ISSN 2385-1031 [Testo stampato]
ISSN 2385-0671 [Online]

Housing Policies and Urban Economics

HoPUE

Vol. 3 - Dicembre 2015

Accademia Piceno - Aprutina dei Velati in Teramo
ACCADEMIA DI SCIENZE, LETTERE, ARTI E TECNOLOGIA
Ente accreditato dal MIUR per la formazione del personale della scuola
(Decreto del 24/07/2009)

HoPUE - Vol. 3 - Dicembre 2015

Housing Policies and Urban Economics – Vol. 3 / 2015

ISSN: 2385-1031 (print)
ISSN: 2385-0671 (online)

Preface 1
Barbara Ferri

THEME "Historic urban landscape"

The Regeneration of Historic Cultural Landscape in Port Cities * 5
Luigi Fusco Girard

Il Patrimonio Culturale come Motore per lo Sviluppo Economico 23
Martina Bosone

THEME "Building quality and energy resources"

Energy, Environment and Safety: technological retrofit of training buildings * 45
Rossella Franchino, Antonella Violano

Towards better planning and design of hospitals; lessons from the Greek experience 63
Evangelia Sklavou, Ioannis Tzouvadakis

THEME "Public space, urban and environmental redevelopment"

Agriculture in School Recovery 79
Francesca Muzzillo, Fosca Tortorelli

THEME "Housing and social policies"

Climate responsive design. Research, strategies and assessment criteria 87
Andrea Mammarella, Gianmichele Panarelli, Thomas Spiegelhalter, Clarissa Di Tonno

****Invited paper***

Housing Policies and Urban Economics Vol.3 / 2015, pp. 87 - 111

Climate responsive design. Research, strategies and assessment criteria

Andrea MAMMARELLA[1],Gianmichele PANARELLI[2], Thomas SPIEGELHALTER[3], Clarissa DI TONNO[4]

Sunto: Le città, così come i territori costruiti, hanno recentemente subito alcune importanti modifiche: mutazioni culturali, nuovi equilibri geo-politici e di cambiamenti climatici. Tutti questi problemi appaiono anomali in un momento in cui la molteplicità di informazioni e conoscenze in rete dovrebbero moltiplicare le risposte, anche se in realtà non sembrano avere successo. Il ruolo del progetto è cambiato e il presente lavoro esplora alcuni approcci innovativi che il gruppo di lavoro ha adottato per la ricerca su questi argomenti.

Parole Chiave: Progetto di Parametric-Algorithmic, Codici/Protocolli di progetto, Net-Zero-Energy Buildings, Innovazione progettuale.

Abstract: Cities, as well as built territories, have recently undergone some major changes: cultural mutations, new geo-political balances and climate changes. All these issues appear anomalous in a moment in which the multiplicity of information and the networked knowledge should multiply the answers, though they don't seem actually to succeed. The role of the project has changed and the present paper explores some innovative approaches that the working group has adopted to research about these topics.

[1] Department of Engineering and Geology, University "G. d'Annunzio" of Chieti and Pescara, Viale Pindaro, 42 – 65126, Pescara (Italy), andrea.mammarella@unich.it;
[2] Department of Engineering and Geology, University "G. d'Annunzio" of Chieti and Pescara, Viale Pindaro, 42 – 65126, Pescara (Italy), g.panarelli@unich.it;
[3]FIU (Florida International University) - Miami Beach Urban Studios, 420 Lincoln Ave. Suite 420, Miami Beach, FL, 33139, USA, spiegelhalterstudio@gmail.com;
[4] Department of Engineering and Geology, University "G. d'Annunzio" of Chieti and Pescara, Viale Pindaro, 42 – 65126, Pescara (Italy), clarissa.ditonno@unich.it

Keyword: Parametric-Algorithmic Design, Design/Protocol Coding, Net-Zero-Energy Buildings, Project innovation

Introduction

This paper describes the research activities of the joint working group (Department of Engineering of the University G. D'Annunzio of Chieti-Pescara and College of Architecture of the FIU Florida International University of Miami, USA) about the topics of sustainable transformations within a time of great changes, to be intended not only as an energy-saving and environmental issue, but also as a socio-economic concern. The attempt is to investigate innovative design solutions, appropriate to different geographical, cultural, environmental, social and economic contexts; according with the need to reflect on new lifestyles and new desires induced by the global socio-economic conditions. The geo-political instability and the following emergencies (great migration, capitalism and widespread poverty, social exclusion…), along with environmental events not always predictable (earthquakes, floods, rising water levels, melting glaciers...) has directed the research within a wide framework of awareness about the existence of a large and consolidated information system and of a global scale data interchange (Smart City). In this sense, more space was allocated to the third chapter, whereas the contributions of the other three have been summarized.

The *first chapter* (*Mammarella*) explores the changing conditions of contemporary planning and designing, stating the need to seek new design paths within the awareness of new cognitive variables, tangible and intangible (construction and desire).

The *second chapter* (*Panarelli*) analyzes the design approach of the *Climate Responsive Architecture*, seen as the only possible way to operate within the current context of major climatic changes, technological innovation and computerization of processes.

The *third chapter* (*Spiegelhalter*), the largest, illustrates the current state of the ongoing research on *Climate-Responsive*, *Carbon-Neutral Architecture Protocols* and *Design/Built Projects*.

