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TECHNOLOGICAL IMAGINATION
IN THE GREEN AND DIGITAL TRANSITION

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From a Liquid Society, through Technological Imagination, to Beyond the Knowledge Society

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Abstract. The paper aims to introduce the Proceedings of the *Conference "Technological Imagination in the Green and Digital Transition"*, starting from the initial idea.
The Scientific Community has been invited to propose visions of technological imagination, in a time of great uncertainty and fragility, so that they could be subjected to a highly interesting analysis. The theme of "fragile" cities and habitats highlights the necessary transition from liquid society beyond the knowledge society. For the purposes of conference, it was noted that these themes, each with its own in-depth considerations, are to be found, thanks to the different contributions, in all of the various sessions. The Conclusions are to upgrade national and international research systems and to change the training modalities.

Keywords: Technological Imagination • Innovation • Knowledge Society • Training

1 The idea of the conference

The idea of the international conference *"Technological Imagination in the Green and Digital Transition"*[1] was born at a very particular moment, characterized by rapid change, the pandemic, the consequent economic crisis and, as the preparatory work was underway for the conference, the outbreak of a war.

As is scientifically recognized, these factors have led to increases in our society in inequality and difficulty in accessing knowledge, while highlighting the lack of various skills and, above all, raising numerous questions about the future, to which it is difficult, and still too early, in any event, to provide answers.

It was in this context that the idea of bringing the theme of "Technological Imagination" to the attention of the scientific community first arose, and that its variations were subsequently developed. The starting point was noting that imagination, unlike perception, which implies an observation of reality, is the outcome of a cognitive synthesis combined with our plans, all aimed at creating an overall image of reality.

A singular concept that, taking its cue from reflections formulated in other disciplines, restores the proper importance to design, in a sense closely tied to reality, and with the social significance typical of technological disciplines.

The assumption was that, starting from technological imagination, questions and

[1] The international conference *"Technological Imagination in the Green and Digital Transition"* was held in Rome, at the Valle Giulia seat of the Faculty of Architecture of the Sapienza University, from 30 June to 2 July 2022. The preparatory work began in the month of June 2021.

interferences could be examined, so as to highlight, and therefore stimulate, transformations of the collective imagination, together with a growing expansion of the technical and technological universe.

The central theme, therefore, was to invite the scholarly and scientific community to propose visions of technological imagination in a time of great uncertainty and fragility, so that they could be subjected to a highly interesting analysis, under the assumption that a radical transformation of the very categories of reference was underway, and that this might even make it possible to highlight new categories.

At the same time, the reference context was also characterized by the targets set, and by the transversal priorities indicated, in the EU Next Generation Program, as part of the National Recovery and Resilience Plan, with the aim of promoting the growth of the innovation ecosystem.

These elements have made it possible, in the contemporary world, to launch, in a way that is both significant and relevant for civil society and for the scientific community, the desired processes of ecological and digital transition involving competitiveness, training, and inclusion with respect to social classes, geographic location and gender inclusion.

Starting from these assumptions, it was decided, together with the colleagues of LAB.ITECH, the Laboratory of Architecture, Building Innovation and Technology, Environment and Climate Change, and Health of the Department of Architecture and Design of the Sapienza University of Rome, to analyze the theme of the technological imagination, first with respect to the "green and digital transition", and subsequently in terms of the topics: Innovation, Technology, Environment, Climate Change and Health, addressing subjects not only of great interest to civil society, but that also the key topics addressed by the Laboratory itself.

To which a very important historical reference should be added, albeit one tied to a very different moment in time: the conference *"Culture, Technology and Metropolis"* held in Florence in 1987, on the occasion of the celebrations of Florence as the European Capital of Culture, during which designers, critics, technological figures, design experts, artists and university professors, both from Italy and abroad, gathered to illustrate their thinking on the metropolis and its difficulties.

The proceedings were published in the volume *"The Metropolitan Technological Imagination"* (edited by Mucci, E. and Rizzoli, P., 1991).

Another reference deserving mention, and one also tied to a very different set of historical circumstances, namely those of an economic recession, is "The Invention of the Future", the first national conference of the SITdA, or Italian Society of Architectural Technology, held in Naples on the 7th and 8th of March 2008, during which various figures from the sectors of public policy and private investment, as well as university professors, gathered together to identify paths of action and contributions that could be reciprocally undertaken, so as to establish a synergistic path for future development.

