LEONARD

2023 yearbook

The New Worlds

"We must collectively rise to our common challenges, or we will one day bemoan our inaction"

Julien Villalongue

A message from
Julien Villalongue
Managing Director of Leonard

The New Spaces of Transition

2022 was once again a year of discouraging news for the planet. In May, the sixth of the nine planetary boundaries identified by the Stockholm Resilience Center, that of the freshwater cycle, was crossed, further endangering Earth's natural balance and its habitability. Over the summer, more than 500,000 hectares of forest went up in smoke in Europe. Talk of 'new worlds' may therefore come as a surprise, but this is not a question of fleeing into space to escape our terrestrial reality. These new worlds are those of transition, those we can imagine, and then build, to better inhabit the future.

To make a transition towards sustainable models, we must make profound changes in our lifestyles, infrastructures and practices. In a world rife with increasing tensions and crises, uncertainty lies beyond the horizon. We must therefore 'get ahead'. Effective action requires anticipation and planning for future challenges. Even in troubled times, we must not lose sight of our goal to decarbonise human activities and economies. Zero carbon is the new north that guides our action.

In this 'decisive decade', we must continue to focus our efforts on projects and funding towards achieving carbon neutrality by 2050, but we must also take the living world as a whole into account. We must take economic and social systems into account to ensure

that necessary initiatives addressing adaptation, biodiversity, and resource management are well received.

The contribution of innovators and entrepreneurs plays a decisive role in achieving these goals. There is a sign of hope, as investments in climate tech startups is sustained despite unfavourable economic conditions for innovation. More than ever, Leonard is working to develop new solutions and create opportunities that will define these new spaces in transition.

We must collectively rise to our common challenges, or we will one day bemoan our inaction. Transition can only be reached by meeting the organisational and cultural challenges that hinder change, and by bringing together actors across the different territorial levels.

This is why, in 2023, Leonard continues to bring together all the players involved in this transformation. We believe that together, it is possible to overcome challenges and build these desirable futures.

2022

Meetings, conversations, prospects and warnings: 2022 as seen by Leonard through some of this year's defining dates.

February

Launch of the events cycle: "Challenges for sustainable, low carbon reindustrialisation" (Leonard).

April

The IPCC publishes the third and final part of its 6th Assessment Report, devoted to climate change mitigation.

May

The collective La Rue Commune opens a public consultation on street transformation in response to 21st century challenges (Leonard).

June

5th edition of the Building Beyond festival: "Cities and infrastructures: the visible and the invisible" (Leonard).

August

According to NASA, the summer of 2022 is one of the hottest on record since 1880. Regions across the world experience extreme weather events such as melting ice, droughts, floods, fires, torrential rains, and heat waves.

November

COP 27 in Egypt closed with a breakthrough agreement to provide compensation funding for damage caused by climate change.

2023

With a dash of aspiration, and a lot of anticipation, but well-anchored in reality and the range of possibilities, Leonard forecasts the near future. Without a magical crystal ball, this is what 2023 could hold for us.

PREDICTIONS

India surpasses China as the most populous country in the world.
High probability

In the technology industry, climate tech leads the way in investment and recruitment.
High probability

Following the COP 27 agreement, the first fund dedicated to building climate change resilience in Southern countries is launched.
Moderate probability

Amid the biodiversity crisis, the first genetically reconstructed mammoth is recreated, opening up the possibility of bringing back many extinct species.
Low probability

The Ocean Cleanup's System 03 begins clean-up of the "plastic continent" currently floating in the North Pacific.
High probability

Off-grid travel is booming: no mobile network, wifi, TV or screen of any kind - complete disconnection.
Moderate probability
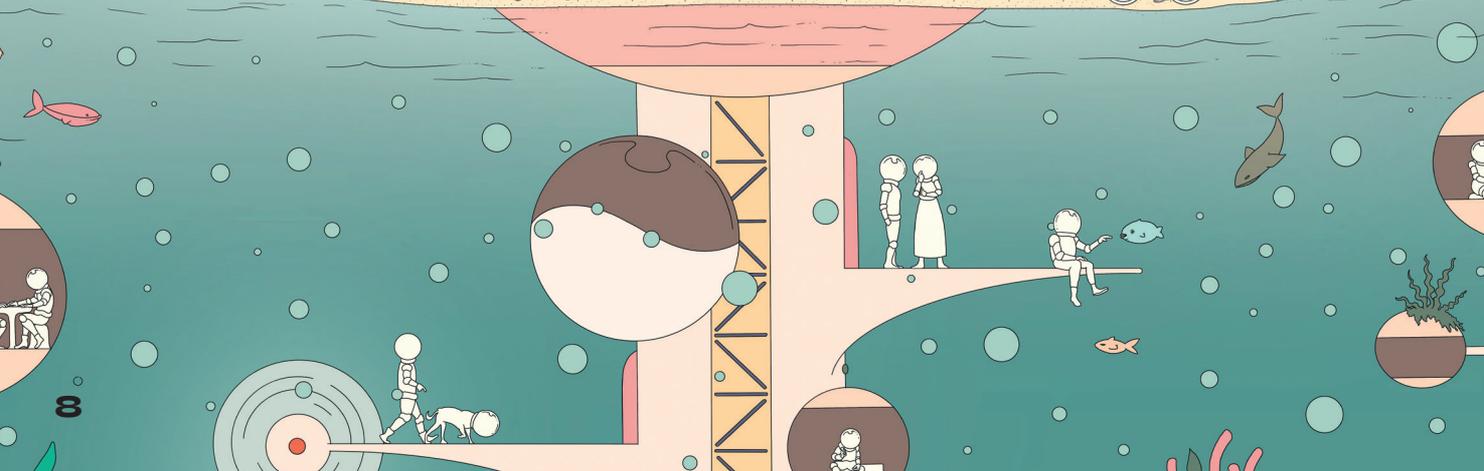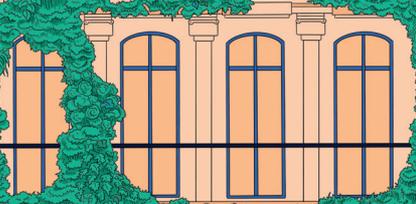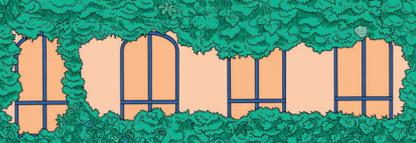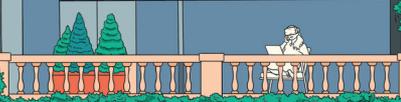
Geographies

As climate change accelerates, the new environmental circumstance is the first of those new worlds that we invite you to explore. Given the urgency of the situation, brainstorming possible ways to mitigate carbon emissions is no longer enough, we must also think about how we will adapt to new extreme conditions. We must build more resilient cities, where more than half of the world's population is already concentrated, reinvent our development and build new cooperations among different territorial levels. The oceans might also hold the keys to this sustainable future. Provided that we do not further weaken their ecosystem, they have much to offer, particularly in terms of energy. Finally, yet another space to be explored is the digital world: will the coming years see a rise in virtual reality? From the metaverse to NFTs, we are on the cusp of a revolution: that of a decentralised, blockchain-based Internet, artificial intelligence and cloud computing. These "geographies" that we describe are new worlds to be explored and opportunities to be embraced.