The *fourth chapter* (*Di Tonno*) identifies a natural bridge over the continuation of future research of the group, outlining (starting from the author's doctoral work) the basis for new operating criteria (*SMART System* and *SMART Protocol*). It is currently in realization a web platform through which it is expected the checking and testing of the elaborated theories.

1.Transforming cities in the age of desire

Knowledge, awareness... doubt and desire.

Actually, it is difficult to imagine whatever kind of strategic planning, aiming to transform cities and territories, without a full capacity of thinking in terms of knowledge, awareness, doubt and desire.

However, let’s go in order.

At the base of any further consideration, we should immediately agree – or at least understand each other – on the fact that since the second half of the last Century our civilization has experienced a radical change of its general cognitive conditions. A change which, consequently, has repositioned design and planning activities within an operative context someway unrecognizable from the one delivered to us by history and Western tradition.

After what Gertrude Stein has defined as the epistemological break of the postwar years, the certainties bred through nineteenth century science have been ruptured, destabilized; the idea itself of progress, with its secure relations of means and ends, thrown into radical doubt [1].

In architecture, these were the years of an unprecedented availability of materials and technologies, combined with an equally unprecedented wealth of needs, fed inside of a newborn– and yet hyper-pervasive – communication society. An evolution so extreme and irreversible from the Modern culture of the early Twentieth Century as to result as a kind of genetic mutation; far beyond – to be clear – from the product of a so-called International Style. A real paradigm shift.

A deep shift from the mechanical and rational sum of needs and numbers (human measured) to the integral of ambitions, dreams and subjectivities (universe measured – we may say, according with the Italian architect Carlo Belli, arguing with the rationalist Le Corbusier about sixty years ago) [2].

Knowledge and awareness, doubt and desire.

To investigate and to plan strategies and methods, as well as the final figurative layouts which better embody the spirit of the Twenty-First Century, thus implies the reinterpretation of its possible transformations in light of this shift of paradigm.

A shift which is probably the core of what may today be defined as the dual problematic dimension of contemporary design and planning.

On the one hand, there is the compelling influence of the Rational equipment, still trusting in the infallibility of the Number: volumetric index, distances, financial statements, transports flows... the last heritage of a positivistic age, yet fully operative into all our currently available instruments (plans, surveyings, zoning...).

On the other hand, the spread of a general condition of subjectivity and permanent doubt in which the technical proposal as much as the more specialized determinations fade and dissolve into a generalized and widespread confrontation between the many actors involved and potentially entitled to participate in any process of transformation (committees, associations, administrators, groups of citizens, stakeholders, technicians, civil servants ...).

It is – in this latter case – the success of an overarching dimension of radical doubt and subjectivity, largely and progressively developed in almost every field and activity; supposedly produced into the dynamics of a *contemporary capitalism* – to say it with the French-Italian philosopher Maurizio Lazzarato [3].

If subjectivity has currently became the 'key good' produced within a collective concatenation of economic, social, communicational production (thus including space, architectures and artefacts), we have to face the fact that the economists have probably already understood – although not always fully consciously – that the rules of production are well beyond the defined needs of Social Theory of the Nineteenth Century. Indeed, they all seem to be engaged in what Michel Foucault called the *aesthetic of existence* [4] and Felix Guattari called the *aesthetic paradigm* [5].

Nowadays, the rules of the 'production of self' (of subjectivity) are no longer those written and described by the systems of Power, but the 'optional' and procedural ones that are invented establishing *sensitive* *territories* [6], producing the otherness of an *other life* and of an *other world* [4].

In these terms, the most powerful agent of our epistemologic dynamics (and, consequently, of those ones transforming space and territories) is *Desire*. In many ways, capitalism's production – always according with Lazzarato's theory – doesn't seem to lie primarily in the division of labour, in specialization, competition or knowledge, but in the fact that it activates, captures and exploits an *economy of the possible*, an *economy of desire*.

We have desires only when there is a possible, a proliferation of possibles, only when, starting from the break of previous balances, relations appear that were impossible before.

Desire thus means acting far from equilibrium; just as – we may say – projecting and planning.

This radical condition of subjectivity and desire probably constitutes the most interesting and prolific field of research that architecture, urban planning and academy in general should actually try to investigate.In other terms, we might say that the necessary step to guarantee the implementation and effectiveness of any transformation of our cities and of our territories has to include the processing of complex responses to a complex contemporarity where - inevitably - the architects are called to operate.

Not so much and not only to define those that the same Lazzarato calls "the conditions of a break", nor to identify "the specific tools to escape the industrial and serial manufacturing from the state" [7], but rather to develop a model of proposal and reflection about the world which, starting and sharing the current state of the art, it is likely to include the project of architecture among its more actual and aware tools. Supposedly halfway between personal aspirations and self-interest capitalist, between Companies, State and inhabitants of what we could now definitely call the *city in the age of desire*.