The proceedings were published in the volume: *"The invention of the future"* (edited by De Santis, M., Losasso, M., Pinto, M.R. 2008).

The theme of linking "imagination" and "technology" is of particular interest not only to the scientific sector of technology, seeing that technological innovation has always been something of a keyword, in combination with studies, research and

experimentation involving technology.[2]

How else, in fact, if not through a technological approach, though with a keen interest in bringing into play other disciplines as well, could the challenge of "technological imagination" have been launched, in a contemporary context, in order to disseminate interdisciplinary contributions, in the broadest sense of the term, during the phase of ecological and digital transition?

Technological imagination has been a subject of study and research for several years under the philosophical disciplines, as well as in the fields of anthropology and sociology, albeit under varying approaches.

In his book *"Technological Destinies of the Imagination"* (2022), Pietro Montani, a philosopher and honorary professor of aesthetics, holds that the human imagination is inseparable from technical endeavors, a relationship that dates back to the dawn of time. Over the course of history, technologies have arisen with enough transformative power to radically reorient the essential profile of forms of human life, while redesigning their destinies.

The contribution of Pietro Montani, who opened the conference with a lecture entitled: "Digital Spaces and the Material Culture", was particularly significant, offering an important introductory frame of reference for all the sessions on the theme of technological imagination.

2 "Fragile" Cities and Habitats: from a liquid society to beyond the knowledge society

About twenty years have passed since the publication of the Italian translation of the book: *"Liquid Modernity"* (Bauman, 2002), in which a series of reflections conveys the sense of precariousness, ambiguity and fluidity that permeates contemporary society.

With the public space finding itself increasingly emptied of public issues, the volume indicates nothing less than the public sphere as the place where reasons for coexistence should come together and be restored.

As Leonardo Benevolo writes in the introduction to one of his books (2012):[3]

"Urban planning - in concrete terms: the organization of human constructions in a given area; urban and territorial programs; their initial operation or that designed for the future; discussion of these topics in various forums, from politics to civil society - is today practically a forgotten practice, playing only a vestigial role in terms of professional activities and social consideration".

The sense of temporariness, of crumbling communities, of an abandonment of stability, have grown particularly strong in the wake of the pandemic.

As is widely acknowledged, the various expressions of fragility to be found in the habitat are not attributable to climate change alone, but are also the consequence of a deeper, cultural crisis that extends to all contexts of habitation.

Once again, attention should be drawn not only to the unthinking use of resources, and especially natural ones, but also to the increasing failure to attribute collective and

[2] The concept of "Technological Innovation", widely discussed with regard to architectural technology, should be understood in all its various permutations involving: process, design and product.

[3] Benevolo, L. (2012). *The Collapse of Italian Urban Planning*. Bari, IT: Laterza.

individual values to environmental and cultural resources, as well as to knowledge.

The concepts of the information society,[4] and especially those of the knowledge society,[5] speak to this state of things.

Issues of welfare, in the forms it takes when applied to the habitat, to cities and their fragile habitats, as well as topics pertaining to the urban metabolism, the smart city, the transmission of data and information meant to increase efficiency in different sectors, and therefore the subject of innovations in systems, tools, products and services as well, have invaded the realm of modern-day scholarly and scientific discussion, and continue to conquer significant space, making the establishment of ongoing relations between architecture and other sectors a necessity.

For the purposes of conference, it was noted that these themes, each with its own in-depth considerations, are to be found, thanks to the different contributions, in all of the various sessions.

Indeed, the very spirit of the technological imagination with which the scientific community was invited to propose its shared visions of the future, has made it possible to raise questions that also touch on the topic of the knowledge society.

On the one hand, the multiple technological tools of contemporary design and construction are rapidly changing, underlining a growing complexity and continuous updates while making necessary new skills. It follows that there can be no ignoring, especially in certain cases, that knowledge undergoes a rapid obsolescence characterized by a finite "life cycle".

At the same time, the rapid change in knowledge must be spread, understood and accepted. It is of fundamental importance, therefore, that harmonious relations be established between resources, technologies and society, to which end the scholarly and scientific community faces the task of constantly asking itself what type of society it wishes to build, as well as what type of knowledge is needed by a changing society.

