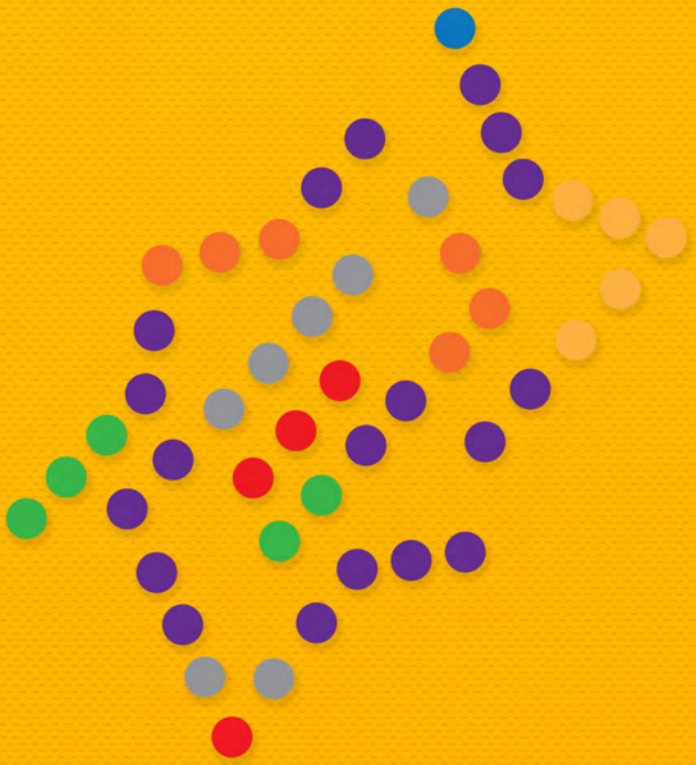

Design in the Digital Age

Technology
Nature
Culture

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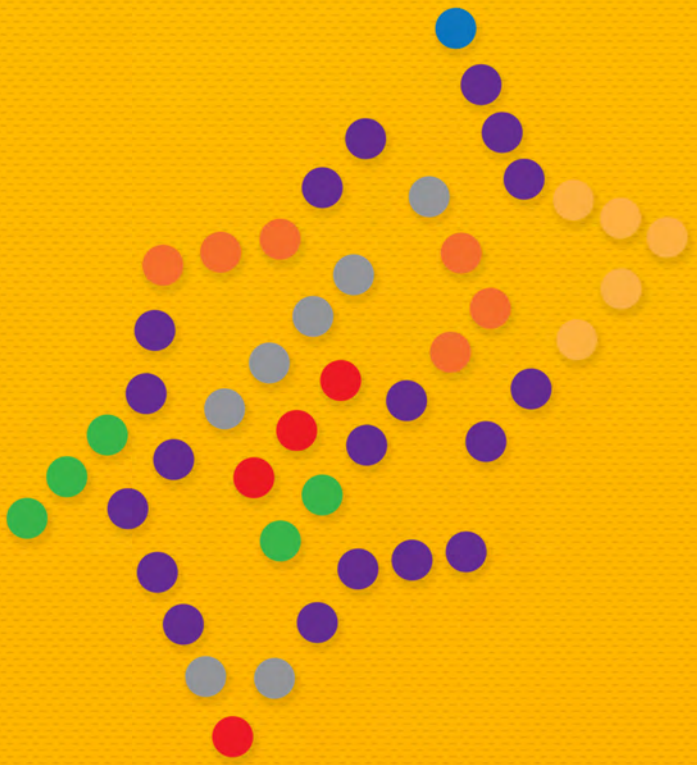

Il Progetto nell'Era Digitale

Tecnologia
Natura
Cultura

SITdA Società Italiana della Tecnologia dell'Architettura

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La SIT*d*A, Società Italiana della Tecnologia dell'Architettura fondata nel 2007, è un ampio network di docenti e ricercatori universitari con l'obiettivo di sostenere la cultura della ricerca nell'area disciplinare della Tecnologia dell'Architettura e di offrire risorse per la formazione e la qualificazione dei giovani ricercatori, promuovendo studi di carattere teorico e applicativo, incoraggiando l'internazionalizzazione della ricerca e l'esplorazione di aree emergenti dell'innovazione tecnologica in architettura.
La pubblicazione raccoglie i contributi di studiosi, *PhD* e ricercatori che hanno risposto alla *call for paper* promossa dalla SIT*d*A in vista della conferenza internazionale "Design in the Digital Age. Technology, Nature, Culture", che si terrà a Napoli l'1 e il 2 Luglio 2021.
I saggi raccolti in questo volume costituiscono un insieme di idee, riflessioni, posizioni e proposte che, nel quadro della crisi epistemologica che investe le ragioni, il senso e le strutture stesse del progetto, possono aiutare a comprendere in che modo la svolta digitale sta trasformando profondamente il ruolo della cultura progettuale nel rapporto tra tecnica e natura in una transizione storica caratterizzata da cambiamenti climatici e sociali con enormi ricadute di tipo politico, economico e produttivo.