2. Technological innovation and Climate Responsive Architecture Approach in the project

Climate and social change, quantity of data, material innovation, new systems and methodologies have direct impact on the way of designing the city of tomorrow. Climate-responsive architecture can be defined as architecture aimed at achieving occupant thermal and visual comfort with little or no recourse to nonrenewable energy sources by incorporating the elements of the local climate effectively [8].This refers therefore to architecture that reduces the negative impact on the environment & sustains the ecosystem of which it is a part[9].identifies the main paradigms of Climate Sensitive Architecture as: (a) Energy Efficient Design (b) Preservation of Natural Ecosystems (c) Use of Renewable Energy (d) Water Resource Management (e) Use of Eco-friendly materials (f) Ecological Landscape Design (g) Solid Waste Management and Healthy Indoor Environment. Köppen climate classification is one of the most widely used climate classification systems. It was first published by Russian German climatologist Wladimir Köppen in 1884, with several later modifications. The system is based on the concept that native vegetation is the best expression of climate. Thus, climate zone boundaries have been selected with vegetation distribution in mind. It combines average annual and monthly temperatures and precipitation, and the seasonality of precipitation.

The Practical Approach. Having established that design with climate is essentially driven by planning a proper projection, a practical approach is to carry out a stage-by-stage phased approach to design schemes. Haruna describes architecture as being successful if it acts well and does the thing it is required to do [10].

If this success is to be achieved, a staged approach (referred to as Phases 1 and 2) is suggested and it involves investigation/evaluation and synthetic application of design responses [11].

Phase 1: Investigation & Evaluation

Clearly, any analysis carried out will give specific results depending on the factors determined by local conditions. The deductions from the information in Stage 1 should guide the architect subsequently.

Phase 2: Synthetic Application

This involves the application of various measures to deal with the problems identified by the analysis and evaluation process. Basically this means taking measures to address Passive Cooling, Orientation, Shading, Insulation, Thermal Mass, Passive Solar Heating and Renewable Energy.

Building form together with plan geometry, building orientation, surface to volume ratio, mass, service and natural ventilation are fundamental elements for the design choices included in its climatic context.

Building envelope is the interface of the building with the exterior surroundings determining the exterior appearance but mainly plays the role of regulating the thermal exchange, exactly how the skin of the body. The proper selection of walls, roof and floor system (materials and technological systems in general) are important components of energy saving strategy. The use of material for construction building causes consequences for the impact which follows in the environment.

Together with reflections on known themes (building form, building envelope, materials, wall system, et.) new scenarios for the project are opened thanks to the logic of the algorithms, the different scales, building, urban, territorial. Some important experiments are conducted on different scales, the most interesting surely Fibrocity project (Cameron Newnham) [12].

This project attempts to use algorithmic means to imbue the intent of the designer into the project. It attempts to challenge the normality of simply applying existing algorithms architectural problems. In this sense, it becomes sculpting through lines of code and tweaks of parameters attempting to remove the 'manual' input. In this sense, it becomes scupting through lines of code and tweaks of parameters attempting to remove the 'manual' input. It is, therefore, an attempt to highlight the difference between an architectural algorithm versus an applied algorithm. It begins with an agent-based algorithm, those generally used to simulate things such as schools of fish or flocks ofbirds. This is used due to the ability to make many complex decisions at a local scale and have emergent global outcomes. In this case the simplicity of the highway infrastructure means programmatically the algorithm is dealing with sound attenuation walls and pedestrian bridges.Through a highly technical feat, the algorithm performs and responds to FEA analysis, locally attempting to alter its form to allow greater structural performance.The last factor is simply that of personal taste, or beauty, which in this case is an attempt to create highly excessive and complex form that still is cohesive across scales. Through this we propose that algorithmic design currently leans far too heavily on simply application of existing systems. Algorithmic design should take into account a much greater spectrum of architecture, not just beauty, and be intricately tailored to a project, rather than found and applied.

3. Climate-Responsive, Carbon-Neutral Architecture Protocols and Design/Built Projects.

3.1 What is the Problem to Achieve Carbon Neutrality?

The average temperature of the Earth's surface has increased by about 0.85°C in the last 100 years. Thirteen of the fourteen warmest years were recorded in the 21st Century, with 2015 on course to set another record. Scientists believe that human caused Greenhouse gases (GHG), mainly carbon dioxide, released from society's activities such as resource use in industry, agriculture, cities and buildings, transportation, etc., are adding to the natural greenhouse effect. These human activities such as burning fossil fuels like coal, oil and natural gas are increasing the amount of carbon dioxide (CO2), the main greenhouse gas responsible for global warming. Carbon-absorbing forests are also being cut down. The concentration of CO2 in the atmosphere is now higher than at any time in the last 800,000 years and reached a record high in May 2015 this year. How can society stop and mitigate this trend of global warming and climate change?

A recent deal to limit the rise in GHG and global temperatures to less than 2° C by 2050 has been agreed during the climate change summit of the 21st Conference of Parties (COP21) in Paris after two weeks of negotiations on Saturday, 12 December, 2015. Nearly 200 countries have been attempting to strike the first climate deal to commit all countries to cut emissions, which would come into being in 2020. The agreement is partly legally binding and partly voluntary [13]. The draft now goes to government ministers and different countries to perform challenging ratification procedures back home.

The first kind of protocols to address the reduction of GHG's at many UNO conferences before the recent GOP21 were in Stockholm in 1972 and later the Brundtland Report in 1987, the Environment Summit in Rio de Janeiro 1992, the 3rd UN Climate Conference in Kyoto with the first binding protocol, the World Summit of Sustainable Development in Johannesburg in 2002, the Bali Roadmap in 2007, and the 15th UN Climate Conference in Copenhagen in 2009.