Cabinet of Curiosities: Towards Resilient Cities

**Philosopher Edgar Morin describes today's world as "a festival of uncertainties". Ecological, economic, geopolitical and migratory crises are posing new risks to cities. In this context, resilience - defined by ecologist Crawford S. Holling as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables"- is increasingly necessary for urban environments.**

"Art of crises and pirate architectures"

When it comes to resilience, rethinking urban planning is self-evident. According to the architect Marco Stathopoulos, author of a thesis on urban resilience[1], "the resilient city is flexible and transformable, [...] risk is part of its foundation, so too are the resources it generates." By definition, this dynamic equilibrium isn't very compatible with fixed outlines. There are, however, observed frameworks that promote urban resilience. A solution manual published in 2021 by the French Plan for Urbanism, Construction and Architecture (PUCA), highlights the importance of "land sobriety which must be combined with the provision of adequate open spaces by integrating water, landscapes, nature and biodiversity in projects. The restoration of land and ecological corridors (green and blue networks) in urban environments is necessary to combat biodiversity loss and mitigate urban heat islands through soil restoration and air circulation." In another study[2], La Fabrique de la Cité reinstates the importance of resource management, the circular economy, new forms of urban agriculture, modular and flexible urbanism and, more generally, taking the transversal 'systems' approach to urban planning. Beyond the more ambitious, large-scale institutional

programmes, when put into practice, these broad principles give rise to more or less structured, always inventive and sometimes surprising experiments. We wish to shed light on these remarkable initiatives in this Cabinet of Curiosities.
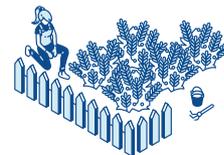
Food: the resilient city feeds itself

Food autonomy among French cities is at about 2%. While it is natural that urban areas do not produce all of their food, adopting 'municipal food' strategies reduces crisis vulnerability and dependence on logistics, while also fostering social connections. In Rosario, Argentina, an award-winning programme provides its poorest inhabitants with access to an empty plot of land. Today, the system is an inclusive agribusiness model. In India, the city of Rourkela has set up community refrigerators to prevent food waste from small produce markets. In France, the startup Cycloponics is reappropriating urban wastelands for food production.

1. Marco Stathopoulos, *Urban resilience: the art of crisis and pirate architectures*, Gollion, Infolio, 2020.
2. Chloë Voisin-Bormuth, "Urban resilience: facing crises and deleterious mutations, bouncing back instead of resisting", La Fabrique de la Cité, 2018.

Density: the resilient city from influx to reflux

In a 2022 publication, engineer Philippe Bihouix makes a case for the 'stationary city', which avoids urban sprawl, all without increasing in density. Instead, he invites us to transform, embellish and make the most of existing infrastructure. Some cities are already exploring forgotten urban spaces. Helsinki, for example, promotes urban resilience with its 'Underground Master Plan', first published in 2011. Its goal is to reduce density on the city's surface allocating a proportion of urban functions to designated underground space. Conversely, in cities such as Baltimore, population is on the decline. The 'smart shrinkage' method of decline ensures continued quality of life for inhabitants through community participation, planning expertise and technology.
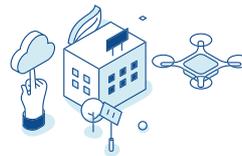

Disasters: the city's resilience to major weather events

Amplified by global warming, the frequency of major weather events is expected to increase. Just as in Aesop's tale of the oak and the reed, many cities are giving up rigid resistance to natural disasters in favour of adaptability. A good example of these new adaptive models is the 'sponge city', designed to work with nature instead of against it. It is achieved through blue grids (natural wetlands) or in the use of new materials, such as porous concrete, Aqui-Por, or the unique draining tiles from Rain(a)Way. In the same vein, in the aftermath of Hurricane Sandy, New York City authorities turned to natural solutions to protect Staten Island against high tides. Based on the developments of a marine ecosystems study, The Living Breakwaters project mitigates risks while preserving natural habitats.

Nature: the city's essential ally

In a 2022 study, researchers from the Institute for Global Health in Barcelona established a fairly simple rule for promoting mental health in the city: 3 - 30 - 300. This figure posits that seeing three trees from your window, living in an area that is 30% covered by vegetation and being less than 300 metres from a park all promote better mental health. The strong correlation between urban nature and health is a strong argument for bio-inspired urban renewal. The biophilic city movement – an approach that seeks to connect occupants more closely to nature - embodies this return to a wilder, less sanitised city.

Smart: technology from risk to solution

When it comes to resilience in cities, digital technology is both a vulnerability and a solution. In this regard, cities such as Rotterdam are developing cyber resilience programmes to protect against cyberattacks. The objective of the FERM programme, for example, is to make the famous Dutch seaport less vulnerable to cyber threats. In addition, digital solutions are being used to optimise resource management. In Germany, the installation of a 'digital twin' at the Cuxhaven water treatment plant has reduced annual electricity consumption by 1.1 million kWh, equivalent to the consumption of 275 households!

"The real mission of urban planning today is adaptation."

Franck Boutté is developing a pioneering approach to environmental engineering and is bringing together urban planning, engineering and architecture to provide transdisciplinary responses to environmental and sustainable development issues. In 2022, he was awarded with the French 'Grand Prix de l'urbanisme' in recognition of his work. Leonard asked him a few questions.

For many years you have been advocating for political and committed urbanism, through a renewed interest in the commons, turning unbuildable areas into sanctuaries, and the concept of TEGPOS, or 'positive energy areas.' What are the conditions necessary for envisioning a sustainable future for cities and their infrastructure?