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The publication collects the contributions of scholars, PhD and researchers who participated in the call for papers promoted by SITdA for the international conference "Design in the Digital Age. Technology, Nature, Culture" to be held in Naples on 1 and 2 July 2021.
The essays in this publication provide a set of ideas, reflections, positions and proposals that, in the context of the epistemological crisis that affects the reasons, the meaning and the very structures of the project, can contribute to understand how the digital shift is deeply transforming the role of design culture in the relationship between technology and nature in a historical transition affected by climate and social changes with enormous political, economic and productive consequences.

a cura di
Massimo Perriccioli
Marina Rigillo
Sergio Russo Ermolli
Fabrizio Tucci

MASSIMO PERRICCIOLI
Professore ordinario di Tecnologia dell'Architettura
DiARC - Dipartimento di Architettura
Università degli Studi di Napoli Federico II

MARINA RIGILLO
Professore associato di Tecnologia dell'Architettura
DiARC - Dipartimento di Architettura
Università degli Studi di Napoli Federico II

SERGIO RUSSO ERMOLLI
Professore associato di Tecnologia dell'Architettura
DiARC - Dipartimento di Architettura
Università degli Studi di Napoli Federico II

FABRIZIO TUCCI
Professore ordinario di Tecnologia dell'Architettura
PDTA - Dipartimento di Pianificazione, Design, Tecnologia dell'Architettura
Sapienza Università di Roma

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Il Progetto nell'Era Digitale. Tecnologia, Natura, Cultura

La Cultura del progetto si confronta oggi con un rinnovato rapporto tra Tecnologia e ambiente, che evolve da una condizione in cui la Natura viene considerata come risorsa da cui trarre senza limiti materia ed energia, ad una nella quale è concepita come patrimonio con cui interagire sinergicamente secondo una prospettiva co-evolutiva. Una visione che appare necessaria per poter affrontare in modo responsabile le crisi antropiche, ambientali e socio-economiche che affliggono il pianeta, dalle emergenze climatiche ai fenomeni migratori, fino alle ineguaglianze sociali.
Su un altro piano, la Cultura del progetto sta subendo da tempo profonde trasformazioni per la gran parte determinate dalla diffusione, sempre più pervasiva, delle tecnologie digitali le quali, se per un verso ne mettono in crisi le tradizionali modalità ideative ed espressive, introducendo nuovi paradigmi cognitivi e operativi, dall'altro ne allargano notevolmente gli spazi di riflessione critica, consentendo un ampliamento delle potenzialità realizzative dai confini ancora sconosciuti. La "rivoluzione" digitale sta generando importanti cambiamenti delle dinamiche dei processi produttivi e realizzativi, nelle quali si delinea un'idea di progetto, sempre più caratterizzata da informazioni e relazioni, che consente connessioni multidimensionali e interagenti tra gli elementi che ne definiscono il campo d'azione.

I due scenari descritti, se considerati nella loro interazione, consentono di definire un nuovo campo epistemologico al cui interno ripensare al ruolo della Tecnologia nel rapporto tra Cultura e Natura nell'era digitale. A tal fine risulta necessario avviare una riflessione critica che consenta di cogliere la sfida sottesa ai cambiamenti in atto e produca un ripensamento di alcune dicotomie alla base della Cultura del progetto contemporaneo, tra le quali materiale-immateriale, soggetto-oggetto, reale-virtuale, locale-globale, possibilità-responsabilità, conoscenza-informazione, rappresentazione-simulazione. Ciò comporta un cambio di paradigma nel rapporto tra Cultura e Natura, fondato su una nuova concezione progettuale che assume il cambiamento e l'incertezza come presupposti epistemologici e pensa la Tecnologia dell'architettura come un campo di possibilità perseguibili capace di generare nuovi modi di produrre, di costruire e di abitare in armonia con i sistemi naturali.

Alla luce di queste riflessioni, la call è finalizzata a raccogliere contributi teorici, metodologici e di ricerca rappresentativi del dibattito contemporaneo con particolare riferimento ai seguenti topic:

1_Tecnologia ed evoluzione dell'approccio eco-sistemico al progetto
2_Tecnologia e costruzione di una nuova cultura materiale
3_Tecnologia e generazione di habitat innovativi

1_Tecnologia ed evoluzione dell'approccio eco-sistemico al progetto
Per comprendere il contesto in continua trasformazione e definire i contenuti di un diverso rapporto uomo-natura, è necessaria una strategia progettuale capace di riconoscere il carattere selettivo ed evolutivo dei sistemi naturali nonché di ripensare il legame tra gli aspetti della tecnologia, dei flussi di risorse e di organizzazione di spazi e funzioni, intesi come elementi tra loro interconnessi e in stretta relazione con l'insieme delle componenti sociali ed ambientali. Pertanto, il progetto trasla da una dimensione meccanicistica e chiusa in orizzonti prescrittivi verso una dimensione "generativa" nella quale trova spazio un approccio ecologico in cui artefatti e natura costituiscono un sistema biologico co-evolutivo.

Focus di approfondimento:
1.a Approccio sistemico per la comprensione e l'interpretazione della realtà complessa del progetto nella relazione tra agenti di natura tecnica e umana.
1.b Processi di trasformazione dell'ambiente costruito, basati sull'interazione tra sistema fisico, sociale, culturale ed economico.
1.c Strategie di adattamento e di efficienza ecologica per i processi di rigenerazione dei sistemi insediativi.