But the recent treaty in Paris is the first signed by nearly 200 countries and the major measures of the new GOP21 agreement contain:

• To peak greenhouse gas emissions as soon as possible and achieve a balance between sources and sinks of greenhouse gases in the second half of this century

• To keep global temperature increase "well below" 2C and to pursue efforts to limit it to 1.5C

• To review progress every five years

• $100 billion a year in climate finance for developing countries by 2020, with a commitment to further finance in the future.

All these GOP21 milestone measures will with certainty support multiple efforts to further develop and implement design protocols, laws and ordinances for carbon neutral cities and buildings.

3.2 How do the Climate Change Analytics and Actions before the GOP21 and after Translate into Green Building Practice?

United Nations Climate Change scientists and policy expert's state to fulfill the GOP21 targets it would require the world to move off fossil fuels between about 2050 and the end of the century. To reach the more ambitious 1.5 degrees Celsius goal, some researchers say the world will need to reach zero net carbon emissions or carbon neutrality sometime between about 2030 and 2050.

Conversely, this is nothing new and was an urgent agenda decade before the GOP 21 in Paris for the most innovative architects, engineers and industries worldwide. Furthermore, the carbon neutrality targets until 2050 match well already in place implemented mandatory and voluntary commitments of several European Countries such as France, Germany, Denmark, Sweden and Ireland.

The question is how carbon neutrality in architecture can and city planning better be design coded and automated, included in ordinances of planning permit processes and finally built and periodically benchmarked? It is uncontested that the automation of green practice is the most successful pathways of interoperable computation for design workflows towards carbon neutral architecture. Major international agreements, before and besides the GOP 21 in Paris, that set new mandatory targets for achieving Net-Zero-Energy-Buildings, Infrastructures, and Cities by 2018-2030 are and will be a major driver of process automation with integrated project delivery in the Architecture, Engineering and Construction (AEC) industry. While there is a growing number of software applications and countless methods for writing custom applications and programs capable of leveraging the use of learning algorithms for many tasks within design process, there is still a very limited understanding of how to integrate and adapt these capabilities into fully automated design factory-file workflows. It is also known that the most improved predictive systems in international design/built examples are the most automated ones. The present generation of computational design optimization tools with whole-project analysis platforms, manufacturing and building automation as they are currently used in the practice of engineering and architecture will change in the next decade. The next generation of design tools will be a type of Green Automation, where designers and engineers deal with graphical descriptions of system and complex cloud software with machine learning algorithms that automatically translate repeatedly new models into optimized executable software. This new era will reorder the global AEC business for decades. The AEC industry that capitalize on these changes across their entire development will set the tone that others will be challenged to follow to remain competitive [14].

3.3 First Net-Zero-Energy Building Design Movements and Workflows

Worldwide, so-called net-zero fossil energy or carbon-neutral buildings and cities are still statistically pioneering concepts with some exceptional, mandatory, national or local code and design protocol implementations in the European Union. Historically, several German municipalities started early with politically driven low-energy and passive house concepts and local ordinances as part of their green party policies and building permitting processes. The imperative for such alternatives to radically design/built energy efficient architecture was mostly supported by grass root movements and alternative anti-nuclear movements with new research eco institutes throughout the nation during the critical phases of the energy crises between the 1970s and 1990s.

With the German renewable energy Feed-In-Tariff (FIT) advanced renewable tariff or renewable energy payments major policy mechanisms and incentives were designed to accelerate investment in renewable energy technologies and low-energy, passive or plus energy building typologies since 1990. These incentives led to innovations in experimental building and city planning by offering stable long-term contracts to renewable energy producers in short pay back periods, typically based on the cost of generation of each technology and applied or integrated in buildings and all kind of types of infrastructures

Almost a decade later, in November 2009, the European Parliament and the European Commission agreed to recast the Energy Performance of Building's Directive (EPBD) from 2003 to make it mandatory that all new buildings in the European Union must use nearly net-zero fossil energy with feed-in-tariffs or onsite renewable energy generations by 2018-2020. The following diagram illustrates the adapted Net-Zero-Energy (NZE) building design, NZE balance line, and benchmarking flow.

3.4 What are Interoperable, Automated Carbon-Neutral Design (CND) Workflows?

The real world planning activities and research and development of CND's to support the targets for carbon neutrality can temporarily be accomplished through interoperable parametric-algorithmic design optimization processes to predict the future of the operational resource use of buildings. These design workflows also incorporate total life-cycle scenario tools for performance, material properties and resource use, and design-to-factory procedures.

The intended interoperability for these building information model (BIM) platforms is the capability of autonomous, heterogeneous systems to work together as seamlessly as possible to exchange information in an efficient and usable way. The advantage is described that these 3-D/4-D/5-D-BIM design platforms links variables, dimensions, and materials to geometry in a way that when an input or simulation value changes, the 3-D/4-D/5-D model automatically updates all life-cycle scenarios and components simultaneously [15].