If by 'sustainable' you mean 'responding to the challenges of climate change,' then urban planning has a new challenge to meet: adaptation. So far, the focus has been on mitigating the drivers of climate change. However, these mitigation strategies are mainly based on extra-territorial, regional, national or even international decisions. Urban planning can play a role, but only marginally. The real mission of urban planning today is adaptation. This is a great challenge that requires a different approach to urban planning, as a contributor to transformation and transition.

What exactly do you mean by 'adaptation'?

The future is largely made up of the present, especially in our northern countries with low economic and demographic growth. 80% of the buildings that will be standing in 2050 already exist today, but hardly any are ready for life in the future. Adapting means asking ourselves where we are today and what risks we are facing and what tomorrow's hazards might be. What is the path from what we know today to what we assume tomorrow will look like? This is far more challenging than mitigation, which attempts to bend global warming trajectories by addressing today's problems. It is a new role for urban planning, much more local, with much more climate-tailored responses. We must find a common ground to envision a more resilient future, and we must be better aware of its limits.

How will this change impact the players involved in urban planning?

Until now, urban stakeholders have been good forecasters, but this change will force them to become futurists to better anticipate, develop trajectories and scenarios, understand the dynamics at work, settle into these dynamics and create the means of adaptation. This is a major change that requires integrating data of a possible future into the present's transformation processes. But this is in line with the way the

IPCC works, for example. And the 'future' is already encroaching on the present: Look at the health crisis or the climate disasters of the summer of 2022. The scenarios are already there.

Do we need to change the way we work?

That is obvious. And it is not a matter of replacing mitigation with adaptation, but of coupling them, to work within different time-frames. Everything must be done to mitigate as much as possible, to minimise impacts; but at the same time, we must adapt our cities, i.e., integrate indeterminacy and hazards into the project, and therefore rethink our approach to 'natural risks', by integrating real-time evaluation methodologies. To take a prospective approach, we must also look beyond the traditional field of urban planning to rely on scientific work or other forms of scenario planning, by calling upon authors and other imaginative people. We need to involve new actors. This is one of ecological engineering's greatest contributions: a transversal approach. This is action-oriented urban planning, which the 2022 Grand Prix de l'urbanisme recognised.

Should this encourage urban planners to consider other fields?

Yes, because adaptation also takes place in the voids and it is necessary to take an interest in them. Voids are unthought of in planning because we only focus on the full, the built-up areas, the infrastructures. However, once we start looking at urban heat islands, voids are essential.

What are the priority issues for urban planning?

As I said, adaptation is the number one priority. But it requires a real change of gear: a cultural, economic, political and social change. It will take courage

to make these important changes. For example, 25% of existing housing is already unsuitable for today's conditions. And it is mainly the poorest who are most vulnerable to climate change. Adapting buildings is therefore not just a matter of urban planning - it is an extremely important political and social issue. These operations are also economically relevant as it requires a change in ambition: rehabilitating existing infrastructure is often more expen-

"Adapting buildings is therefore not just the responsibility of urban planning – it is an extremely important political and social issue."

sive than building new. But addressing land take and biodiversity preservation further complicates the economic equation. Choices will therefore have to be made, but it is only under these conditions that urban planning, which combines social, economic and environmental issues, will be able to serve its mission and contribute to a new, adapted world.

Adapting the city by rethinking the street

In France, more than 20 million people cross or use a street every day. What if tomorrow, this street became 'La Rue Commune ('The Commun Street')'? A group of nationally and internationally renowned actors have come together to meet the challenge: urban planning, landscape and architecture specialist, Richez_Associés, Franck Boutté Consultants, pioneer of environmental design and engineering, as well as Leonard, known for its innovative urban construction and development processes.

There are two ways to build a resilient city: starting from 'above', through urban planning, or on the contrary, from 'below', by bringing public decision-makers, private actors, city planning professionals and inhabitants around the same table to build together. In favour of this second approach, the collective considers the street to be a city's first common good, and that it is in the streets that we will be able to build the post-Covid, post-car and post-carbon city, which brings urban qualities and environmental quality into harmony.

Launched with the support of the French Environment Agency (Ademe), La Rue Commune gathered 25,000 participants to a public consultation between April and June 2022. They received 800 proposals and 200,000 votes in response to the question, 'How can we transform city streets together to meet

Representation of a La Rue Commune project

21st-century challenges?' Nearly 80 experts then worked together to draft a guide and methodology for identifying and transforming potential streets. This three-phase approach aims to help build peaceful, healthy, pedestrian-friendly, and cooler (thanks to trees) cities, with adaptable, dynamic public spaces, strong community life, increased biodiversity, and harvest rainwater using natural cycles. Trials will begin next year before being rolled out nationwide in 2024.

"Once we start looking at urban heat islands, voids are essential"
**Franck Boutté,
Grand Prix de l'urbanisme 2022**

For further information: contact Étienne Bourdais, project manager at Leonard.

Is the Ecological Transition a Local Matter?

French cities are among the first to face direct consequences of climate change and are often considered world leaders in the collective fight for the environment. And yet, ill-equipped, under-resourced, bogged down by tech silos that slow down innovation and partnerships, and acting within electoral cycles that cannot keep up with the climate emergency, French cities seem to be dragging behind. This is highlighted by a report drawn up by the Essec Chair of Urban Economics, in partnership with Leonard.

34,955 different realities that share common difficulties

In a collaborative effort, Leonard and the Essec Business School's Chair of Urban Economics intend to assess cities' ability to identify, organise and strengthen skills needed for the ecological transition. It particularly relies on literature reviews and observations of four regions representative of the country's heterogeneity: the urban area of Aix-Marseille-Provence Metropolis, Lille, the city of Nevers, and the small town of Tarnos, in the southern portion of the Landes department.

Given the regional differences, these four local authorities take different approaches to climate change. However, they appear to face common difficulties. Although the ecological transition is a long-term process, it calls for immediate action. However, the electoral cycle doesn't lend itself to the urgent implementation of monitoring, evaluating, and revision processes. Moreover, what constitutes an urgency varies among the levels of government. Rated by French citizens as a top priority, ecological issues are part of national agendas, but they are rarely addressed by municipal leaders, which have to deal with the often-contradictory interests linked to the local economy.

The issue of scale creates many roadblocks. Ecological issues are among municipalities'

"We will never meet the challenge of sustainable development with technology alone, because, from persistent administrative silos or the gap between strategy and implementation, the barriers to environmental transition are above all organisational and cultural."

Julien Villalongue

main responsibilities, however, decentralisation initiatives in France have left municipalities with very little authority to address them. The regrouping of municipalities into EPCIs[1] was supposed to help regions develop transition plans on a more relevant regional scale. Instead, it diluted their competencies, and they struggle to implement strategies given the divergent political interests of communities often comprising more than 100 municipalities.