2_Tecnologia e costruzione di una nuova cultura materiale
La cultura materiale nell'era digitale è contraddistinta dalla produzione di manufatti, a tutte le scale del progetto, nei quali sono presenti in misura sempre maggiore contenuti "immateriali" che ne trasformano le modalità di funzionamento, uso e interazione, consentendo al contempo elevati livelli di ottimizzazione di componenti, sistemi e tecnologie e di diversificazione formale e prestazionale. Le potenzialità degli attuali sistemi produttivi permettono ampi livelli di condivisione e di accessibilità riducendo, da un lato, i tempi di trasformazione fisica e prestazionale dei prodotti e contraendo, dall'altro, le fasi di ideazione, realizzazione e utilizzo.

Focus di approfondimento:
2.a Integrazione delle tecnologie digitali nel rapporto tra il progetto, la produzione, il prodotto e il ciclo di vita.
2.b Innovazione dei sistemi produttivi per l'offerta di soluzioni diversificate in rapporto alle specificità fisiche e culturali dei luoghi e degli utilizzatori.
2.c Scenari collaborativi per la produzione eco-orientata finalizzati al raggiungimento di obiettivi di innovazione socio-tecnica.

3_Tecnologia e generazione di habitat innovativi
La ricerca di un equilibrio tra ambiente artificiale e ambiente naturale fondata sulla costruzione di un comune ecosistema, dovrebbe prevedere la generazione di habitat che privilegino approcci interattivi e relazioni multiple tra le componenti fisiche e tra queste e gli abitanti. La dinamicità prodotta dalla dimensione interattiva consente di delineare scenari di progetto diversi e mutevoli e di sperimentare altresì processi flessibili capaci di indurre adattamenti continui. Come la Natura si presenta nei suoi caratteri trasformativi ed evolutivi, così gli habitat, generati da tali processi, rispondono ai contesti ambientali in virtù della capacità adattiva e informativa degli elementi e degli spazi di cui essi si compongono.

Focus di approfondimento:
3.a Tecnologie per habitat responsivi capaci di mutare le proprie prestazioni e configurazioni se stimolati dall'ambiente e dagli utenti.
3.b Processi capaci di proporre risposte dinamiche di organizzazione degli habitat attraverso l'interazione combinata tra le componenti ambientali, tecnologiche e sociali.
3.c Strategie evolutive e adattive per l'abitare in grado di prefigurare e di consentire una pluralità di configurazioni possibili e alternative, alle varie scale, entro quadri di regole condivise.

Design in the Digital Age. Technology, Nature, Culture

Today, the Culture of the design is facing a renewed relationship between Technology and environment, evolving from a condition in which Nature is considered as a resource whence to draw without limits material and energy, to another in which it is conceived as a heritage to synergistically interact with, according to a co-evolutionary perspective. The latter vision appears to be the only one possible to responsibly face the anthropic, environmental and socio-economic crises that plague the planet, from climatic emergencies to migratory phenomena and social inequalities.
On another level, the Culture of the design has been for long undergoing deep transformations, for the most part determined by the increasingly pervasive diffusion of digital technologies which, if on the one hand are undermining its traditional thinking and expressive methods, introducing new cognitive and operative paradigms, on the other hand are considerably widening the spaces for critical reflection, allowing an expansion of the potentialities of realization, whose limits are still unknown. The digital "revolution" is generating important changes in the dynamics of production and building processes, outlining an idea of the design as increasingly characterized by information and relationships, able to allow multidimensional and strongly interacting connections between the elements that define its field of action.

The two scenarios described above, if considered in their interaction, allow us to define a new epistemological field where to rethink the role of Technology in the relationship between Culture and Nature in the digital age. To this purpose, it is necessary to begin a critical reflection to take up the challenge subtended to the changes that are taking place and to produce a rethinking of some of the dichotomies underlying the Culture of contemporary design, including material-immaterial, subject-object, real-virtual, local-global, possibility-responsibility, knowledge-information, representation-simulation. This involves a paradigm shift in the relationship between Culture and Nature, based on a new design concept that assumes change and uncertainty as epistemological assumptions and thinks about the Technology of architecture as a field of feasible possibilities capable of generating new ways of producing, building and living in harmony with natural systems.

Since these reflections, the call aims to gather theoretical, methodological and research contributions representative of the contemporary debate with a specific focus on the following topic:

1_Technology and evolution of the eco-systemic approach to the design
2_Technology and construction of a new material culture
3_Technology and generation of innovative habitat

1_Technology and evolution of the eco-systemic approach to the design
In order to understand the ever-changing context and to define the contents of a different relationship between man and nature, a design strategy capable of recognising the selective and evolutionary character of natural systems is necessary, as well as rethinking the link between the aspects of technology, the flows of resources and the organisation of spaces and functions, intended as interconnected elements and in close relation with all the social and environmental components. Therefore, the design shifts from a mechanist dimension, closed in prescriptive horizons, to a "generative" dimension, in which an ecological approach finds room and artefacts and nature form a co-evolutionary biological system.

In-depth focus:
1.a Systemic approach for understanding and interpreting the complex reality of the design in the relationship between technical and human agents.
1.b Transformation processes of the built environment, based on the interaction between the physical, social, cultural and economic system.
1.c Adaptation and ecological efficiency strategies for the regeneration processes of settlement systems.

