision makers in selecting the interventions most capable of pursuing the objectives. The financial resources used for the implementation of the policies are borrowed from future generations, to whom we will have the obligation to be accountable for our work.

Unfortunately, at the time of writing we must also register serious concerns for the future of humanity, stemming from the risks of the spread of the conflict between Russia and Ukraine. In addition to the obvious concerns about the suffering that was always cause to civilian populations, this situation makes future scenarios even more uncertain: It is clear that the circulation of goods, people and ideas will be increasingly conditioned by future geopolitical balances.

The ethics of research, in the disciplinary sectors that the Symposium crosses, invites us to feed, with scientific rigor, policies and practices that make the territory more resilient and able to react effectively to catastrophic events such as the pandemic or the war: We hope to know the outcomes of these courses in the next editions of the New Metropolitan Perspectives symposium.

For this edition, meanwhile, the more than 300 articles received allowed us to develop 6 macro-topics, about “Post COVID Dynamics: Green and Digital Transition, between Metropolitan and Return to Villages’ Perspectives” as follows:

1. Inner and marginalized areas local development to re-balance territorial inequalities

2. Knowledge and innovation ecosystem for urban regeneration and resilience
3. Metropolitan cities and territorial dynamics. Rules, governance, economy, society
4. Green buildings, post-carbon city and ecosystem services
5. Infrastructures and spatial information systems
6. Cultural heritage: conservation, enhancement and management.

And a Special Section, Rhegion United Nations 2020-2030, chaired by our colleague Stefano Aragona.

We are pleased that the International Symposium NMP, thanks to its interdisciplinary character, stimulated growing interests and approvals from the scientific community, at the national and international levels.

We would like to take this opportunity to thank all who have contributed to the success of the fifth International Symposium “NEW METROPOLITAN PERSPECTIVES. Post COVID Dynamics: Green and Digital Transition, between Metropolitan and Return to Villages’ Perspectives”: authors, keynote speakers, session chairs, referees, the scientific committee and the scientific partners, participants, student volunteers and those ones that with different roles have contributed to the dissemination and the success of the Symposium; a special thank goes to the “Associazione ASTRI”, particularly to Giuseppina Cassalia and Angela Vigliani, together with Immacolata Lorè, for technical and organizational support activities: without them the Symposium couldn’t have place; and, obviously, we would like to thank the academic representatives of the University of Reggio Calabria too: the Rector Prof. Marcello Zimbone, the responsible of internationalization Prof. Francesco Morabito, the chief of PAU Department Prof. Tommaso Manfredi.

Thank you very much for your support.

Last but not least, we would like to thank Springer for the support in the conference proceedings publication.

Francesco Calabrò  
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# Re-think Building Codes for Indoor Air Quality

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**Abstract.** Assuming the need to create safe and healthy environments as an essential priority, the text aims to promote the design and use of organic regulatory tools, able to promote conditions of well-being, in relation to the places where the building is located, the activities that are exercised in the interior of it and the construction methods. This is the need to “accompany” the designers in the evaluation and management of health risks, especially those related to indoor air pollution (IAQ), indicating effective protocols for prevention, control and correction. It is proposed, in a non-manual key but problematic, a reinterpretation of the Municipal Building Regulation; conceptually different, operationally alternative to those in progress. Bringing this regulatory instrument back to its original usefulness and meanings, the aim is to make it reassume a role of control and direction of the building activity, which expresses its effects at the moment of examining the requests for intervention and in the verification of the quality of the constructions. An objective that can be achieved only through collaborative actions and according to common and shared methodological and operational lines, between structures operating on the territory, with different technical-building and hygienic-sanitary competences.

**Keywords:** Sustainability · Energy · Living · Indoor air quality

## 1 The Challenge of Complexity

For some time now we have been witnessing a series of alarms that continually warn us and remind us that our well-being is leading to an exaggerated and ever increasing use of energy and resources, as well as the deep and irreversible transformation of natural systems, social inequality; in practice, it is the overall impact of the human species that continues to grow.

In truth, we had already been warned of this uncontrolled growth back in 1972 by the report [1] commissioned by the Club of Rome from the Massachusetts Institute of Technology and drawn up by a group of researchers led by Dennis Meadows. They argued forcefully that planetary ecological constraints on resource use and continuous polluting emissions would profoundly affect the future of the planet in the 21<sup>st</sup> century.