In addition, cities are bogged down by organisational silos. It is difficult to achieve the interconnectivity essential for tackling environmental challenges when technical divisions are managing multiple, isolated systems. The fragmentation of competencies makes it difficult for private partners to identify the relevant contacts to coordinate expertise to bring about real change. These structural obstacles also hinder innovation and the development of risk culture, which are essential for inventing new solutions to new problems.

Doing better together

A partial solution to the lack of interconnectedness is better public-private partnership opportunities. The development of comprehensive engineering is the central theme in the Essec and Leonard report, which demonstrates that we must revise our economic models and our approach to public procurement. Following the lead of Barcelona and London, the private sector can help municipalities define their environmental planning by making up for the lack of support from the State's deconcentrated services. Technological improvement is therefore just as important as cultural change if we want to make the ecological transition a reality on a local level. No organisation or governing body alone can meet the colossal challenge of climate change, but with coordinated effort and support, we can improve the effectiveness, clarity, and acceptance of public action.

For further information: contact Isabelle Lambert, Head of Foresight at Leonard.

1. Public inter-municipal cooperation establishment.

Exploring the Challenges of a Sustainable Blue Economy

Our oceans and seas offer many opportunities for employment, innovation and solutions to global challenges. But given the impact of climate change on marine ecosystems, we must protect their resources and biodiversity from business development more than ever. From decarbonising ports to marine renewable energies, and coastal protection to sustainable fishing, how can we build a sustainable blue economy?

They make up 70% of the planet's surface, providing invaluable economic, social, environmental and cultural services. The extent of their fantastic biodiversity is still largely unknown, and they harbour potentially ground-breaking solutions to climate change's challenges. But oceans and seas also make up a heavy economy, equal to 3,000 billion dollars per year by 2030 and at least 40 million jobs according to OECD estimates. Despite the constant development and monitoring, they are still poorly regulated. Therefore, if we want to secure their future, it is high time we consider a more sustainable economy for maritime and coastal areas. This is the purpose of the 2022 conference cycles organised by Leonard and the Sustainable Ocean Alliance (SOA). Here are some of the lessons we've learned.

Investing sustainably: the challenges of the sustainable blue economy

Is the sea an economic and technological promised land? The heart of the problem is our reliance on marine and coastal environments for resources: fish populations are already being depleted, ocean acidification is increasing and biodiversity is collapsing. "For a long time, we have been talking about conservation, but what can we conserve now that we have destroyed a large part of the ocean? We need regeneration," says Christian Lim, Managing Director of SWEN Capital Partners. Innovation is the key because almost everything remains to be invented when it comes to the sea, as Catherine Chabaud, former sailor, MEP Deputy and former Delegate to the Sea and the Coast, reminds us. We need to design infrastructures that will have a positive impact, particularly those that help decarbonise maritime transport and ports. Ocean decontamination techniques, both upstream and downstream, require innovation. Furthermore, marine renewable energy development is a new frontier in the energy transition, provided we can preserve these endangered areas and deplete as little of their resources as possible.

Financing solutions are crucial in achieving this. Both public and private funds will be needed to boost investments in the blue economy, which are still too often slowed down or redirected towards priorities deemed more urgent or profitable. A significant overhaul of maritime governance will be needed to align global operations with a goal and encourage cooperation, while simultaneously saving the ocean from overexploitation.

The sea as a collaborative space

Half of the world's population lives within 150 km of a coastline, and 90% of the world's goods are carried overseas. Yet, the human relationship with the sea is more strained than ever. The threat of large-scale displacement caused by rising sea levels provoked by climate change is challenging our relationship with coastal areas. Long seen as a threat, coastal evolution is increasingly understood as a natural movement that we must learn to live with. We realise now that we cannot dominate the sea, we must instead learn to live with it and open a field of possibilities that until now were mere science fiction.

The time has also come to revolutionise our ports. As essential cogs in our consumer societies, not only do they face the challenge of decarbonisation and digitalisation, but they also must find their place in a more sustainable future. Will they be able to catch the wave of renewable energies, by becoming offshore energy production and distribution hubs? Will they be able to contribute to the transformation and sustainability of decarbonised economies, both at sea and on land? One thing is certain: Earth's future is also unfolding at sea.

For further information: contact Ludivine Serriere, project manager at Leonard.

Marine Renewable Energy is Making Waves

While renewable marine energy only makes up 28% of the world's power generation mix, it is expected to account for 90% of global capacity expansion over the next five years[1]. Renewable energies are already one of the main assets for achieving the climate objectives for 2050. While onshore solar and wind power have made up a large share of the market for a good decade, many are now looking to the sea. Marine renewable energy (MRE) could provide up to five times[2] our global electricity needs. In a series of conferences organised with the SOA (see p. 17), Leonard took a closer look at this new energy frontier.

The promise of the elements

In the energy lottery, the ocean is the big winner. The International Energy Agency estimates the ocean's production potential to be 20,000 to 90,000 TWh/year (excluding wind power). In comparison, global consumption is around 16,000 TWh annually. The European Union owns the largest exclusive economic zone in the world, i.e., the largest maritime territory, with 18 million km^2, of which France alone accounts for over 10 million. The EU has announced its intention to increase its meagre production capacity (excluding wind power) tenfold, from 1 GW in 2030 to 40 GW in 2050[3]. French MPs have been working on a 'Renewable Energy Acceleration' bill, a short-term response to the energy crisis that includes a section dedicated to offshore wind power. However, even in a crisis, the development of these renewables is far from revolutionary.

And yet there is no shortage of choice when it comes to marine renewable energy. **Tidal stream generators** harness energy from currents much like an underwater wind turbine. **Tidal barrages** use the ebb and flow of the tide in moving in and out of a reservoir. **Wave power** uses devices in the open sea or near the coast to harness the up-and-down motion of the waves. **Hydrothermal energy** or **ocean thermal energy conversion** uses the temperature difference between deep and shall seawaters, while **osmotic power** is the energy available from the difference in the salt concentration between seawater and river water.

We could also count offshore wind, whether floating or fixed-bottom. With nearly 15 GW installed in Europe, **offshore wind** is probably the most developed offshore renewable. Its global market is estimated to reach 86 billion dollars by 2026, 90% of which will be in the EU. We could also consider SWAC (Sea Water Air Conditioning), an air-conditioning system that uses deep cold seawater to produce cool air. Although it is not technically considered marine renewable energy, it has enormous potential, especially in regions where cooling electrical systems is a critical energy issue in itself.