2_Technology and construction of a new material culture
The material culture in the digital age is characterized by the production of artefacts, at all scales of the design, in which there are increasingly "immaterial" content that transform how they work, how they are used and how they interact, while allowing high levels of optimization of components, systems and technologies and formal and performance diversification. The potential of today's production systems allows wide levels of sharing and accessibility, reducing, on the one hand, the times for products physical and performative transformation and contracting, on the other, the conception, implementation and use phases.

In-depth focus:
2.a Integration of digital technologies in the relationship between design, production, product, life cycle.
2.b Innovation of production systems to offer diversified solutions in relation to the physical and cultural specificities of places and users.
2.c Collaborative scenarios for eco-oriented production, aimed at achieving socio-technical innovation goals.

3_Technology and generation of innovative habitat
The search for a balance between artificial and natural environment based on the construction of a common ecosystem should involve the creation of habitat that encourage interactive approaches and multiple relationships between the physical components and between these and the inhabitants. The dynamism produced by the interactive dimension allows to outline different and transforming deign scenarios and to experiment flexible processes able to stimulate continuous adaptations. As Nature presents itself in its transformative and evolutionary characteristics, so the habitat generated by these processes respond to environmental contexts by the adaptive and informative features of the elements and spaces of which they are composed.

In-depth focus:
3.a Responsive habitat technologies able to transform their performance and configurations if stimulated by the environment and users.
3.b Processes able to offer habitat dynamic organization responses through the interaction between environmental, technological and social components.
3.c Evolutionary and adaptive strategies for living capable of foreshadowing and allowing a plurality of possible and alternative configurations, at various scales, within frameworks of shared rules.

Presentazione

All'ampia pubblicistica che in questi ultimi anni SIT*d*A – Società Italiana della Tecnologia dell'Architettura ha realizzato come esito delle numerose attività promosse, si aggiunge un testo di grande interesse per densità e significatività di contenuti: *"Design in the digital age. Technology Nature Culture";* questo è il titolo della pubblicazione pensata all'interno di un progetto più ampio che prevedeva la presentazione nell'omonimo Convegno Internazionale, programmato a Napoli per Giugno 2020 e rimandato per l'insorgere della pandemia.

La relativa *call for paper* nasceva da un'esigenza di approfondimento, ma anche di allargamento del dibattito già avviato all'interno della Società Scientifica in altre occasioni di confronto, in particolare nel Convegno "La Produzione del Progetto"[1] (2018) dove sono state evidenziate le trasformazioni indotte sull'attività progettuale, dai cambiamenti climatici e dalle emergenze ambientali, dalla digitalizzazione e dalle ICT, oltre che dalla perdurante crisi economica.

Tuttavia, l'evoluzione assai rapida che la *cultura* del progetto sta subendo – sia per i drammatici eventi climatici e sanitari che prefigurano nuovi scenari anche dell'Architettura, sia per la sempre maggiore diffusione delle tecnologie digitali che introducono nuovi paradigmi cognitivi e operativi – ha imposto un ulteriore e necessario passo avanti nel ragionamento che inevitabilmente guardi a un nuovo rapporto «… tra Tecnologia e Ambiente (Natura) […] secondo una prospettiva co-evolutiva», così come emerso dalla *call for paper* del Convegno[2].

Accogliendo questa sfida ambiziosa, il volume prende sostanza da 92 stimolanti contributi di un'ampia comunità scientifica, interessata ad avviare – come evidenzia Massimo Perriccioli nell'Introduzione – un ragionamento sul "progetto" (e sulla sua cultura) «… come un potente strumento per formulare le giuste domande da porsi di fronte alle sfide del presente e come un progressivo agente di cambiamento sociale, politico, ambientale per il miglioramento delle condizioni di vita sul nostro pianeta».

La stessa struttura del testo è delineata sulla base di un percorso consapevolmente ragionato, che individua, attraverso i tre *topics* proposti, possibili nuovi approcci al progetto contemporaneo, in cui la Tecnologia dell'Architettura sia capace di generare nuovi modi di produrre, di costruire e di abitare in armonia con i sistemi naturali. Un obiettivo, quindi, per compartecipare all'evoluzione del pensiero scientifico accrescendo la conoscenza sui temi proposti, come ben si evince dai contributi critici dei tre "*discussant*" nell'avviare alle articolate tematiche dei *topics*.

Conoscendo, quindi, la complessità del progetto editoriale – che ha richiesto una notevole impegno da parte degli autori e dei curatori, ma anche la capacità di superare le difficoltà organizzative determinate dalla pandemia – la presentazione di questo volume assume per la Società Scientifica più valenze: è motivo di soddisfazione per gli interessanti esiti raggiunti, da cui emerge chiara la consapevolezza della trasformazione profonda indotta dalla cultura digitale e, contestualmente, dell'importanza di possibili, auspicate sinergie tra Tecnologia e Natura/Ambiente. Allo stesso tempo il testo rappresenta uno stimolo alla riflessione ma anche all'azione, compito che, in un momento complesso di transizione quale quello che viviamo, la cultura, la scienza e la ricerca devono assumersi.

E questa è una delle *missioni* di SIT*d*A.