Some of those interoperable BIM platforms allow free plug-ins for several CAD tools (Graphisoft, ArchiCAD, Autodesk's Revit Architecture & MEP, Rhino, SketchUp, Grasshopper, Bentley, etc.). However, the major problems with this plug-ins are the inconsistencies in the non compatible format exchange between different platform applications. Other limitations are the missing graphical human-computer interaction (HCI) user interface capabilities to allow easier and faster input and output of data with simple automated adjustments and improvements via learning algorithms. Cloud-based service for architects that enables data exchange capabilities in gbXML format for automated building thermal geometry zoning, energy, water, carbon, and life-cycle analysis. The Cloud service engine imports any space type, usage, schedule, systems, components, and location. It automatically accesses over a million virtual real-time data-collecting weather stations worldwide. The analysis runs automatically through multiple parameters and algorithms of international, national, or local code compliance.

In general, each of these BIM engines generates predictive statistics and can compare baseline parameters with selected or customized Energy

Star, LEED, DNGB, UK-BREAAM, CASBEE or UNFCC Carbon Emissionsratings nearly all aspects of a building life-cycle during the design and planning process.

However, most of these Cloud services or BIM platforms for architectural design workflows depend – for example – on DOE-2, Energy Plus, or TRNSYS software algorithms and therefore inherit several of their problems and limitations. In particular in academic or professional further education procedures cumbersome software glitches or incompatible software files hinder knowledge transfer and updates in implementing carbon neutral design flows.

3.5 Space Planning with Synthetic User Experience

Another example of semi-automated design represents Christian Derix's developed "Space Planning with Synthetic User Experience" at the Computational Design Research (CDR) group of Aedas|R&D. It features early forms of semi-automated design flows during 10 years from 2004–2014. The group focused on developing design methodologies that would provide architects and stakeholders with new real-time, algorithmically semi-automated driven design flows and representations of space planning. Both types of models—syntactic spatial analysis and epistemic generative design—have always run in parallel and recently also synthetically, being the first models that integrate the two approaches. Fig. 1 shows an example of an initial random placement of accommodation units for a Building in Abu Dhabi with interactive and semiautomatic ordered layout, block model visualization, and second skin developments for final envelope optimizations and scenarios [15].

Fig. 1, Space Planning with synthetic user experience by Christian Derix, AEDAS: Abu Dhabi Education Council competition, Abu Dhabi, UAE (2009). From left to right: Initial random placement of accommodation units; interactive semiautomatic ordered layout; block model visualization; second skin for final envelope extends. (Courtesy of Aedas Architects, Christian Derix, 2014.)

3.6 Game Engines for Real Time Space Planning and Knowledge Transfer

Another example of real-time space planning is games engines, such as Quest3D® fed by 3D-data resulting from multiple scenario inputs of Built Environment Modelling (BEM) tools. Today we can create navigable, immersive integrated 3D urban models that illustrate potential flooding, adaptable infrastructures and buildings, cities, storm, humidity and air movement, and people or vehicle circulations using false colour. Based on information from Geographical Information Systems (GIS) databases and accurate physical analyses, these quantitative interactive 3D environments provide unified, multidisciplinary representations of proposed urban development and building walk troughs [16]. They help to analyze increasing environmental challenges that require that stakeholders and planners share knowledge and work together to reduce and mitigate environmental, economic, and social degradation induced by climate change.

The SLR design concept was based on the fact that as people finally accept sea level rise, because it's too late for sea walls or horizontal retreat. Designing and building a safe upper level above the existing flood zones, away from direct SLR impacts, waves or storm surge, water supply and salt water intrusion into the sediment geology, is the only feasible option as the inundation increases in Florida. By the time polar ice caps have melted and the Russian taiga zone releases dramatically methane gases, the elevated landscape city is complete. The project was shown at a two-day national Rising Sea Summit in Boston in December 2015 featuring international, national and local macro-scale to micro-scale approaches for the resiliency of urban environments and energy and transportation systems.

The author also presented semi-automated "what-if-design-scenarios" that involve relinquishing space to water and integrating the natural regenerative potential of low-lying regions with adaptive, amphibious blue infrastructures. He mandated that holistic parametric-algorithmic planning with design agents should take full advantage of the dynamic relationship between land and water for flexible, carbon-neutral lifework hydro-geographies. These new geographies are more adaptable to climatically changing tides and seasons. Built carbon design protocols that demonstrate floating and renewable energy and water producing infrastructures and aquatic lifework networks with alluvial sponge combs to mitigate floods [17].

3.7 The Next Generation of System Integrated CND platforms and executable software

The next generation of system integrated space planning and CND platforms will be a type of inclusive automation, where computational programming and carbon neutral manufacturing will be completely processed within the automation domain and not anymore in terms of computer systems. Designers and engineers will use flexible and easy graphical descriptions of the used system model and then there will be a more complex portion of software with integrated high-speed machine-learning and data analytics algorithms that automatically translate in real-time new models into executable software. Another change will dominate the future will be that the process of computation will be replaced by model-driven developments toward the use of conceptual models of applications rather than by concepts of computation.