Clearing the fog on the horizon

First, we must reach a technological consensus. There is nothing new about these technologies as far as the concept goes; we have known of their potential for centuries. But transforming motion into electricity is a technical dilemma that requires innovation, and few are yet to agree on how to achieve this. This makes it difficult for potential investors, public authorities or entrepreneurs to navigate the ocean of possibilities. In tidal stream technology, for example, it seems that

1. "Renewables 2022" report, International Energy Agency, December 2022.

2. Renewable marine energies, ecologie.gouv.fr.

3. EU Strategy on Offshore Renewable Energy, November 19, 2020.

there is a convergence towards horizontal turbines, but the arrival of tidal kites, which can harness energy from weaker currents, is shaking things up. Wave power is still relatively immature. Of the ten technologies in the running, there is still no convergence in sight.

Then, there is the financial challenge. Convincing private investors is not as straightforward as for other types of renewables; only the most mature technologies benefit from traditional venture capital schemes. However, MRE remains uncharted territory where everything has yet to be invented, and crossing the first 500 MWh mark is a critical step that few entrepreneurs reach. Public money is coming in, but slowly. The EU has invested more than four billion euros in 10 years towards development in the sector, but this has mainly benefited the already tried-and-tested offshore wind sector. The competition among renewable energies should not be minimised either. The sea may be vast, but each concession is snapped up at a high price, and here again, the more mature technologies have a greater chance of gaining support. Especially since these projects often face political or citizen opposition, and the 'Not in My Backyard' phenomenon, as is the case for many wind farm projects in France. Timing is crucial, however, and the EU will have to invest massively, and quickly if it still wants to be in the race, because China and the United States are hard at work, with targets of 200 and 86 GWh respectively by 2050.

Finally, there is the political and regulatory issue: marine energy development frameworks remain vague and uncoordinated. Initiatives are emerging, through a series of European or national investment plans, but don't define any go-to areas to guide industry players. Stability and leadership are lacking in this Wild West, because "like politicians, economists think in five-year periods," as Irina Lucke, Division Manager of Omexom, pointed out at the round table organised by Leonard and the SOA. "One of the main challenges facing the marine energy sector is to set clear targets. If we want to tackle climate change and help MRE take the next step, we need to discuss our priorities and multi-uses as soon as possible, and avoid the mistakes made with offshore energy."

The virtues of multi-use

Multi-use is one of many reasons to believe in MRE's future. Every square metre is precious in this endangered natural environment. One possible framework for MRE development is marine energy farms that combine several technologies, including wind turbines and tidal turbines, and thermal. Compared to land-based renewables, MRE technologies are much more efficient in terms of the yield/size ratio: since water is denser than air, the kinetic energy yield from tidal turbines is estimated to be 830 times greater than wind turbines. A single marine energy farm could thus easily combine complementary technologies, thereby compensating for intermittent, single technologies.

Also possible is the continual decline in production costs, as is the case for land-based renewables, reaching around 2030 at €0.10 / kWh for the most mature technologies[4]. MRE innovation is also crucial for maintaining Europe's competitiveness in the renewable energy sector, especially when the economic sovereignty and independence of coastal communities are on the line.

4. Strategic Energy Technology Plan, European Commission, 2021.

An opportunity for coastal and littoral areas

Marine Renewable Energy could provide 500,000 jobs by 2050[5], especially for coastal or island communities particularly touched by the negative impacts of deindustrialisation and ocean economy expansion. They offer an unprecedented opportunity to revitalise and decarbonise ports by converting them into energy hubs. Also, since more than half of the world's population lives within 150 km of the coastline, local communities would benefit from the decentralised energy production, ultimately allowing for energy autonomy. The energy produced in proximity to its final consumers also reduces its infrastructural carbon impact.

Multi-use would prevent energy production infrastructure sprawl and could encourage the development of recycling technologies, which are still in their infancy, to give a second life to wind turbines, for example.

The future of Marine Renewable Energy has yet to be written, much of which depends a great deal on political choices and investment priorities. However, they have, as we can see, much to offer in the evolution of our energy mix. They could be the beginning of a virtuous cycle, provided that we do not repeat the mistakes of the past. It's time for maritime stakeholders to work in the direction of the current.

5. "A study into the potential value offered to Europe from the development and deployment of wave and tidal energy to 2050," ETIP Ocean, 2021.

Four Pioneers in the Sustainable Blue Economy, Supported by Leonard

Offshore Windfarms: predictive maintenance of offshore wind turbines using AI

According to the European Energy Agency, offshore wind could become the leading source of energy in Europe by 2050. With more than 7,000 turbines already installed worldwide, the market is fast-growing. But wind farm operation has its share of difficulties, particularly in maintenance. The slightest technical problem can incur a loss of tens of thousands of euros per day, but difficulty in accessing installations makes them difficult to anticipate and correct. When a generator breaks down, the wind turbine is out of service for more than thirty-five days. Offshore Windfarm, developed by Omexom Offshore (VINCI Energies) as part of Leonard's AI course, is a predictive maintenance solution based on artificial intelligence. It helps anticipate generator failures to programme replacements and thus limit its time out of service. The system relies on a wind turbine's pre-existing sensors. By comparing a wind turbine's current performance with a present standard performance, the system alerts the operator, who either orders the necessary parts or requests a repair on the vessel. Since its first trials in Germany, Offshore Windfarm has detected more than half of failures on an average of 180 days before they occur.

Observareo: offshore wind turbine blade inspection is made easy with drones and AI

Inspecting the blades of wind turbines installed in the open sea, several kilometres from the coast is not an easy operation. The process requires a team of technicians, and for at least twelve hours, each turbine must be immobilised. This represents a significant loss for the operator. Lennart Reepschläger (Omexom Offshore) proposed a lighter, but equally effective technique for inspecting blades' condition and compliance with regulatory requirements: drones and AI analysis. With the support of Leonard's intrapreneurship programme, Lennart was able to put his Next Level Rotor Blade Service to the test. The results? Average downtime was reduced to one hour and a half and intervention cost was divided by six. His system has already found its first clients and has convinced the German regulatory authorities, which granted it the accreditation to carry out four-year inspections.