Maria Teresa Lucarelli

Presidente della SIT*d*A – Società Italiana della Tecnologia dell'Architettura

[1] Si fa riferimento al Convegno SIT*d*A *" La Produzione del Progetto"* organizzato a Reggio Calabria nel Giugno 2018

[2] Call for paper del Convegno Internazionale, Napoli 2020 *"Il progetto nell'era digitale. Tecnologia, Natura, Cultura",* 2019 - www.sitda.net

Foreword

In addition to the extensive publications that SIT*d*A – Italian Society of Architecture Technology has carried out in recent years as a result of the many activities promoted, there is a text of great interest for the density and significance of its contents: "Design in the digital age. Technology Nature Culture"; this is the title of the volume conceived as part of a wider project to be launched at the homonymous International Conference, scheduled for June 2020 in Naples and postponed due to the pandemic outbreak.

The relative call for papers was intended to deepen, but also to widen the debate already started within the Scientific Society on other occasions of debates, especially in the Conference "La Produzione del Progetto"[1] (2018), that highlighted the changes induced by the design activity, climate change and environmental emergencies, digitization and ICT, as well as the ongoing economic crisis.

Nevertheless, the very rapid evolution that the project culture is undergoing – both because of the dramatic climatic and sanitary emergencies that foreshadow new scenarios even in Architecture, and because of the increasing diffusion of digital technologies that introduce new cognitive and operational paradigms – has imposed a further and necessary step forward in the reasoning that looks inevitably at a new relationship «... between Technology and Environment (Nature) [...] according to a co-evolutionary perspective», as emerged from the Conference call for papers[2].

Accepting this ambitious challenge, the volume draws on 92 stimulating contributions from a wide scientific community, interested in starting – as Massimo Perriccioli points out in the Introduction – a reasoning on the "project" (and its culture) «as a powerful tool to formulate the right questions to face the challenges of the present and as a progressive agent of social, political, environmental change for the improvement of living conditions on our planet».

The structure of the text itself is outlined on the basis of a consciously reasoned path, which identifies, through the three proposed topics, possible new approaches to contemporary design, in which Architecture Technology can lead to new ways of producing, building and living in harmony with natural systems. Thus, an objective to contribute to the evolution of scientific thought by increasing knowledge of the suggested issues, as it emerges from the critical contributions of the three "discussants" in introducing the articulated themes of the topics.

Therefore, knowing the complexity of the editorial project – which required a significant commitment from authors and editors, but also the ability to overcome the organizational constraints due to the pandemic – the presentation of this volume acquires several meanings for the Scientific Society: it is a source of satisfaction for the interesting results achieved, which clearly shows the awareness of the deep transformation induced by digital culture and, at the same time, the importance of possible, desired synergies between Technology and Nature/Environment.

At the same time the text is a stimulus for reflection but also for action, a task which, in a complex moment of transition like the current one, culture, science and research must undertake.

And this is certainly one of SIT*d*A's missions.

Maria Teresa Lucarelli

President of SIT*d*A – Italian Society of Architecture Technology

[1] A reference is made to the SIT*d*A Conference "La Produzione del Progetto" held in Reggio Calabria in June 2018

[2] Call for papers of the International Conference, Naples 2020 "Design in the digital age. Technology, Nature, Culture", 2019 – www.sitda.net

The Envision of Infrastructure Project Design

Maria Antonietta Esposito[1], Spiro N. Pollalis[2], Filippo Bosi[3]

Abstract

The contemporary Design Culture and Theory deal with the improved connection between Deep Technologies Ecosystem and the Natural one, in the perspective of continuous equilibrium maintenance and improvement in a co-evolutionary perspective. The contribution discusses the Envision® protocol, introducing a systemic approach for understanding and interpreting the complex reality of the infrastructure design evaluate the sustainability of infrastructure projects within the global trends and human agency. The protocol is illustrated with examples and cases study to point out strong points of the sustainability systemic practice.

Key words: Sustainability, Technology, Project Design Management, Evaluation, Infrastructure

[1] Department of Architecture, University of Florence, mariaantonietta.esposito@unifi.it
[2] Institute for Sustainable Infrastructure, Harvard Design School (USA), pollalis@gsd.harvard.edu
[3] Department of Architecture, University of Florence, txp.fbo@gmail.com

Introduction

The contemporary Design Culture and Theory talk about the improved connection between the Deep Technologies Ecosystem and the Natural one: new challenges and opportunities have risen. Design technology is dramatically changing both architectural practice and the role of the architect and related design professionals very fast. Authors question the current skillset necessary for the architect role, the value provided by every component of the project group, how architects relate to the new work environment and how the design process has changed due to technology (Deutch, 2019). Other authors focus on process reshaping needs and requirements (Kiviniemi, 2018; Esposito, 2018) and pointing out more industrialised approaches base on new methodologies and tools (Bosi, 2016). All the three approaches are interlinked and must be considered together to understand the potential innovation in Construction and to enable digitalization trend engagement (Esposito, 2019).