The hoped-for renewal of society, through technological, cultural and institutional transformations aimed at preventing the impact of mankind from exceeding the carrying capacity of the planet, unfortunately did not take place and in the 1992 edition [2], which

reviewed the 1972 report, the authors confirmed what they had written twenty years earlier, denouncing another dramatic result: in fact, humanity had already exceeded the limits of the earth's carrying capacity. The considerations that arise in the latest edition [3], that of 2004, confirm and weigh down the previous pessimism of the authors: despite the undoubted progress made in the scientific field, humanity is currently living in the field of unsustainable development.

The Nobel Prize for economics Joseph Stiglitz [4], arrives at such dramatic results: "(...) if we do not find a way to limit environmental damages, to save energy and conserve other natural resources, as well as to slow down the warming of the planet, we are destined to disaster (...)"

"Ecology" and "environment" have become the key words of the third millennium: a media bombardment that has helped overcome the insurmountable barrier of indifference and insensitivity. The growing universal alarmism on the subject has cracked some of those certainties behind which most of us have long hidden: that progress had inevitable costs without escape and that, above all, the consequences would be paid in several centuries. "The hypothesis that in four hundred years our descendants would have no gasoline did not trouble us much. However, the prospect that our children are already living on a collapsing planet, the idea that the future of the environment directly concerns us and that the bill is coming to us well in advance of our predictions, changes our outlook. As a result, the concept of sustainable development has now entered the vocabulary and agenda of politics, industry and economics" [5].

This situation has worsened considerably also due to the spread of urban systems that has inevitably increased the vulnerability of natural systems making it more difficult to implement concrete measures towards sustainability. The city is the most widespread habitat of the human species. Today in Europe at least 75% of the population lives in urban areas. In no other place as the city man has modified and altered the environment, determining the increase of material and energy flows and promoting environmental fragmentation. After decades of speculation not only in construction but also in energy, after having transformed three quarters of our housing stock in a thermal trap that devours oil and gas, even if there is a widespread regret, an effect of the growing environmental anxiety, we must unfortunately admit that the main problem of humanity for the next decades will be to reduce the consumption of fossil fuel because the survival of millions of people will depend on it. Because of the order of magnitude of the problem, one cannot help but demand greater accountability from those whose profession involves buildings.

The building sector is responsible for more than a third of global carbon dioxide (CO<sub>2</sub>) emissions, and it accounts for nearly 40% of all the waste that humans produce, which contains enormous amounts of embodied energy. We live in cities connected to nature through markets and technology. All cities must import food, fuels, and materials, and all cities are markets. The environmental challenges posed to the city vary according to the level of economic activity.

The theme of the third edition of the World Conference on the Future of Science is The Energy Challenge. The challenge is: how to produce the energy necessary for the development of well-being, protecting our most precious asset, the health of man and the planet; and also how to make understand and accept the solutions that science proposes

to a confused and frightened society. If in fact energy indicates something positive and vital, in recent years the term is increasingly associated with air pollution, ecological disasters, global warming, climate change, unsustainable costs.

There are many reasons, today, that make us say that the restoration of compatibility between transformation and environment, between artifact and nature, between production needs and global security needs, represent the real challenges for the architecture of the next decades. From many quarters we are invited to consider a new approach that, rather than making us speak in abstract terms of sustainable materials and technologies, suggests, to reintroduce expressions long out of use that refer to appropriate materials and technologies; making this term take on new and more complex meanings with the recovery of the needs of health and the concept of “material place” of the project [6]. Sustainable does not mean self-sufficient. To embark on a path toward sustainability, a country must improve the health and well-being of the collective, reduce environmental impacts, engage in recycling of materials, and use energy efficiently.

More and more frequently we talk about flexibility, which has become the key word that big cities, today the stage of the biggest environmental dysfunctions, must “adopt” to counteract the monoculture that kills any urban form.

The worst evil for a city is the inability to open up to the new and to adapt to changed circumstances. The city is bound to grow, but growth poses a problem of sustainability.

The ways in which sustainable development is encouraged and promoted vary according to the schools of thought and the history of each. Almost all of them, however, agree that the indispensable measures to be taken, in the construction sector, concern the adoption of verification criteria to be used by the designer, on the waste of resources, on harmful emissions or on any activity that weakens or threatens the availability of resources, on the man-made environment; on the health and well-being of humans.

But it is not that simple. The difficulties also stem from the fact that our legislative and regulatory apparatus, especially national, is incapable of defining adequate measures and methods of verification. Even if there are more and more attempts to identify precise standards for living comfort; to identify precise reference thresholds to be followed in the design, construction and production phases of materials and components. Even today, the question remains open.

The situation in which we find ourselves is actually more serious than the most pessimistic forecasts: in fact, the report of the Energy Watch Group, set up by some German parliamentarians with the participation of scientists and economists, contains a merciless comparison between the forecasts made by experts from the IEA, the International Energy Agency, where there is a glaring and worrying gap between what was predicted and reality.