WaveX: waver power at your fingertips

This startup project led by Thomas Allen and Clément Puech, backed by Leonard's 2023 SEED Acceleration programme, is developing solutions for recovering wave energy. WaveX's proprietary technology is lighter, cheaper and easier to install than anything on the market, with an estimated worth of nearly 20 billion dollars. Installed on the seabed a few kilometres from the coast, turbines are buried so as not to disturb ecosystems, and can even combat erosion and dredging. Available in various capacities, WaveX can be deployed in small 0.3 MW units for isolated island communities or in 1.5 MW devices for larger networks. After an initial proof-of-concept phase in 2021-2022, prototype testing will begin soon.

Geocean: the SWAC leader in decarbonising air-conditioning

SWAC (Sea Water Air Conditioning) technology cools buildings by pumping water from the depths of the ocean and circulating it in an open or closed loop, thus saving energy on air-conditioning. In 2021, Geocean, a subsidiary of VINCI Construction Grands Projets, won a contract to equip Taaone hospital in French Polynesia with the world's longest SWAC. The goal is to save the hospital nearly €3 million a year on its electricity bill. The company had already installed a SWAC at The Brando hotel on the Tetiaroa Atoll in 2011.

Metaverse: Somewhere between the New Frontier and Augmented BIM

Between sci-fi fantasy and the "future of the Internet", the metaverse remains a difficult concept to grasp. Without bringing about an immediate revolution for the building and infrastructure sector, it raises a certain number of interesting questions, particularly regarding the future of Building Information Modelling (BIM).

Metaverse, a construction sector 2.0?

The current concept of the metaverse remains largely cloudy, giving rise to as many definitions as there are experts on the subject. Perhaps the most interesting definition for the construction and energy sectors is that of a 'new digital territory'. It raises the issue of digital living and workspace structures, which both create new technical constraints and engage more traditional skills. As Roblox founder Niel Riemer explains, the metaverse's success is directly tied to user-generated content. Without activity or creators, the platforms remain powerless – even Meta recognised this when it admitted that its Horizon Worlds was desperately empty. This is where architects come into play. For them, the metaverse is a playground with limitless possibilities. It's the opportunity to explore the idea of 'virtual public space', to give free rein to creativity often restricted by the heavy constraints of reality, the opportunity to revive places that no longer exist and to test real solutions in a virtual sandbox.

Metaverse real estate: just a mirage?

In 2020, artist Krista Kim sold the first NFT (non-fungible token) house for $500,000, branded the Mars House. The euphoria around the concept of the metaverse then caused a sort of digital land rush. The record for the most expensive land sale in the metaverse was when real estate firm Realm Republic purchased $4.3 million worth of land on The Sandbox. Today, the various platforms have not (yet?) found their audience and prices have collapsed (-97% between November 2021 and June 2022 on The Sandbox and Decentraland). This hyper-volatility can be attributed to a whole range of factors: 1) Metaverses are still in their early stages and have not won over the general public. 2) The digital space is almost infinite, so it's harder to create scarcity. 3) If a platform ceases to exist, so do its goods, which constitutes a significant risk for investors!

New trades for the construction industry?

Long decried for its inertness, the construction industry has recently undergone a major digital transformation. The BIM sector in particular has given rise to a whole new range of professions (BIM manager, modeller and coordinator, to name a few). The metaverse's promises are an extension of this transformation, and some professionals are seizing the opportunity. Take Alexandre Ogar, who refers to himself as an "architect and designer of virtual buildings for the most popular metaverses such as Somnium, Cryptovoxel, The Sandbox and Decentraland." Apart from construction, the metaverse is getting in on the action when it comes to infrastructure and city management methods, allowing for the invention of new jobs. With Metaverse Seoul, the Korean capital is a pioneer. The platform is designed as a digital twin of the city, allowing residents to access new services while consolidating maintenance and urban planning tools. To make this project a reality, the city plans to create 40,000 jobs, from virtual receptionists to specialised developers. The mayor himself is even playing along by answering questions from his constituents about the new virtual space.

Metaverse in the workplace

The metaverse is full of promises regarding the future of work in the construction industry. Once again, it's a matter of pushing BIM's potential to the max by offering more immersive environments that facilitate remote collaboration – even on complex topics. The Wild is a startup that describes itself as the platform for "VR collaboration for the construction industry". It has identified five main benefits of working in the metaverse for the construction industry: remote collaboration, rapid prototyping of architectural variations, immersive BIM coordination, live testing of finishing options with clients, and full-sensory project presentations to stakeholders.

Before the metaverse, digital twins?

One of the most ambitious definitions of the metaverse undoubtedly comes from the famous VC Matthew Ball, who describes it as being a persistent, synchronous and 'live' universe capable of creating a sense of presence while offering a fully functioning economy. This sci-fi fantasy worthy of Ready Player One is probably still relatively far from our everyday lives. That said, the first industrial metaverse opens the door to significant transformations. The now-famous digital twin technology is indeed becoming essential in most sectors of industry. It's used in construction to simulate virtual models to optimise a building's operations, limit its consumption and make adjustments throughout its lifecycle. They represent a form which culminates the principles of BIM. The BIM d'Or 2022 awards have also awarded a certain number of projects which use Digital Twins, such as the digitisation of Eaux de Paris' existing assets to help reduce future maintenance work costs by facilitating virtual visits and documentary research.

Beyond the professional and technological dimension, digital twins can be used to create new forms of immersion, time travel, or even the emergence of 'immobile' tourism. The Venice Revealed exhibition at the Grand Palais Immersive in Paris is a good example of this trend. Thanks to photogrammetry, this virtual experience enables users to visit the City of the Doges and discover its history without leaving Paris.

Building in the metaverse, an environmental ambiguity

Building in the metaverse intuitively represents a considerable saving in energy and raw materials: digital administrations, virtual showrooms and offices in VR consume less than the real-life construction industry, which today represents approximately 38% of global CO_2 emissions. At the same time, Intel estimates that implementing the metaverse will require a thousand-fold increase in available computing capability. While digital technology represents 3 to 4% of global greenhouse gas emissions, it's the promise of uncontrolled growth of digital technology's impact. In short, the metaverse can be virtuous, but only if there's a massive transfer of uses to the digital world.

Stories from the Virtual Worlds

In a round-table discussion organised by Leonard as part of the Building Beyond festival last June, several experts were invited to present their vision of the metaverse and to explore its possible fields of application.

"Ownership is a key notion if you want to build on Web 3 and the metaverse. I own my house, why shouldn't I also own my digital assets? Keep in mind that, for the younger generation, there is no distinction between real and digital."

Kristofer Moisan
CEO of Wytland

"The metaverse is a new universe. We're going there to discover, to understand it, to explore its new applications, to meet people there, such as experts in new technologies who will potentially help us build the insurance of tomorrow."