Lean Construction, derived from Industrial production, is not just another specific approach to construction, but rather a methodology that challenges of the conventional understanding and practice of construction. In consequence, it is in the interest of every player in the construction sector to assess this new thinking and practice. The future development of Lean Construction will have two directions: breadth and depth. On one hand, the seminal ideas of Lean Construction were related to the management of site operations. After that, new methods were developed for supply chain management, design management, cost management, and for total project delivery. This process of more ample breath will eventually lead to the situation where all issues of construction project delivery have a methodical solution based on the new theoretical framework that balances design process, continuous improvement and use of technology. Lean Mindset supports design organizations in achieving higher efficiency, reducing costs and errors since the onset of the Design Process, overcoming many barriers and difficulties of traditional processes such as poor top management support, wrong perception of innovative processes and practices and mostly the lack of information sharing and integrated design process control (Demirkesen et al., 2019; Mota et al., 2019)

The impacts on practice of emerging technology trends such as generative design, automation, artificial intelligence, and machine learning are now evident clearing up the market by obsolete and non-competitive AECO operators and companies. It already happened in most of the Industry: such emerging technologies are already applied to production process innovation where the link between innovation aptitude and digitalization maturity looks to be significant (i.e. Electronics, TLC, Aviation, Automotive, etc.) as well as in the whole set of Industrial and Academic R&D. With reference to the international scenario the Harvard Business Review (HBR) points out the Construction Industry significant delay in productivity and innovation capacity recovering compared with other Industries. The gap has been more and more evident because of the decade's Economy crisis. In fact the Construction Industry is positioned at the second to last position in Industry ranking in 2015 (Gandhi et al., 2016). Some situation is shown for the Public Administration closely related to Construction especially for public works and infrastructures at the very last positions by the results of HBR's ranking. The McKinsey & Company research about digitalization in USA (2015) (Manyika et al., 2015) shows that automation has caused a 200% acceleration in the expulsion of low and medium skilled workers from the labour market.

The timeline of digital evolution illustrates how the separate focus on a single system is overcome by facts: already today the digitalization is oriented to the exploitation of the big data field – new economy's fuel – and to the interaction between the physical apparatuses. Essentially, successive waves of digital innovations have structured a digital economy. Digital economy generates 17% of earnings in the US, but uses only 18% of its potential according to research (Manyika et al., 2015) digital economy will simply be the future economy. Industries digitize various aspects: the maximization of digital coincides with the increase in value creation. In fact, the growth of wages from 1997 to 2014 sees construction in the fourth place, and the highest wages are offered by the industries with higher digital penetration. A sign that such industries create more value per capita.

Today the industries that create the most value are those that

revolve around ideas, innovations, research, and skills – in view of the fact that they have talents with adequate creativity and digital skills. Such type of industry also creates an external drive for those endowed with a high degree of digital capacity (digital fluency).

However, finding these skills becoming more difficult. Globally, more than 1/3 of job seeker declared the lack of needed talents in 2014 and more than half of the companies declared that such difficulties have had a tangible effect on their capacity to meet client expectations (Manpower, 2014).

Technology evolution trend asks for continuous competencies updating. The issue at hand is to focus on determining which digital competencies are needed by the field.

The global scenario shows the new needs and trends rose by the environmental, social and financial sustainability of projects. The presentation wants to show that to seek such needs require structured processes to face the digitalization because these aspects call for holistic approach bringing requirements that fulfill new performance classes within the design brief. That means more complexity to manage and further methodologies and tools in the process organization (Mota et al.; 2019) and management. Most important it implies new methods and taxonomy to manage and evaluate the results achievement.

The European scenario for digitalization in Construction (Eurostat, 2018) is highly targeted to sustainability. It has been set by a series of regulations[1] that have created the reference framework both for policies and for norms in the whole Industry sectors of all member States that have had adopted it step by step.

To that aim integrated interdisciplinary methods and instruments of integrated design have been introduced within European member states regulation. Such regulation allows introduction of multidimensional approach using parametric management.

Beyond utility and coherence within processes of such methods and tools, their transformative potential with regard not only to environmental sustainability but above all referred to the socio-economic aspects of Construction Industry has to be taken into account. This potential needs to advance in the global industry innovation and productivity ranking, also asking for stopping the employment rate decay, stake-holders conflicts, the process and then the product non compliance. The presence of a cultural gap in facing the digitalization challenge in general – and BIM in particular – is evident.

The added value created by digitalization may generate if it is merely identified with the BIM technology adoption is substantially trivialized just like as productivity and efficiency improvement. But it is not a sufficient objective nor really achievable if new organizational approaches based on shared and collaborative models aren't adopted. Such aspects are often confused and impossible to apply with the current unclear regulation adopting obsolete verification and control methods and protocols. On the contrary it is necessary to adopt approaches that allow open and interoperable communication flow sharing not only standard formats but also the whole set of data both within the design team and the stakeholders during the project life cycle. The first different disciplines professionals in AECO, Finance and Law that populates the industry scenery but also owner and users must have access and share information.

The added value resides in that not only in time, costs and quality.

Taking in consideration the dominant transformative technologies for Sustainability and Digitalization (Esposito et al., 2019) it is evident that to successfully integrate digital technologies it is necessary both to implement hard skills (i.e. process engineering, information sharing, use and standard of virtual design technologies and construction, etc.) and soft skills (i.e. Lean mindset, social sciences applied to design management, sustainability evaluation and certification protocols, etc.).

In particular sustainability evaluation and certification protocols are seen as a contribution to performances set definition, but in this discussion we would like to consider their value within the digital ecosystem that includes the Industry transformation technological drivers. Such point of view is very peculiar because it allows the infrastructures sustainability protocols not only for their primary scope but also most to design preventive verification management methodology and definitely as project design development tool.