And again the conclusions of the United Nations Report on Climate Change (IPCC) are ominous. It is predicted that by the end of this century, as a result of human activities, the global temperature will probably increase by 3° Celsius, to reach a level not reached by planet Earth since the Pliocene era, three million years ago. Scientists warn us that a climate change of this magnitude will endanger civilization itself and the future of the planet.

At the same time, international conferences that want to avert this dramatic prediction follow one another without respite.

Environment, ecosystem, greenhouse effect, harmful emissions, citizens' health, energy consumption, sustainable development. It is a list, which could be even longer, of terms that are part of our everyday life and that show how much the human "footprint" today is disproportionate, comparable, as Gianfranco Bologna says "to the geophysical forces that have profoundly shaped our planet, in billions of years".

A situation that must be faced and can no longer be postponed. The problem of improving our relationship with natural systems is increasingly becoming one of the great political emergencies of the immediate future. Scientific knowledge and the best available technology, today, provide us with theoretical and practical tools to seriously address these problems and try to reverse current trends.

If we do not learn to anticipate events and, in some way, to "govern" them, they will mark our destiny and, from this point of view, we could also suffer effects that could lead us to truly dramatic situations. The main path of true development, as stated by economist Georgescu Roegen, is to get more and more utility from fewer and fewer resources. Not that of the destructive and bold growth whose causes are: the increase in population, the increase in consumption per capita and the impactful technologies (Holdren equation).

The pressure exerted by social metabolisms on natural ones, even more increased by the overall increase in population with consumerist lifestyles, is now clearly unsustainable. If consumption trends continue to grow, as seems to be the case, without corrective action, the outlook cannot be rosy. The signs of suffering of the planet's ecosystems are very evident and our pressure on their regenerative and assimilative capacities is now considerable. The paths proposed by sustainability are feasible and practicable; however, it is necessary a real revolution of sustainability that is, fundamentally, a "cultural" revolution.

These are issues that, even if they inevitably concern the construction sector, the strategies and solutions to be adopted are not only its responsibility. It is necessary that large sectors of the scientific and political community define a line of demarcation between what must and must not be done with a logic not only of interdisciplinarity, but of transdisciplinarity, the only one capable of constructing a global thought capable of articulating the different areas of knowledge. (...) Understanding the interdependence of cultural systems and ideas is now more necessary than ever. This will help to change our way of thinking, giving us one more tool to escape the abyss towards which the planet seems destined (...).

## 2 Technology and Environment

The new scenario implies the need to relate decision-making processes for design to different categories of reference - political, social, economic - involving different orders of complexity in design practice. And yet, in this phase of great investments, our country is considerably behind on the issues that guide the innovation of building production. The reflection to make is how much this expansive and developmental phase has contributed to qualify the architectural project and govern, in an environmental sense, the transformations. In response to this, the signals that arrive are, in fact, very weak and

with difficulty we read in the cities, in the suburbs a new season in the model of transformation of the territory, a new contribution to the quality of life that comes from a vision of the 2000s of the building products.

What does it mean today to realize a quality project? In recent times quality has often coincided with certain requirements considered, rightly, fundamental or perhaps necessary for a new way of building that is attentive to environmental issues, but above all to management costs.

It is well known that the architectural project is confronted, today, with an increased complexity, both theoretical and technical, which requires broader and more articulated skills. A new complexity that presupposes, as Nicola Sinopoli [7] states:

"(...) a formation in the field of the project of architecture, aware of its formal, physical, economic aspects, and of constructability, of the complex contexts (city, client, production...) in which today such project is realized, of the evolution of the demands, of the technological resources of the technologies of the questions related to the energy and to the sustainability, of the aspects related to the industrial culture, to the production and to the innovation in the picture, obviously, of the actual internationalization of the markets of the materials, of the components, of the business performances and of the professional services (...)"

The generalized objective of saving resources and using renewable energy sources has now become a necessary strategy that fully involves architecture, since the environmental weight of buildings in industrialized countries has grown considerably in recent years.

The fact that the building industry is the main responsible for the consumption of all energy produced and huge amounts of CO<sub>2</sub> emissions, must make people realize that the project is now at the center of a revolutionary change in the way buildings are designed and built. A change so radical in its importance and scope that it is a real opportunity that will finally "force" us to face the double challenge of energy waste and impact on people's health [13; 15].

Technology is configured, for its current and past history, as a discipline, able to undertake new design paths. Thanks to the latest technological advances, it is now possible to design and construct "healthy" buildings that create their own needs from local renewable energy sources, configuring themselves "(...) to serve as both power plants and habitats (...) [8].