Cyrille Magnetto
VP Innovation of Axa France

"Covid has increased user demand for digital content, and in particular it has increased the sale of standalone VR headsets."

Jeanne Marchalot
Head of the France TV StoryLab

"Armies have been working on the concept of digital warfare for several years, but the metaverse adds another dimension, especially in terms of information manipulation and shared reality. When the platform you are on dictates your reality, it is very difficult to know whom to listen to and how to orientate yourself."

Jean-Baptiste Colas
Defence Innovation Agency of The French
Ministry of the Armed Forces

"I don't believe at all in a metaverse that requires us to wear headsets. Little by little, we will stop using terminals and end up with retinal implants. The metaverse, therefore, converges with transhumanism: the metaverse will become natural as soon as it is integrated into our bodies. I'm not saying it's good, but that's where we're heading. From an ethical point of view, the metaverse is the most relevant subject today."

Benoît Baume
Founder of Fisheye magazine
and the VR Arles Festival

Why do Blockchain and Metaverse (often) Go Together?

As a revolutionary way of storing and transferring information over the Internet in an immutable, secure and without trusted third parties, blockchain can be used to build the kind of digital ecosystem that metaverse advocates dream of.

A revolutionary technology for some, a Ponzi scheme for others; blockchain never ceases to provoke bitter debates. In 2022, in addition to explosive news of the cryptocurrency crisis, Leonard analysed blockchain technology over the course of several foresight workshops, particularly as it relates to the metaverse. The metaverse is at the crossroads of several cutting-edge technologies, including video games, persistent worlds, virtual and augmented reality, and blockchain. The latter is a revolutionary way of exchanging information securely, immutably and without a trusted third party on the internet. One of the most popular uses of this technology is to transfer value, for example through cryptocurrencies.

The Internet of value

Bitcoin, one of the first examples of blockchain, illustrates its principle well. If I send a document or an image by email or through social networks, the document or image will exist in two copies, on my computer and on the computer of the person I sent it to. But if I make a payment in bitcoins, the money is naturally not duplicated: thanks to its blockchain, it leaves my virtual wallet and goes to the recipient. Of course, the same result can be achieved by transferring euros through one's bank, but then one has to go through a trusted third party (the bank), which has some control over the transaction. With blockchain, there is no need for a third party, and transactions can therefore be carried out freely and anonymously. Although the exchange of virtual currency is currently the best-known use of the blockchain, the uses of this immutable, secure, and decentralised database go far beyond that: it can also be used to host contracts, store digital works of art or trace the value chain of a product.

From NFT to metaverse

NFTs (Non-Fungible Tokens), which were much talked about in 2022, are unique digital identifiers recorded in blockchains, which allow for the value of assets, especially virtual ones, to be traced on the internet.

They are used to sell digital artworks, such as the famous Bored Apes, portraits of anthropomorphic monkeys wearing caps, gold chains or military helmets or shooting lasers with their eyes, which sell for the equivalent of hundreds of thousands of euros in cryptocurrencies. They can also be used to sell videos and music albums; Linkin Park singer and guitarist Mike Shinoda sold his fans an exclusive playlist, called 'Ziggurat', in the form of NFT.

What does this have to do with the metaverse? One of the objectives of the latter is to build a virtual universe composed of a multitude of interconnected worlds, each with its ecosystem and economy. Blockchain's properties make it the ideal tool for creating and transferring digital property in these virtual worlds.

In the metaverse, NFTs can, for example, be used to buy an avatar for one's character, but also items to become more powerful in a game. Above all, the blockchain and NFTs make it possible to set up a real parallel economy: for example, a virtual community

that wishes to develop can thus distribute a digital currency to each of its members in the form of digital 'tokens.'

Blockchain and decision making

In addition to making financial transactions in the metaverse possible, these tokens confer a kind of digital property title. Their holders own a part of this virtual universe and can therefore vote to influence its evolution (extend the universe, welcome new members, change the appearance or the rules, etc.).

Indeed, the decentralised aspect of blockchain makes it an excellent tool not only for exchanging value without a trusted third party but also for democratic decision-making on a large scale, with each participant in the network using the blockchain to vote rather than to transfer value.

This is the idea behind Decentraland, a virtual world where participants can play various types of games, but also meet people virtually, educate themselves and visit digital art exhibitions. Decentraland is not owned by a company but by the community of players: it is a Decentralized Autonomous Organization built using blockchain. The platform has its own currency, the MANA, which allows its holders to make in-game purchases, such as acquiring plots of virtual land, but also gives them decision-making power within the community.

Inventing new means of interaction

Some brands are already banking on the potential of this online community: Vice Media has opened an office in Decentraland, while Samsung has unveiled one of its new phones in its virtual shop located on the platform. Because through blockchain, NFTs and the metaverse, new forms of online communities are developing, as are new ways of interacting with each other. The sporting goods retailer Decathlon has tried this with its Barrio project, in which a pair of football boots designed by football champion Séan Garnier was sold, backed by an NFT.

The latter allows its holders to access a variety of exclusive content, including a live video with Séan Garnier and access to confidential information about the shoe design process, as well as the Barrio Club, a virtual world where the community can express its views on design choices for the rest of the range and enter competitions to win prizes.

It is a very volatile sector, as illustrated by a depreci-

Blockchain's properties make it the ideal tool for creating and transferring digital property in these virtual worlds.

ation of the main crypto actives and the spectacular crash of the American platform FTX in 2022. However, blockchain, and its new perspectives online, are worth following.

Compasses

To navigate the new worlds, and guarantee that they are sustainable, we need "compasses" to guide us. Among them is the vision of an industry which would integrate environmental challenges, use digital technology in performance development, and invent means of production. However, there is a demand for improved risk management, whether they're physical, environmental, digital, health or psychosocial. From this perspective, digital tools offer many opportunities to guarantee better safety and simplify infrastructure maintenance, a crucial issue for the construction, energy and mobility sectors. Finally, to be able to navigate these new worlds, we must also redesign mobility for the future, in a way that is connected, decarbonised and multimodal. Our best ally? Green hydrogen.

Sustainable and Local: The Industry's New Clothes?

Re-establishing the country's industries after years of outsourcing is one of the major challenges for the next few years, in efforts to revitalise the French economy and reinforce its sovereignty. However, faced with an environmental crisis, reindustrialisation must take its environmental impact and sustainability into account. From renewable energies to digitisation, to circularity — what will tomorrow's industry look like?