In addition, the next generation of platforms will also include personal supercomputer systems and interoperable Cloud-service worldwide. With such high-speed Cloud-service supported super computers, sensor infrastructural polling in event-driven architecture simulation will eventually update or replace all the fore mentioned data exchange BIM platforms, which are currently only, based on fixed or variable time step simulation concepts. Today many sophisticated software applications are available to design and engineer infrastructures, buildings, and industries. For example, Siemens AG, a German multinational engineering and electronics conglomerate headquartered in Munich and Berlin, already uses and further develop the latest parametric-algorithmic and automated 3D/4D optimization tools and how they are utilized to plan and operate entire factories and production lines in the automotive and transportation industry. SIEMENS works in the divisions of Industry & Factories, Energy, Healthcare, Infrastructure & Cities, and Siemens Financial Services (SFS). Siemens broad range of existing activities includes digital factory design and real-time operation with PLM software. Many automotive industries from the Volkswagen Group, Mercedes or BMW use their Tecnomatix robotic simulation tools, genetic algorithms (GAs), neural networks, and wasp swarm optimization of logistic systems and automation. [18]. The revolutionary SIEMENS digital (Self-Learning) Factories and Automation showcases just the latest parametric algorithmically driven multidimensional optimization tools in industrial design and in the automotive and transportation industries. For example SIEMENS PLM and Tecnomatix tools with integrated machine-learning data analytics algorithms renew and optimize constantly the software models during design, manufacturing, assembly, and operation.The PLM capabilities offer open event architecture with multiple interface support, value stream mapping, and automatic analysis with constant optimizations of simulation and measured results to produce and deliver products and systems just-in-time (JIT) or just-in-sequence (JIS) [19].

3.8 Human-Computer-Interface in Green Building Automation Systems and Manufacturing

Today's building automation systems (BAS) are centralized, interlinked, and sensor driven human-computer-interface (HCI) networks of hardware and software. They monitor, control, and optimize in real-time the environment in residential, commercial, industrial, and institutional facilities. Whilemanaging various building systems, the learning automation system ensures the operational performance (transportation, light, water, HVAC, energy generation, storage and distribution, etc.) of the facility as well as the comfort and safety of building occupants.Today, most BAS operate with intelligent agents (IAs) and machine learning algorithms by identifying patterns for real-time optimization potential including time scheduling and trend logging and verification of building automation process. Intelligent agents in a BAS are sensors and effectorsthat interacts with their environments. The systems topology of most BASs include the real-time generation of knowledge patterns and locations in multiple data scales that reiterate, change, and optimize automatically new building energy, resource, security, circulation peak load, and user comfort management processes.For example, Siemens uses wireless, automated, self-learning two-position algorithm sensor infrastructures that constantly control and fine-tune building spaces and zoning conditioning demand. Today, fully integrated multidimensional trend data processing allows effortless event-driven polling and analysis of real-time (online) data and (offline) historical data in compliance with multiple standards. Any energy/water/resource use and cost reports including CO2 or net-zero-energy building (Net-ZEB) benchmarking values can be assembled and polled in real-time at any time during the operation of buildings [18]. For example, the Q1 Thyssen-Krupp headquarter in Germany shows how a real-time SIEMENS total green building automation system (BAS) performs with intelligent control feedback loops and learning algorithms for constantly optimized building performance, security, and user comfort operation. This system also includes a wireless environmental management system to ensure trend analysis and optimizations toward yearly mandatory net-zero-energy certifications.

The future of green building automation will be cloud-computing controlled buildings. Cloud-controlled buildings provide the flexibility to expand wireless infrastructures with sensor-collected trend data and self-programming data analytics algorithms. The cloud will be where the applications run and where the data is analyzed and acted upon as it arrives. Digital data is changing; we are moving into a world with an ever growing number of data sources. As the amount of the data and the requirement for algorithms that act on the fly increase, a green BAS cloud will be able to automatically do real-time stream analytics of different variables in seconds and expand itself to accommodate the operation and peak load control needs on any scale from buildings to cities.Another example is that flexible automation with self-learning robots in mass customization will also usher in a new era of green choice and flexibility for manufacturers and clients in the AEC industry. Sustainable traditions from the craftsman era that were either lost or underscored during the era of mass production can now be individually integrated in green manufacturing and 3-D and 4-D printing settings. The fourth Industrial Revolution is under way through the increased use of cyber physical system and new degrees of complexity (Fig. 2).

Over the next couple of decades, we will see major enhancements in the use of cyber physical systems and automated scenario network planning and in high-speed cloud computing that will further improve resource innovations and flexibility.

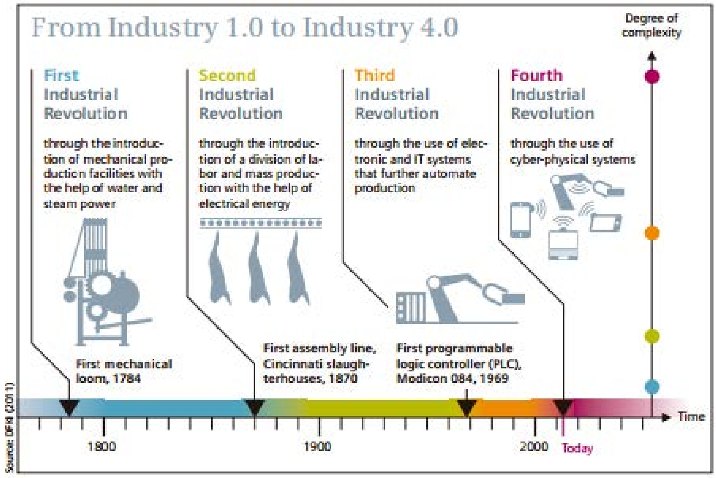

Fig. 2. The German Research Center for Artificial Intelligence (DFKI) is demonstrating how such a system of Industry 4.0 can work in practice in a smart factory in Kaiserslautern, Germany, which was built in cooperation with 20 industrial and research partners, including Siemens. (Image Courtesy SIEMENS, 2013.) [20].