Although the issue of environmental sustainability is one that must be addressed globally, through coordinated policies, the ability to activate strategies depends on the local scale.

In Italy, many public administrations have begun to introduce environmental sustainability criteria in their building regulations, assigning volume "premiums" or incentives to sustainable construction.

Unfortunately, to date there are still few that address the issue in an integral manner, taking into account all the different parameters that contribute to a rigorous environmental assessment. The lowest common denominator present in all regulations that have adopted environmental sustainability guidelines is the promotion of energy saving through the increase of the level of thermal insulation of the building envelope. In fact,



since energy consumption accounts for 70–80% of the environmental impacts generated by the building in its life cycle, energy saving is given a leading role in environmental protection.

In the recent past, the Italian Government took an important step, facilitating and regulating the energy optimization of buildings through the application of advanced heating and cooling systems. The most important aspect is the promotion of a fiscal policy in the field of housing linked above all to the performance of buildings by encouraging the implementation of energy-environmental renovation programs of the public heritage. Not thinking, however, that houses increasingly sealed to ensure energy savings have repercussions on another issue: the lack of ventilation and the stagnation of stale and polluted air. The most recent regulations on energy saving - made more attractive by tax breaks - push towards situations of this kind.

In truth, our country is slow to address issues that other countries have long since resolved. In spite of the fact that from many sides, it is stressed how serious the situation is now and the repeated alarms of environmentalists and scientists, there is a considerable delay in complying with agreements that would lead to an extraordinary improvement of our development. Consequently, there is an extreme difficulty in spreading a culture capable of correctly combining the issues of economic development with strategic environmental budgets for the preservation of natural resources and systems over time.

And the European Union, whose technical policy member states must conform to, has included environmental protection among its strategic objectives for some years now. In the construction sector, this should be translated into a drastic limitation of the consumption of resources, seeking a general improvement of environmental comfort and increasing the conditions of livability and urban identity. The environmental parameters define new requirements that affect the project, transforming the established structures. The current debate on sustainability presents evident contradictions. If, on the one hand, we are in the presence of a metabolization of its general principles, on the other hand, we have not yet reached a stage in which the methods of implementation or the results of concrete eco-friendly architecture are widespread and controllable.

In response to these needs, tools have been developed, some time ago, to support environmental design and evaluation of the building through, design criteria oriented to sustainability (energy saving, water saving and recovery, recycling of materials, measures to ensure a healthy indoor air quality). Starting from these “lists” of requirements, multi-criteria evaluation tools have been developed, called “score systems”, which associate these criteria with a merit score, based on the degree of satisfaction of the requirement verified through indicators [9].

Especially at the international level, the development of such systems was born at the urging of the builders, who expressed the need to “certify” the realization of buildings with high energy performance and low environmental impact, based on consolidated references and with the endorsement of reliable reference structures: BREEAM and LEED, which are the only real environmental certification systems for buildings, have found considerable success on the market. Thanks also to the acquired awareness on the part of end users and large real estate investors, who have expressed the need for tools to guarantee the quality of the buildings they purchase.

In fact, sustainable skyscrapers are emerging, especially in the United States, certified by LEED, whose influence is not marginal for the definition of the commercial value of the construction to which it is attributed. In the past, building a “green” building involved an increase in costs of 20%, currently this increase is estimated at around 5% and is amply rewarded by the increase in profits that a building with good sustainability characteristics can generate. Energy cost containment can reduce operating costs by up to 70%. According to the Indoor Environment Department at Lawrence Berkley National Laboratory, this provides colossal indirect savings by reducing illness and disease to which office and home occupants are subjected. This becomes an incentive for constructing buildings that meet the LEED standard, which can access funding and substantial tax reductions.

However, scoring systems have several critical issues. First of all, their approach is apparently performance-based, in fact because it is articulated in so many indicators it ends up being prescriptive. In addition, they do not have a “systemic” approach because the approach is aimed at “optimizing” individual elements of the project without an overall verification of results: it is taken for granted that the sum of performances corresponds to the final overall performance of the building, but this does not always happen, also because often the optimal design solution to meet a certain requirement is to the detriment of other requirements (the project is always a compromise of often conflicting needs). Finally, there is a total lack of a life cycle approach, especially in the criteria related to the choice of materials and building components: even the indicators related to the verification of energy consumption calculate separately the energy incorporated in materials and the energy in use, without a unitary balance of the entire life cycle.