With this in mind, visions of the future play a special role, requiring an even greater sense of responsibility, so that they can be disseminated in a way that ensures understanding, awareness and inclusivity, all resulting in practical, and therefore effective, application.

3 The organization of the Conference into sessions

As already noted, the international conference *"Technological Imagination in the Green and Digital Transition"* was divided into five sessions which got underway following the welcoming remarks from the authorities and after the opening lecture by Pietro Montani.

Each session included, during its introductory phase: presentation of the managers of the session, and of a discussant chosen to act as the “alter ego” with respect to the session topics, along with a number of video-interviews done with qualified experts on

[4] A useful reference source is *Dialogue IV on Sustainability. A culture for the Information Society* (edited by Morcellini, M.), Sapienza University, 2016, which brings together contributions on the topic presented at the conferences held by the universities of the Lazio Region for the “Jubilee of Mercy”.

[5] The knowledge society of today differs from the information society, in that its task is to transform information into resources and tools that allow society to act effectively.

the topics addressed in the different sessions.

At the deadline for submitting the abstracts, 114 contributions had been received, including many from abroad.

It is interesting to observe that, as early as the first call for submissions, the session for which the greatest number were presented was that on the topic of "Climate Change", demonstrating the noteworthy engagement and the extensive interest of the scholarly and scientific community in the single greatest environmental risk, as well as the potential consequences facing mankind in contemporary society.

For in-depth information on the individual sessions, as well as their results, the reports drawn up by the session managers should be consulted.

Of interest herein is a review limited to some general reflections comparing the initial goals with the contributions presented.

If it is true that the digital revolution lies at the heart of the agenda of the world of design and construction, then what emerged, in general terms, from the contributions of the *"Innovation"* session, is the highly experimental nature of technological innovation, whose rapidly evolving methods and tools undoubtedly represent a great opportunity for the growth and development of sustainable cities, as well as for the construction sector and the achievement of quality results.

And this is a sector that, as has been pointed out on numerous occasions, is historically backward when it comes to innovation.

In fact, while the *"Technology"* session set itself the goal of discussing the impact of new design and manufacturing technologies on the construction of buildings and the urban environment, and on the repercussions that new housing models can have on the quality of life, including perceived quality, care was also taken to choose topics able to maintain the link between research on industrialized construction and that on sustainable development.

In the process, the need for innovative education in the fields of design and construction also came to the fore.

The goal of the *"Environment"* session was to discuss R&D models and design strategies for a low-tech environment, as well as for advanced, carbon-neutral building/plant integration achieved through low-intensity policies for the regeneration of the constructed environment, featuring elevated energy and environmental efficiency. Particular attention was focused on situations of energy poverty and economic need. The contributions presented outlined new scenarios, and proposed pilot-cases, pertinent to low-intensity, high-efficiency contexts that definitely call for a useful "systemic structuring" of the relevant experiences, methods and tools.

The *"Climate Changes"* session started from the assumption that, as things currently stand, cities are both the problem and the solution of climate change, meaning that the built environment must be rendered both adaptive and resilient to the effects of climate change and climate neutral. With this in mind, the goal was to discuss procedural models, strategies and solutions involving design, technology and digital advances potentially of use in defining new images of resilient cities capable of contributing to reducing the effects of climate change. The numerous contributions presented illustrated the various approaches, the different issues addressed with respect to the objectives set and, most importantly, the different scales at which interventions could be carried out: from observation of the earth to gauging the potential of cities, as well as the environmental design of urban areas and sectors, of buildings, of building shells,

plus the reuse of abandoned areas and decommissioned assets: a wealth of research and experimentation on the topic of environmental sustainability that amounts to a body of theories and good practices for the ongoing evolution of the built and urban environment in response to climate change.

The goal of the *"Health"* session was to discuss how the environmental determinants of health and their "material manifestations" could be classified and studied with respect to architectural technology, at the various scales of intervention, eventually through a dialogue of osmotic exchange with other disciplines. The call for contributions referred to visions of planning, decision-making, design and implementation focused on people, foreseeing the short, medium and long-term impacts on their health.