Project Design can evolve from considering Nature just a resource pool to take advantage of. It can envision Ecology as Technological and Natural factors, intertwined with the scope of maintaining, preserving, renewing and possibly improving project objectives. All of this according to co-evolutionary perspective.

The future Ecology vision encompasses Technology itself. For example it is already applied in medicine where digital supplies support human functions (e.g. pace-makers, robotic limbs, nanotech drugs, etc.). Such applications not only is able to maintain functionality but may save the life or improve its quality.

In fact the latter vision suggests the possibility to focus Technology to face the sustainability on the three pillars of EU strategic scopes: environmental, socio-economic and business challenges. Worldwide approaches are very similar since awareness about the crisis that plague the planet, from recession to climatic emergencies and migratory phenomena as well as social inequalities rise in many countries.

That means the project must evolve and include its effect on the reality. Some theories calls for evolutionary project in software development, or biomimetic design and other ideas that can be put in place adding more data then producing and managing more useful information definitely adding complexity to the project.

Integrating new approaches can be a big effort that also needs additional money and knowledge. The affected knowledge areas are many. For now, being in transition from "delayed" industry to a new set, we may expect the opportunity to experiment innovation in major projects to later transfer the results to the whole Construction industry.

Infrastructure projects are subject to the resource constraints of multiple public administration bodies and decisional levels. Such constrains create problems and delays at different design steps when not properly managed. Ratings systems and tools intended for buildings are not designed for this context and cannot adequately assess the extensive external benefits and impacts infrastructure has on a community. The basic requirements to meet are efficiency and long-term sustainability of the communities the infrastructure serves.

Nowadays we can see the effect of lack of efficiency and long-term sustainability and the negative impact on the communities. The Genoa's bridge a 210 meters (690 ft) section of the viaduct that collapsed during a rainstorm on August 14, 2018 is one of the many examples. Looking at the Civil Aviation Industry that is accounted for 2,4 % of total transport emissions no ground infrastructure protocol existed before. There have been attempt to use LEED® (*Leadership for Energy and Environment Design*) protocol adaptation to airports within their Manuals and creating derived protocols like GREEN PLANES®, or more whole airport management protocols like ACA – *Airport Carbon Accreditation* by ACI – Europe (*Airport Company Internation-*

al). Furthermore many actions have been experimented in route ATM (*Air Traffic Management*), plane engine, green fuel.

Methodology and timeline of Envision

Envision is a framework that provides the guidance needed to support this systemic approach in the planning, design and delivery of sustainable and resilient infrastructure. The protocol works as decision-making guide based on a set of performance and flexible measures. It allows higher performance through more sustainable choices in infrastructure development. The framework provides a flexible system of criteria and performance objectives to aid decision makers and help project teams identify sustainable approaches during planning, design, and construction that will carry forward throughout the project's operations and maintenance and end-of-life phases. It provides sustainability metrics for all types and sizes of infrastructure to help users assess and measure the extent to which their project contributes to conditions of sustainability across the holistic full range of social, economic, and environmental indicators.

In agreement with national and local regulation it is possible to adapt the performance set to specific infrastructure location and local regulation. The presentation shows examples and cases study to point out strong points of the sustainability systemic practice. The aim of the discussion is to evaluate the possibility to apply Envision as effective project planning and design tool in Italy and more in specific to check its suitability confronted both to Airports and to Public works regulation. Airport owner or regulatory body (ENAC) formally require environmental impact evaluation process (VIA – Valutazione Impatto Ambientale) in Italy. Public agencies want third-party confirmation of project achievements for the public good regarding socio-economic impact. Civil Aviation stakeholders may use the verification process as a learning tool, a process for accountability, and to calibrate their internal project assessments and application of Envision. Regulator entities (e.g. ENAC – Ente Nazionale per l'Aviazione Civile, Italian National Civil Flight Authority) and Airport Companies may pursue verification for the public recognition it brings to their commitment to sustainable infrastructure in the Program Agreement (Accordo di Programma). Both of them can use the same framework as annual verification method during the contract.

The Envision verification method is targeted to the following:

- to instill community confidence that the project addresses their needs and concerns;
- to Help rate-payer or tax-payer confidence that their money is being spent in their best interest;
- to demonstrates that the sustainable achievements of the project are recognized and considered noteworthy by an independent internationally recognized system;
- to motivate project teams to collaborate to achieve better outcomes;
- to provide an objective measure of sustainable performance and draws attention to the good work being undertaken.

Envision foresee two verification pathways: design plus post-construction and post-construction. Project teams may choose to pursue Envision verification during the project's design phase, or once it is constructed. The second case is very frequent in Airport projects over and over again changing because of flow and technological trends adaptation.

Pathway A: Design + Post-Construction

Airport projects that pursue verification Pathway A may do so any time at or after 95% design completion, in other words, after all major design decisions have been made. This allows leaner and less costly the other rating systems processes (i.e. LEED). Projects pursuing Pathway A will be required to complete a post-construction review, the purpose of which is to confirm that commitments made during project planning and design were carried through construction. This concept is very relevant to refurbish the connection between design and construction phases traditionally separated by the bid phase. Projects pursuing pathway. A may earn an Envision award after undergoing a thorough iterative design review. This id also required by the Public works regulation in Italy (Dlgs 207/2016, art.26). The post-construction review is required to maintain the award earned after the design review(s) and can also support the final testing of the works. If the airport project is developed and constructed using BIM (*Building Information Modeling*) data gathered during the reviews are made accessible within the ACDat (*Ambiente Comune dei Dati*) digital repository.