Sustainable development is certainly one of the major challenges of this century: the priority objective of a new sustainable design should be to properly select materials and components of the building in order to reduce, in the first instance, especially its most significant energy consumption attributable to the operating phase. The design for sustainability must base its proposals on the comparative assessment of the environmental implications of different solutions technically, economically and socially acceptable, and must result in the creation of materials, products, components and services designed taking into account their entire life cycle. Knowing the environmental impact of the life cycle of materials is therefore essential to make the right choice: the basis of any choice is a comparison between different options that allow to perform the same function.

### **3 Reducing Emissions and Saving Energy**

Energy saving and environmental sustainability are considered fundamental objectives in the realization of new buildings and in the requalification of the built environment, so much so that they occupy prominent positions both in the debate on contemporary architectural design and in the processes of definition of future regulatory frameworks. Unfortunately, most of the buildings are constructed without paying attention to the environment and energy, and although there is a significant increase of interest from technicians and administrations, qualified solutions remain a niche.

Moreover, user behavior, due to this situation, is hardly oriented to the control of energy consumption. Being able to have a comfortable indoor microclimate all year

round, given that the buildings we live in, in most cases are not able to guarantee it, often makes us resort to the help of technology, which over time has fatally improved, but has also contributed to aggravate a global situation.

Energy blackouts, climate change, polluting emissions are the most obvious aspects of the need to rethink our way of doing construction. This is due to the increasingly alarming inadequacy of the current way of producing energy, in meeting the demands of consumption, but also for the impossibility of thinking about an increase in production and consumption of energy without an immediate impact on the quality of life.

The awareness campaigns carried out by the Ministry of Environment, the new European and national regulations, the tax relief for interventions that increase the level of energy efficiency, as well as the continuous increase in fuel costs have made the reduction of energy needs of buildings become an intent shared by most of the community.

Today's times require that as many people as possible learn to think in an environmentally friendly way. In small and big daily choices.

There are countless technical solutions that show a greater interest in environmental issues, but too often outside our country. If Germany and Great Britain have reduced polluting emissions by 3%, thanks to the use of renewable energy instead of coal, Japan is the world leader in photovoltaic roofs and ISO 14001 certified products (more than ten thousand).

The analysis of the Italian building production of the years two thousand, through the filters of innovation, provides a great discomfort: we are faced, for the most part, to monofunctional buildings, with outdated energy solutions and technological components in the building product for nothing different from those of the seventies, no trace of environmental sustainability in the projects, no attention to energy saving.

In the field of sustainability, combined with energy saving, pollution reduction, biotechnology, the life cycle of the building product, on which the European Union is pushing, we can only record some timid experimental experience, some innovative but new building regulations and little else and even less if we use the filter of technological innovation and information communication technology, apart from the use of information technology in the design studies, there is very little engineering in construction.

It is therefore evident that the energy issue is central to the construction sector, and in turn central to the concrete implementation of emission reduction. And it is equally clear that it is a cultural issue.

The consumption and the impacts of the building sector are distributed on two fronts: on the one hand the production, the installation and the disposal of building components, on the other hand the management of the building system during its use.

But it is not believed that the energy problem can be solved by intervening on individual components. There are several reasons for this. The first is that the environmental quality of the building does not derive from the sum of components and materials, but from their interaction within a unitary organic system, which is precisely the building organism. The second is that the building is closely related to the way of living in places and therefore to the culture, the technical capacity of individuals and communities that live there.

These observations open the field to a way of acting that is not limited to identifying innovative solutions of materials, components and techniques, but that places them in

the context of a more complex technological, environmental and social treatment. The design aimed at energy saving must be able to control and act on three different levels: environmental, typological and technical construction.

## 4 A New Building Hygiene

The problem of air quality in non-industrial confined environments, since a few decades, has assumed considerable importance certainly for the importance of the technical implications - design but especially for the problems of impact that air quality has on people's health. The scientific community, due to the occurrence of specific pathologies and situations of discomfort in the occupants of homes and offices, has reiterated the need to investigate the sources and agents responsible, to quantify the impact on health of exposure to particular substances or materials and, of course, to indicate possible remedies and appropriate technical solutions. Terms such as *Sick building syndrome* and *Building related illness* are now treated with insistence. Homes, schools, hospitals that until a few years ago escaped any control of air quality - indoor air quality - and healthiness of the environment are now the subject of specific studies; however, there is still an extreme difficulty of communication between the different fields involved in research.

These issues are of growing interest in Europe, whose European Community has always given priority to research into the well-being and health of its citizens.

"We have to worry about dusts, gases, microorganisms, odors" (...) it should be noted that in total, in this very important field of air purity, which has worried hygienists for so long, we are actually very poorly armed to establish the needs.