The contributions presented confirmed, using a variety of paradigms, theories, methodologies and case studies, and with respect to all the different approaches and issues addressed, the validity of the initial premise that health is "the result of a complex system".[6] Also confirmed was the fact that health, as shown by how goals of the session were interpreted, definitely bore significant relevance to the other sessions of the conference as well, in particular with regard to topics of environmental and social sustainability.

4 Conclusions: upgrade the national and international research systems and teach how to think

While the conclusions, in terms of the results of the sessions, will not be revealed until the related discussions, it can be stated, in general terms, that the contributions of the various sessions of the conference highlighted how unproductive it is, in modern-day reality, to maintain clear-cut boundaries and divisions between disciplines, and how an interdisciplinary approach is critically important to research activities, especially when it comes to achieving results that prove original (a characteristic that, over time, has been slightly in decline), concrete and useful to society.

All the more so since the rapid developments in the field of science and scholarship themselves are increasingly geared towards eliminating boundaries between sectors, in keeping with the pace of technical-production transformations in industrial sectors.

The contributions of the various sessions also highlighted how certain topics were relevant across the board, to all the sessions, in that they brought up concepts, theories, methods and tools which, at times, were also characterized by their dynamism (an added value), and which were common to multiple areas.

The characteristic of "operability" played a noteworthy role in the contributions presented, confirming the "design" aspect of the technological disciplines and their vocation for experimentation.

Naturally, the visions of the technological imagination, to be such, increasingly need to be developed, disseminated and shared through national and international research groups that are trans-disciplinary in nature, making it possible, through a systemic approach, to arrive at continuous moments in which permanent knowledge is shared, updated and renewed.

[6] See the contribution by Giofrè, F. that served as the introduction to the "Health" session.

But certainly, not even this is sufficient.

The modern-day speed and complexity of knowledge, the high potential for the "spreading"[7] of technology, are reflected in the learning models of technological disciplines, which are closely related to the technical-production ends of the cities of the future.

On the one hand, an effort must be made to address the complexity, in assigning priorities, through new and advanced tools and methods that make it possible to maintain a dynamic relationship with the changing needs of society, while also serving as guides for research and innovation.

At the same time, there is the fundamental theme of the need to encourage critical and creative thinking regarding the processes for modifying the built environment.

This entails orienting education towards dynamic learning capable of absorbing new knowledge, of managing and synthesizing information, but, most importantly, of perceiving aspects relevant to all sectors while establishing connections and putting forth arguments.

In short: "The new challenge is to teach how to think".[8]

A new way of transmitting the culture of the built environment, but also of creating new skills.

With regard to the Conference *"Technological Imagination in the Green and Digital transition",* it had already been decided, even while the proceedings were still underway, to view it as only the first of future international conferences on technological imagination, demonstrating the shared intent to repeat the encounter in a few years, when the experience acquired in the meantime will doubtless add to the value of the event.

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Innovation for the digitization process of the AECO sector

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Abstract. The conference's Innovation session gathered more than 20 papers ranging from the digitization of the construction world to the digital twin of complex infrastructure such as port areas. The common denominator of the presentations was the methodological search for the best combination of physical reality and digital replication, always putting the functionality and operability of the built environment at the center of the study.
In fact, the contributions, although coming from very different research realities, clearly highlighted the inescapable path toward the integration of the digital world in the AECO sector.

Keywords: Digital Twin • AECO • IOT • digital platform

The cultural and socioeconomic shocks of the last years, deeply marked by the pandemic crisis, are proposing with the greatest urgency new thoughtful and evolutionary visions building on all positive and negative recent experiences, bearing in mind the fundamental contribution of technological innovation to cope with the present global changes scenario.

The dawn of the digital revolution heralded and described before it had even been triggered, is a key issue on the agenda of the built environment, considered at any scale of analysis. It seems that a new paradigm is presently needed, in order to replace the actual documentation-based approach with a practical method of quality control, able to recognize both in structural evidence and building processes, those pivotal factors of development that can be used to measure and monitor the performance of single and multiple buildings and the parties involved.

The initial transition to the digital world, which focused essentially on three-dimensional models, led to a significant transformation in planning, design, construction processes, and management, in terms of both contents and participants, with a focus on the organization of collaborative information flows and production procedures, optimizing instruments crucial to determining when top-quality results have been achieved.