Fully automated production control and optimization will boost factory productivity. With fewer inputs to make more outputs, managers and production workers will naturally still be in charge, but they will be controlling automated software and processes rather than the self-learning machinery, robots, and sensor-driven intelligent agents. Increasingly, 3D printing technology will create complex building materials, components, and systems in multiple programmable scales. Even further advances in multidimensional printing technology scales are enabling mass customization at increasingly granular levels including the design of the properties of materials even at the macroscopic, atomic, and molecular levels [14].

3.9 Conclusion

Green automation applied for design optimization, manufacturing and life-cycle sustainability will increase in the next decades. Certainly the related works presented here are neither complete nor exhaustive. It only shows some samples that demonstrate the significance of self-organizing systems and green automation in the present and in the future.We are on the verge of a paradigm shift as Katrin Nikolaus in her essay "Building the nuts and bolts of self-organizing factories [21]. Already, software using architects have migrated from the old error, prone paradigm of programming to the "new world of system integrated and model-driven development, that is, the use of conceptual models of applications rather than computing concepts" [22].

In the future, computational programming will happen in terms of the automation domain and not in terms of computer systems. The next generation is a type of green automation, where designers and engineers deal with graphical descriptions of system and complex cloud software with machine learning algorithms that automatically repeatedly translate new models into optimized executable software. If countries, companies, architects and engineers want to stay competitive, they have to adapt to this new era of creative green automated virtual-design-to-real manufacturing, assembly, operational control and benchmarking, that will reorder the global AEC business for decades. The transformation of the AEC business will also include a shift toward digitally and biologically controlled design-to-file-manufacturing that will change the traditional role of designers and contractors.

4. New instruments supporting design, planning, maintenance and transformation of the territory (Climate Responsive Architecture, SMART System, SMART Protocol). Self-sufficient emergency modules.

The major changes in climate, economic, social and territorial in general (often cause of real emergencies) have led to reconsider the tools supporting design and planning with a new attention to geological aspects, not always taken into due consideration and with the objective of promoting the maintenance of land and works of defense, as essential elements to ensure the gradual improvement of security conditions and of the environmental quality of the territory [23].

The study of the different approaches (protocols) has made emerge the fact that, in addition to the large number of protocols in use (in different regions and further) – in Europe there are about a dozen in use – these systems are often highly specialized (for measuring/containment of energy consumption, for evaluating the degree of sustainability, etc), but rarely taking into account social, economic or managerial factors (indicators).

An interesting experiment is represented by the protocol Estidama drawn from public office in Abu Dhabi in 2010 [24].

Estidama, which means 'sustainability' in Arabic, is the initiative which will transform Abu Dhabi into a model of sustainable urbanization. Its aim is to create more sustainable communities, cities and global enterprises and to balance the four pillars of Estidama: environmental, economic, cultural and social.

The aspirations of Estidama are incorporated into Plan 2030 and other Urban Planning Council (UPC) policies such as the Development Code. Estidama began two years ago and is the first program of its kind that is tailored to the Middle East region. In the immediate term, Estidama is focused on the rapidly changing built environment. It is in this area that the UPC is making significant strides to influence projects under design, development or construction within the Emirate of Abu Dhabi. One of Estidama's key initiatives is the Pearl Rating System.

The Pearl Rating System for Estidama aims to address the sustainability of a given development throughout its lifecycle from design through construction to operation. The Pearl Rating System provides design guidance and detailed requirements for rating a project's potential performance in relation to the four pillars of Estidama.

The Pearl Rating System is organized into *seven categories* that are fundamental to more sustainable development. These form the heart of the Pearl Rating System:

1) Integrated Development Process: Encouraging cross-disciplinary teamwork to deliver environmental and quality management throughout the life of the project.

2) Natural Systems: Conserving, preserving and restoring the region's critical natural environments and habitats.

3) Livable Buildings: Improving the quality and connectivity of outdoor and indoor spaces.

4) Precious Water: Reducing water demand and encouraging efficient distribution and alternative water sources.

5) Resourceful Energy: Targeting energy conservation through passive design measures, reduced demand, energy efficiency and renewable sources.

6) Stewarding Materials: Ensuring consideration of the 'whole-of-life' cycle when selecting and specifying materials.

7) Innovating Practice: encouraging innovation in building design and construction to facilitate market and industry transformation.

Many protocols used are "hard", not open (non-upgradeable) to the constant changes and the continued growth of data that the "Smart City" provides to the networks well as being frequently "impersonal" with respect to the specificity of the transformation to deal with.

Hence the need to rethink an "Intelligent System" (SMART – also intended as an added value), able (through an appropriate protocol, adaptive and updatable) to examine the different strategic topics (environment, social, economic, management), in order to provide the best possible response to the intervention to be carried. The new SMART System flows into a web platform, able to absorb the existing data available in the network and those who, after scientific validations made by specific bodies, could then contribute to the updating thereof.