The actuality of this consideration by Blachere, from 1971, confirms that our living is characterized by a condition of discomfort that is increasingly caused by the houses in which we live, the factories and offices in which we work, and the cities in which we live.

The attention paid to the building as a "problem within the problems", more and more disturbing that invest the future of our species, seems justified on the basis of at least three considerations:

- it is always opportune that reflection on the ecological question starts from the everyday, from the well-being and health of the individual;
- there is, especially in our country, still an immense cultural and behavioral gap around these issues;
- it is necessary to address the same scientific and technological research towards the development of knowledge capable of placing the quality of life as a central theme of study.

For some years, in the most developed countries, it has been noted the emergence of a new issue of primary interest for public health: the air we breathe inside the non-industrial buildings is more polluted than the outside air and this is particularly serious because most of the population spends most of the time of their lives in such places. The house that after decades of building policy oriented towards objectives of "quantity" had long since lost that aura of sacredness that has historically distinguished it, has now become a dangerous place exposed to radiation of natural and artificial origin.

Houses, hotels, offices, schools present concentrations of pollutants dangerous to health higher than those in outside. The causes of this situation are attributable to several factors, such as the introduction of new products in the building cycle, the lack of attention to design and technical solutions, the decrease in ventilation due to the increased sealing of buildings.

The problem is aggravated by the fact that today we are far too distracted by problems of energy efficiency, energy conservation and energy saving. And such indications are absolutely antithetical to strategies for solving indoor problems that prefer more ventilated and less sealed environments.

But indoor pollution is not a “new chapter” of risk conditions linked to particular alterations in air quality, it is added to those already known in the history of public hygiene and that have concerned the relationship between environmental conditions, the built environment and the individual: requirements for healthiness, risks from air pollution and safety in the workplace. The role of the impact of outdoor climatic conditions on the indoor microclimate as well as the relationships between indoor and outdoor pollution are obvious and need not be repeated here.

But the possibility that the home itself may pose a threat is particularly unpalatable, though not a new idea. Whenever large masses of the population have become urbanized, problems of danger related to the built environment have arisen, such as epidemics and diseases due to the unhealthiness of living and working places. The building hygiene of the last century had focused its attention on the pathologies resulting to people from the permanence in humid and unhealthy living places. Their spread was facilitated by overcrowding, promiscuity and lack of hygienic conditions. Pathologies such as rickets, tuberculosis, various forms of rheumatism and pulmonary diseases found ideal conditions for development in cold, humid environments where sunlight rarely entered.

From the observation of the relationship between the built environment and disease was born the concept of public health that led, centuries later, to the modern urban planning and hygiene-building regulations, with the requirements of habitability and well-being.

Retracing its history, we recall: the ordinances of the Roman era on the maximum height of buildings, the proposals of Vitruvius and Alberti [10] to make the building healthier and more durable, up to the nineteenth-century legislative measures aimed at improving housing conditions, Broggi’s proposals on hygiene and housing decorum, but also the rationalist ideology of air, light and green.

Lavoisier had the intuition that to “spoil” the air contributed the by-products of organic combustion of tissues expelled through the respiratory tract, consisting mainly of carbon dioxide, rather than the reduction of oxygen content. This hypothesis, however, began to be questioned since the middle of the last century, as it was noted that, under conditions of normal occupation of the environments, the rate of CO<sub>2</sub> in the confined air never reached the values for which it could be considered harmful ( $\approx 5\%$ ), as per experimental tests, and that in the case of considerable crowding the sense of discomfort and disturbances affecting the occupants were felt long before the percentage of CO<sub>2</sub> had reached these harmful values. It was therefore very likely that the air pollution reached an unbearable level and was highlighted by discomfort and intolerance not due to the production of CO<sub>2</sub>, but of other substances. The latter were identified in some volatile

organic products, whose entity is linked to the presence of man in the environment and therefore were called by the hygienists who studied them, Brown-Sequard and D'Arsonval, anthrotoxins. Little was known about the nature of these substances; in general they were gases eliminated by the lungs, products of skin perspiration and sweating and were difficult to measure.

Since the content of CO<sub>2</sub> in the air could, however, be measured exactly, it was possible to assume for the sought-after index of tolerance the value of the percentage of CO<sub>2</sub> above which the first discomfort could occur, even if their cause was not attributable to the CO<sub>2</sub> content mentioned above. Thus, the criterion was established that in order to maintain the air in an occupied closed environment in healthy conditions, the percentage of CO<sub>2</sub> [9] should not exceed one per thousand (Pettenkofer's anthracometric index). Subsequently, with the widespread development of industrial production processes, the attention of hygienists has shifted to the study of working environments - where production processes can introduce into the environment high concentrations of pollutants - identifying the risks of exposure to which people were subjected and defining the technical and regulatory precautions to be taken.