It is precisely this surprising stock of untapped but available potential that makes digitalization appear to be less a phase of evolutionary adaptation, strictly speaking, than both a significant moment of growth and, in the meantime, a tremendous opportunity.

As a matter of fact, the digital revolution is becoming more and more an essential asset at the core of architectural design and construction activities, and this is calling for the mentioned paradigm shift from a document-based approach to a concrete application of a quality control method, to be reflected in the use of structured data

within all construction process.

This is the reason why, the “Innovation” session within the “Technological imagination” conference - held in Roma La Sapienza in June 2022 - has been designed as an occasion for discussing those features and tools to be considered as driving factors of the mentioned digital revolution, with careful attention to innovative methodologies and instruments for controlling the quality of construction projects and processes, as well as their integration with best available technologies.

The session focus centered on the following topics proposed for the discussion to the participants:

- ICT Innovations in Architecture and Civil Engineering;
- Digital Transformation & AEC and The Role of Enterprise Architecture;
- Advances in Digital Engineering, Computing, and Simulation for the AEC Industry;
- Innovative Digital Technologies and Engineering Systems (e.g. Digital Twins);
- Project Management in design and construction processes;
- Advances in digital engineering, computing, and simulation.

The introductory statements were entrusted to highly qualified technology and communication experts. The initial contribution to the debate was an interview by the editor-in-chief of La Repubblica, Mr. Maurizio Molinari, who was asked to elaborate on his vision of the new professional profiles emerging as a result of the impending digital transition. Afterward, it was Professor Michael Grieves, the developer of the digital twin approach in 2002, who was asked to make a projection of prospects after the digital twin.

Data Analysts are usually focusing on the process of combing data to find new relevant patterns for the business sector or other stakeholders. BI analysts are more suitable at making sense of what has happened and doing so at scale. Data analysts are better at looking for patterns that state what might happen, and vice versa BI Analysts are sounder at translating business requirements into the appropriate graphs, charts, spreadsheets, and dashboards. They tend to work close to the front line with business users and subject matter experts. They also need a solid understanding of business workflows, finance, and accounting to translate the raw data into a form that final users would find easier to use.BI analysts need a deep understanding of the technical side of working with structured databases and data warehouses. They must be fluent in writing complex SQL queries and creating complex joins across tables. Familiarity with various query optimization techniques helps ensure they create reports that cut database processing overhead.

BI analysts may get formed with very different SQL data transformation skills.

For example, they may work with extract, transform and load tools, to transfer subsets of data from an operational database into a data warehouse to support a new query. Some basic user experience design skills can also help them identify the best way of presenting data to users that is simple and can explain the appropriate story.

The next keynote speaker, Prof. Grieves, provided an overview of the state of digital innovation and pointed out that digital transition is already going further, converging into experiments in the metaverse. According to Prof. Greves, the driving force behind this transition is the Digital Transformation of business, with extensive use of advanced technologies related to artificial intelligence, digital twins, augmented and virtual reality, AR/VR goggles, and wide connectivity.

Digital Transformation is already transferring part of the activities to cyberspace where even portions of the company’s assets are relocating, changing their economic

value; this process can be both an issue or a huge opportunity. To leverage the opportunity most companies will need to transform their business models and their market offer. The potential issue is whether their market could also shift to the cyberspace with similar rapidity, and if it would make sense to create rapidly metaverse as a platform to meet their customers and provide them with a satisfying experience.

How and when people will actually access the metaverse is the current unknown of the matter: there will be probably a hybrid situation where part of the company (processes, activities, resources, services, softwarised products) will be in the cyberspace and part of the customers will be accessing those by moving to the cyberspace, thus effectively transacting in the metaverse. However still part of the company will remain in the physical space and consequently part of the transactions will be occurring in the physical space. A mixed space will keep existing where the cyber is in connection with the physical dimension for a long time.

Afterward, Prof. Maurizio Talamo, full professor of cyber security at University of Rome 'Tor Vergata', opened as key discussant the thematic session on innovation, with an introductive speech. Prof. Talamo emphasized how the concept of cyber security is of paramount importance in the development of digital innovation and clearly highlighted the most relevant fields of application for this matter in the field of innovation, namely:

- Risk Assessment & Management;
- Business Continuity & Resilience;
- Cyber Defence;
- Digital Identity management & Privileges;
- Application Security (API, ERP, secure code review);
- Data Protection.