Pathway B: Post-Construction

It is the case of already built or with approved design Airports. In such cases many reasons will require to achieve a demonstration of the Airport conformity – as a whole or in part i.e. to changed regulation – after upgrading, revamping or reconfiguration. Projects that pursue verification Pathway B may do so any time at or after 95% construction completion, up until the airport has been operational for three (3) years. The airport operation phase observation is very important to establish the real performances. Projects pursuing Pathway B may earn an Envision award after undergoing a thorough iterative post-construction review. No subsequent follow-up reviews are required for projects that earn an award after completing Pathway B. The pathway be can also support the decision process aimed to allocate resources for revamping or demolish a terminal.

The evaluation method is based on a set of credits. Each credit has several scopes to be described in a specific cover sheet. The credits list within the Envision v3 framework (2018) is the following:

- improve community quality of life;
- provide effective leadership and collaboration;
- support sustainable procurement practices;
- preserve sites of high ecological value;
- reduce net embodied carbon.

The five credits are deployed in questionnaires per every significant scope. The applicant must fill the answers and document as much as possible evidences to support them. The aim of such very lean evaluation scheme is to help applicants to be clear and do not waste time in redundant information and on the other hand easy the evaluation process.

In conclusion the evaluation method seems to have a multidimensional approach rooted in several disciplines to deal with infrastructure's project complexity. Such kind of evaluation meets the requirements of the European rule set and in particular the environmental impact evaluation ones as requested by the Italian regulation. Furthermore Envision holistic method seems to embody most of the aspects that the global scenario points as new needs and trends rose by the environmental, social and financial aspects of project sustainability evaluation. As mentioned above these aspects call for more holistic approach than in the past bringing requirements full filling new performance classes

within the design brief. That entails more complexity to manage and further methods and tools introduction in the process development, check and evaluation and management within the digital environment. It implies methods to evaluate the results achievement to be suitable for process digitalization as a whole. A multidimensional evaluation framework like Envision seems to be relatively easy to translate in parametric environment rules within a BIM platform. It makes the method suitable for airport projects coped with more general airport carbon management already adopted.

Results

This contribution reports a work hypothesis for further application in airport design and evaluation. Since its early stages in the post war two age Commercial Aviation Industry has demonstrated to be very much sensible to sustainability concepts particularly considering noise, air and water pollution mitigation, taking in account social communities needs to be served by the air transportation service and its support to the local economy. Despite the evaluation and mitigation methods have been apparently mainly focused on the environmental impact the social and economic aspect have been always considered because the business model need to evolve with the demand. It not a case that peaceful and freedom periods allow Aviation Industry to flourish on the contrary outbreak, war or terrorism like as regimes create barriers. The Aviation Industry growth average is around 5.4 % per year more than 1.4 billion passengers loaded in 1.6 million flights are expected to fly using EU air space in 2030. Its 440 airports will be fully congested with resulting 160 to 490 million passengers affected. It means that 25% of the EU traffic will be unaccomodated and 50% of the EU airports will be affected by GHG (Green House Gases) emissions peak (Fig. 6).

Passenger experience despite airport ground management improvement will decay no doubt. Tripling the capacity demand the current targets related to no baggage lost, no delay, no cancellation will be hard to cope despite the EU advanced solutions already adopted. Within the EU successful projects have to be mentioned the inclusion of Aviation Industry in the ETS (Emission Trading System) the SES (Single European Sky) realization with the SESAR (Single European Sky ATM Research) resulted by the adoption of a centralized ATM (Air Traffic Management) by Eurocontrol and the strict Clean Sky regulation for plane engines classification to fly throughout EU sky. It is evident that to specify and define an action plan to achieve the objectives set, already established the Advisory Council for Aeronautics Research in Europe (ACARE), a body composed of all the stakeholders in the air transport sector, which in 2002 and 2004 sets out the contents of the *Vision* through two versions of the Strategic Research Agenda (SRA) to improve safety, reduce environmental impact by 10% and cut ATM costs by 50% has to be reviewed and powered to cope with the future capacity crunch challenge. EU continental policies have to be deployed at local level by airport owners to adapt the future needs. On the airport project design and management side we need to develop better methods refine tool and take advantage by digitalization and the deep technology ecosystem. New more comprehensive protocols are very much useful to reshape processes and be able to evaluate their results confronting theme with the needs. The proposal is to use theme as shared framework to make transition easier in airport projects development.

Discussion

BIM is considered the target platform for collaborative and integrated design. To pursue the 7D maturity related to green building, we need to define the information management plan (pGI) keeping in consideration the method used to define and manipulate sustainability management related data and their links within the model. Therefore the significant parameters have to be selected and to achieve a suitable level of definition. Adopting the Envision® protocol it can make immediately available such scheme to properly fill each technical section. It is previously necessary to define data supply responsible as well as all the involved stakeholders within such information process, the data exchange method within the ACDat (*Data Common Archive*) and the ACdoc (*Document Common Archive*) and the software operators involved (as requested by the UNI 11337:5 Italian standard for BIM management). In conclusion much of the problems again is arisen by the organization side that must be oriented to green building scheme. A robust scheme is needed to base the project and its organization.

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