Environmental retrofit to change urban devastated land into environmentally compatible environment is a huge market and a great occupational opportunity should the macro-economic key for its opening be operated. Urban retrofit: the transformation of decayed highly polluted and polluting urban crusts into organic tissues, energy wise and climatologically reactive will supply a market and push research for alternative knowledge and materials. A sector which we can call territorial maintenance technology will require huge investments in the coming years and the preliminary signals are now emerging: continuity is entering the shift stage.

Fig.3. Model of SMART System© and SMART Protocol© (Di Tonno)

Important applications of this supporting methodology are the aim of the study of some self-sufficient modules in different contexts [25]. Important case study are: Ecos PowerCube® [26] is the world's largest, mobile, solar-powered generator. It runs on high power photovoltaic panels that extend from its container combined with an easy to set up wind turbine. Energy is stored in onboard batteries and Techstyle Haus together with many experiences of Solar Decathlon competition [27].

In this paper:
Introduction and§ 2 Gianmichele Panarelli; § 1 Andrea Mammarella;
§ 3 Thomas Spiegelhalter; § 4 Clarissa Di Tonno.

Bibliography

[1] Stein G. (1945) *Wars I have seen*, Random House, New York
[2] Belli C. (1987) Le Corbusier, l'Italia e il Gruppo 7, *Domus*, 687, 17-24
[3] Lazzarato M. (2010) Capitalismo e produzione di soggettività, in *Peoplemeet in Architecture. Biennale Architettura 2010. Catalogo*, Venezia, 23-27
[4] Foucault M. (1998) *Il pensiero del fuori*, Edizioni SE, Milano.
[5] Guattari F. (1989) *Le tre ecologie*, Sonda Edizioni, Casale Monferrato
[6] Deleuze G, Guattari F. (2002) *Che cos'è la filosofia*, Einaudi, Torino
[7] Lazzarato M. (1997) *Lavoro immateriale*, Ombre corte, Verona.
[8] Yannas Simos (2003)*Towards Environmentally-Responsive Architecture* PLEA 2003 - The 20th Conference on Passive and Low Energy Architecture, Santiago (CHILE), 9-12 November 2003
[9] Roshni U. (2006) *Architecture For Eco-housing in Mumbai Rachana*. India: Sansad's Institute of Environmental Architecture
[10] Haruna P. (2006) *Architecture and Environment: A StrategyTowards Enhancing The Ecosystem in The Design of The Built Environment*. Aarches Publications
[11] Kabiru S. D. (2011)Climate responsive architecture: creating greater design awareness among architects, in *Journal of Environmental Issues and Agriculture in Developing Countries*, Vol. 3 N. 1, Kaduna (Nigeria)
[12] http://www.camnewnham.com/portfolio/fibrosity.
[13] BBC. (2015) COP21: World awaits landmark climate deal,*BBC Science and Environment,* http://www.bbc.com/news/science-environment-3508289, retrieved on 12. Dec. 2015
[14] Spiegelhalter T.(2012) Achieving the net-zero-energy buildings 2020 and 2030 targets with the support of parametric 3-D/4-D BIM design tools, *in: Journal of Green Building.* Spring 2012, Vol. 7, (2), pp. 74-86
[15] Andia A., Spiegelhalter T.(2014)*Post-Parametric Automation in Design and Construction,* Artech House, London, UK
[16] Spiegelhalter T. (2013) Mitigate, Adapt, Sustain: Emerging Workflows and Design Protocols for Carbon Neutral Subtropical H2 Cities, in *Proceedings of theConference,* ACSA Regional Conference: Subtropical Cities, Fort Lauderdale, (USA)
[17] Spiegelhalter T. (2015) Mitigate, Adapt, Sustain: Design Protocols for Carbon-Neutral Adaptive Blue Infrastructures., in *2015 Rising Seas Summit – Transforming Decision Making, Developing Adaptive Infrastructure & Advancing Solutions*, Nov. 3-5, Boston MA(USA)

[18] SIEMENS AG (2013) Tecnomatix for Plant Simulation, http://www.plm.automation.siemens.com/en_us/products/tecnomatix/plant_design/plant_simulation.shtml, retrieved Oct. 2013

[19] SIEMENS AG (2013)https://eb.automation.siemens.com/mall/en/ca/Catalog/Products/10042041

[20] SIEMENS AG (2014) Manufacturing: Self-Organizing Factories, http://www.siemens.com/innovation/en/home/pictures-of-the-future/industry-and-automation/digtial-factory-trends-industry-4-0.html, retrieved on 12. Dec. 2015

[21] Katrin N. (2013) Building the nuts and bolts of self-organizing factories,in *Siemens-Picture of the Future, s*pring, p.19

[22] Borrmann L. (2013) Making sense of complexity, in *Siemens-Picture of the Future*, fall

[23] Matteoli L., Perretti G.(2013) Quaranta anni di attenzione all'ambiente nella tecnologia dell'architettura*,* in *TECHNE, Environment emergency Journal of Technology and Architecture*, 5, Firenze

[24] The Pearl Rating System for Estidama, Emirate of Abu Dhabi Building Rating System, Design & Construction, Version 1.0, April 2010 http://www.upc.gov.ae/sud

[25] http://www.ecospheretech.com/environmental-engineering technologies/powercube

[26] http://www.techstylehaus.com/#1-0-c-Haus.-Architecture

[27] http://www.camnewnham.com/portfolio/fibrosity