For assisting construction industries, manufacturing and business opportunities, digital security can employ the technology to stress-test and otherwise evaluate the vulnerabilities and capabilities of controls on computing environments. The ability to attack a live twin of a production environment — complete with ongoing updates reflected from the original system or environment — without putting data or productivity at risk potentially allows security teams to be as aggressive as they need to be without compromising operations.

Concerning the contributions to the session, 18 papers were accepted for publication, coming from several Italian universities as well as from academic institutions from Iran, Pakistan and Belgium; five contributions were selected for oral presentation at the conference, namely:

- *Short-Term Wind Speed Forecasting Model using Hybrid Neural Networks and Wavelet Packet Decomposition;*
- *Digital-Twin for an innovative waterfront management strategy. Pilot project DSH2030;*
- *Digital Twin Models Supporting Cognitive Buildings for Ambient Assisted Living;*
- *COGNIBUILD: Cognitive Digital Twin Framework for Advanced Building Management and Predictive Maintenance;*
- *Untapping the potential of the digital towards the green imperative: the interdisciplinary beXLab experience.*

The most selected topic by the authors has been “Innovative Digital Technologies and Engineering Systems (e.g. Digital Twins)”.

The 'digital twin' concept is returning frequently among the keywords as well as 'Maintenance'. Also, the 'Energy' related topic received a consistent attention, intended

in some cases as 'simulation' as well as 'culture'.

The field of technological innovation seems a very productive ground for methodologies, tools and experimentation, and the digital twin emerges as the most promising methodology.

The analysis of the selected interventions also shows that the main use cases of the presented methodologies concerned the fields of energy management, maintenance and safety applied to the whole built environment (both single building and more complex infrastructures). Innovation in technologies leads to the following major innovations:

- *For energy: integrated management of local micro-grids capable of simultaneously managing energy consumption and production;*
- *For maintenance: moving from 'scheduled maintenance' to 'predictive maintenance';*
- *For safety: use of imaging and computer vision technologies to automatically monitor abnormal behavior, processes and management of human and instrumental resources.*

Research in Technological innovation is confirmed as the field of applied experimentation on which to continue implementing the industry/university relationship. Most of the papers in fact concerned experimental applications of applied technologies with direct connection with the built environment such as, for example the utilization of digital workflow for social housing deep renovation design process

In conclusion, it is important to underline how innovation is one of the fundamental drivers for the green and digital transition of built environment, where technology has a key role for many different aspects.

Innovation is crucial for all industrial sectors to keep their competitive edge, as it fosters a shared culture of constantly looking to do things better. It can help organizations become more efficient and sustainable, and adapting to continuous and multifaceted changes of the conditions in which they operate.

Adopted at scale, it can create more consistent supply chains, with each member driven to meet a shared goal of progressive change and improvements, guided by the latest standards of construction methods, construction products or facilities management.

The increasing diffusion of innovations on the organizational-managerial level with the use of information Communication Technology (ICT), both thanks to the introduction of these technologies together with those of electronic systems for plant automation, security systems and communications in the building product to realize the new forms of building control and management that are variously defined as Computer integrated Building (CIB), when applied to tertiary buildings, "domotics" or Home Automation, when implemented in residential construction sites.

In this direction (technological and organizational innovation), new technologies based on electronics play a very crucial role. They allow the efficient realization of administrative, material purchasing, design and work scheduling operations, with a small number of technical employees, favoring, through the concentration of information, the possibility of decentralizing production functions.

Information technologies formalize and standardize procedures and lead to the development within the companies of precise and defined responsibilities for specific problems, favoring the processes of specialization and technical-managerial management, Innovation, research and development, and invention are closely linked.

Research and development thrive on the application of new information that will aid in the development of new technologies, products, services, or systems. Inventing new products or services is a sign of a progressive organization and can be a significant revenue earner.

Innovations drive efficiencies through standardization, while many technical innovations have created joined-up workflows beyond the physical space, from offsite construction to virtual reality, the Internet of Things and flying factories.

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