Pollution thus begins to take over not only industrial cities but also ancient cities, sociologists and scholars of hygiene and public health, even if they do not yet speak of ecology, operate among several difficulties the first proposals for intervention, through technical measures and health laws, to try to stop the growing environmental contamination.

The first examples of environmental intervention, however, were carried out right inside those industries that were the main causes of pollution, and this was done not so much for philanthropic reasons or for workers' claims, but to make work more productive by controlling the thermal conditions, humidity and ventilation of the environments. The fact that this circumstance then contributed to a decrease in the amount of infections and illnesses contracted at work is in fact a coincidental episode, since much more will have to pass before this requirement becomes essential, even if respect for it is still often achieved in terms of regulations rather than reality.

The introduction of industrial processes therefore determines a new kind of environment and a new way of life and requires an increasing use of scientific instruments and increasingly sophisticated techniques that consequently trigger further changes.

In the last twenty years or so, air quality has once again become a major health concern, given that many people spend most of their time indoors.

The increasing complexity of the production process has made it difficult to understand the interrelationships between different technical acts. The advent of industrialization and, within this, the contribution of chemistry, has introduced in the construction field hundreds of new materials that should have perfected the living and building, but that, in reality, have made it more difficult to control the quality of the built and the control of the correspondence of this to the needs of users, more and more distant from the process for the production of housing.

The search for solutions that would allow the exploitation of valuable areas have made designers forget the beneficial influence, both psychological and physical, of air and natural light. The haste to build and the cost of labor has imposed the use of materials that are easier to use, but often little tested.

The spread of “do it yourself” has put in the hands of the common man highly dangerous products, if used without due caution.

All these actions, but especially the combination of them, has had the effect of worsening the quality of indoor air.

The discovery of indoor pollution is therefore, an aspect directly linked to a new way of thinking about environmental and hygiene requirements, which have been neglected for too long in the construction design process.

The current building situation unable to respond to the changes in demand and the emergence of needs that have occurred in recent decades is closely linked to the qualitative aspects of indoor air.

“It is necessary, as Guido Nardi [11] says, to deepen the role of design both in determining some causes of the current situation of discomfort and in allowing ways out of what seems to be an irretrievably compromised situation. From this point of view, a clarification is necessary: the causes of the widespread discomfort with the built environment are to be found not only in the increasingly precarious competence of designers (architects or others), but above all in the inability to culturally interpret contemporary reality, both in terms of materials and techniques, and in terms of the increasingly rapid transformations of behavior that affect society.

The prevention of indoor pollution can be carried out by acting simultaneously on different levels: that of information, that of control and that of normative or regulation.

Designing and constructing a healthy building, as recommended by the various studies that have been dealing with the problem for years, means:

- That the different actors in the building process must work synergistically;
- that the different responsibilities of those who have to ensure that the users’ demand for healthy buildings is observed are well understood;
- that there is a correct approach to the initial phase of the project in the given environmental context;
- that there is real scientific knowledge on the part of planners and designers, and builders must ensure that new and old knowledge is always applied;
- define laws, regulations, and standards so that the roles and responsibilities of the final product are clear;

The designer’s task is to provide a healthy building [14], in which all risks of indoor pollution are reduced as much as possible by acting, in particular, on:

- the control of factors that worsen air conditions;
- the reduction of polluting sources (choice of products);
- the confinement of polluting sources (design of plant location);
- dilution of concentrations (ventilation design);
- expulsion of pollutants (evacuation devices).

## **5 Innovation in Local Building Regulations**

Today, the overall quality of living is affirmed in order to face and solve the new social and market conditions in a way connected to the real evolution of society, overcoming

the concept of healthiness, not in order to demolish it but to include and enhance it. In this regard, the trend that we try to affirm here takes note of the profound transformation that has affected in recent decades the overall sector of building regulation, that of the project and that of construction techniques, and proposes a completely different approach than in the past.

The perspective is to bring back every regulatory instrument to its original meaning and purpose. In this sense, the Building Regulations must be a real instrument of control and direction of the building activity, which has its effects at the time of examining requests for interventions and carrying out checks on the quality of buildings, with the intention of developing a whole series of collaborative aspects - according to common and shared methodological and operational lines - between structures that operate with technical-building and hygienic-sanitary competences.

This work wants to identify the means and methodologies through which the two sectors of construction and sanitation can be structured with progressive cohesion, starting from the point of view and the reason that the separation has increased the amount of constraints, contradictions, discretion, possible interpretations, not always and perhaps not more to the benefit of the welfare and real safety of end users.

Among other things, the procedures and methods of control are not homogeneous in different realities and not very consistent within them, creating uncertainties of interpretation, overlaps and contradictions that result in objective difficulties for operators and citizens.

The product of the research is aimed at renewing the entire apparatus of guidance and control of the activities of protection, use and construction of the territory. A regulatory intervention that wants to renew the regulatory apparatus building - municipal, specifying the objective of driving to the achievement of safe and healthy environments. It introduces new indexes in the current regulation, new performance aimed at achieving conditions of well-being in relation to the places where the building is located and the activities that are exercised in the internal environments of it. It is proposed, that is, a tool that leads to unity the complex problem of environmental hygiene and safety, taking into account the risks that may arise.

Through the study of the regulations in force in complementary sectors and disciplines, procedures, design criteria, requirements and controls are established, to be exercised by looking at the global aspects of the problem; thus overcoming the limits of a sectoral regulation.

The fundamental principles of the proposed tool are:

- The adoption of normative prescriptions of a demanding-performance type and, of a set of quality levels, clear, measurable and released from specific constructive references, resulting from a series of basic needs (safety and well-being) and controllable in a systematic way.
- The attribution to the designer and the builder of the responsibility to ensure the compliance of projects and works to the requirements and the municipality to be able to carry out no more paper checks, but substantial on the work carried out.
- The explication of all performance characteristics (mandatory and recommended requirements) of the real estate unit, as well as its metric and dimensional data, through the establishment of a special descriptive data sheet.



The proposed legislation has as a consequence a substantial revision of competences and controls in the building process. In fact, once all requirements and reference parameters have been precisely defined and made explicit in advance, there is no need for opinions which, by their nature, are justified only where there is room for evaluations not covered by precise regulatory provisions. In the hypothesis outlined by the new norms, all the technical investigations pertaining to the local authority become, instead, substantially, controls of correspondence to what is disposed in the Building Regulations systematizing and reunifying in this way the framework of competences.

The renewed municipal building regulation must be the fundamental seat of this new philosophy and can be so under two conditions:

1. the first is that it be supported by a regional (or state) law that allows the repeal of certain technical disciplines, contained in primary regulatory sources, replacing them with provisions of a demanding-performance nature;
2. the second is that the choice of the exigency-performance approach be made fully and coherently, replacing a system based on the prior regulation of every aspect with another new system, based on the relative freedom of forms and methods and on the rigorous control of results.

In the product envisaged, there are undoubtedly greater difficulties of control and verification compared to traditional instruments, especially in terms of preparation of operators, availability and suitable equipment and, perhaps, definitions of further knowledge and specific methodologies. The problem is certainly open, but the solution can only be evolutionary. From this point of view, it is essential to be convinced that there can be no seriously managed regulation, but above all no quality policy, without adequate experimentation, without control of real quality in actual operating conditions and without adequate technical support information. With the support of the exigency and performance methodology it is possible to overcome that dispersed exercise of single competences that often results in a general de-responsibilization on the results of the control process; this implies the realization of an interdisciplinary and multidisciplinary approach, codified in a unitary normative instrument, according to the hypothesis just schematized, defined independently from who will then operate the single disciplinary interventions of standardization and control. The standard regulation is expressed through a series of minimum performances that must be possessed by buildings and housing. The satisfaction of these performances constitutes an effective threshold, below which non-compliance corresponds to a judgment of impossibility to a healthy, safe and comfortable use. The proposed legislation has as a consequence a substantial revision of the responsibilities in the building process and control that will have to develop according to:

- *Design Verifications*. Many of the currently proposed calculation procedures are unreliable and discriminating, and should be improved in light of the latest disciplinary findings. They are the most important form of error prevention and should be conceived as self-directed checks.
- *On-site audits*. Performed by a third party, they function as an external control to supervise the self-directed control, but in this sense they must be comparable with

the results of the verifications on the project and allow, when necessary, to start a diagnosis of the causes of non-compliance.

- *Third Party Control*. It allows to identify “technical structures” able to accumulate a historical memory of data on pathologies, errors and defects, through self-directed control. It is a learning and correction tool available to the design structures, but in this perspective the identification of responsibilities and competencies must be clear.

From this framework emerges a direct empowerment of design and operators in general, which reasonably reduces multiple and overlapping controls and simply and clearly identifies who is responsible and for what. Redefining the roles and competences of the public administration, the highly simplified procedural control can be overlapped by a substantial control on the real quality of the interventions; this role, freed from margins that today are too often discretionary, should be supported by appropriate equipment and professionalism for control and verification.

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