"Strongly urge the individual who wishes to undertake an establishment to succeed, and if he needs the protection of the king, you can assure him that he will be without it". If we disregard the reference to royalty, this sentence could have been uttered by any current political representative. It is actually due to Colbert, famous for having encouraged (proto-) industrial activity in the 17th century. At that time, France was lagging behind its neighbours, weakened by the poor production quality and a lack of circulating capital. This situation resembles that of contemporary history, marked in Europe –and particularly in France– by widespread deindustrialisation. France's performance is inadequate, with industry accounting for 10.1% of GDP (compared to 16% in Europe and 28.3% worldwide). In light of this observation,

public opinion and political representatives across the political spectrum are calling for 'neo-Colbertism,' to re-establish French industry and productivity. The arrival of Covid in 2020 revealed that French sovereignty is in jeopardy. This is also evident in the everyday economy; It comes down to competitiveness, employment, and even national pride.

While this enthusiasm is commendable, the reality is that today's world has little in common with that of Louis XIV, and therefore faces a different set of challenges. Industry accounts for 40% of global energy consumption and 9.4 Gt of CO_2 emissions per year, increasing 70% since 2000. The new generation of industries will therefore have to take part in the energy transition, energy sobriety and addressing the environmental crisis. Sustainable reindustrialisation implies major transformations in our production methods to meet the colossal challenge of climate change.

Overcoming major industrial contradictions

"The main challenge is drastically reducing negative externalities" says Anaïs Voy-Gillis, geographer and expert on industrial issues. During the conference series, 'Industry and low-carbon territories,' organised by Leonard, she bluntly laid out the industry's

road ahead: We must reduce CO_2 emissions and resource consumption, including land. This last point is crucial for meeting the goal of zero net land degradation and calls the use of industrial wastelands into question. For example, the transformation of the Renault factory in Flins demonstrates the possibilities for rehabilitating industrial sites. Dubbed 'Refactory', the project aims to become Europe's first factory dedicated to the circular transportation economy. The transformation of the former car assembly plant has already begun, turning it into a site dedicated to battery recycling, retrofitting and providing circular economy training.

Beyond land use, the externalities from energy systems and emissions are undoubtedly even bigger constraints. The national low-carbon strategy requires that by 2030, cut emissions levels to equal those of the 1970s, which demands massive investments in decarbonisation solutions. At the same time, energy costs add additional constraints and limit the Old Continent's competitiveness, which is trapped by its energy dependence. Before we can begin to even discuss reindustrialisation, we must save what already exists. One example of the effects of this competitivity crisis is Duralex, which was forced to temporarily close down the furnace in its factory in La Chapelle-Saint-Mesmin.

Industry 4.0: when the tool is adapted to the challenge

Despite threats to the reindustrialisation effort, it is far from doomed. Indeed, rapid technological developments can overcome, at least in part, energy and ecological roadblocks. Circular processes such as heat recovery and improved energy efficiency support the development of an industrial system that consumes less energy and is less dependent on fossil fuels. In Dunkirk, for example, ArcelorMittal's blast furnaces are connected to the city's heating network. According to the network operator, Dalkia, this prevents 20,000 tonnes of CO_2 emissions each year.

On a global scale, Danone plans to increase its energy efficiency by 30% by 2025, and 50% by 2030, thanks to the massive use of renewables (including biomass and biogas) and hydrogen at its 182 production sites. This rapid industrial transformation now has the support of another important ally: digital technology. Much like software versioning, revolutions in the industrial sector are numbered. Although the count is somewhat arbitrary, it does help illustrate the transformations that are taking place. Today,

what we refer to as 'industry 4.0' is the digitalisation of manufacturing, accompanied by optimisation and automation. This fourth industrial revolution is intrinsically linked to sustainable reindustrialisation, which relies on technical performance to compensate for labour costs or environmental constraints. AI software, such as Energiency, uses data to compare a factory's production rate with energy costs. With this real-time comparison, the plant then optimises production rates or operating hours according to the most advantageous rates. Also at ArcelorMittal, the startup Metron has created a digital twin of the preheating furnaces at the Le Creusot site, which can predict reductions in efficiency.

A test in political will

The technical aspect alone is not enough to explain the success or failure of reindustrialisation. From investment plans to protectionist tendencies and regulatory adaptations, the future of the industrial sector is highly political. The United States' recent implementation of the Inflation Reduction Act in August 2022 is one such example. It includes a whole series of protectionist measures, such as subsidies, incentives, and national preference clauses linked to the expansion of renewable energy. This is a big blow to Europe, whose major industrial players are already eyeing Uncle Sam. Such is the case for the Italian company Enel, which just announced plans to build a solar panel manufacturing facility there. Trajectories within Europe are diverging. This is what Anaïs Voy-Gillis referred to when she compared France's 10-billion-euro buyout to promote energy competitiveness to the 200-billion promised by Germany. In this contrasting picture, the only remaining consensus is the need to continue an effort that, in the years to come, will require real political courage.

"VINCI's objective is to use 90% low-carbon concrete by 2030"

The construction industry is developing new ideas, such as waste reduction, reusing raw materials, and low-carbon concrete, to reduce its environmental impact and promote circular models. Isabelle Spiegel, Environment Director at VINCI, reviews the major advances in circularity, the innovations emerging to avoid dependence on limited resources and how businesses are renewing their approaches in the light of this new economic model.

Why is the circular economy so important for the construction and infrastructure industries?

Firstly because the negative impact of resource extraction is a huge challenge for the construction industry. Secondly, because the circular economy is an opportunity to innovate and reinvent our businesses. It is an occasion to innovate and circularly reinvent our businesses. Quarries are excellent examples. Through its Granulat+ offer, VINCI can convert certain sites into recycling facilities. The aim is to continue to sell and use materials (sand, aggregate, etc.) of recycled origin, to limit dependence on limited primary natural resources.

How does innovation promote circularity in the construction industry?

There are many avenues. The first is to integrate materials from the circular economy - recycled or reused - into our processes. In road construction, sub-layers have long been made with recycled backfill. Innovation is building roads using 100% recycled materials, and pushing the limits as far as possible so we can analyse new technical or maintenance constraints. Innovation is also the on-site recycling of materials to limit transport costs and emissions. The mobile TRX unit, therefore, recovers elements from the road's upper layer and then reprocesses them to use on the new pavement.

There is much talk about the impact of cement, which is the most carbon-intensive component of concrete. How can it be integrated into a circular supply chain?

There are two leads. I have already mentioned the first one , which is to recycle concrete into aggregate. The other option is to do without cement, replacing it with something else, either partially or completely. Today, when making very low-carbon concrete, we use steel slag instead of cement, for example. This material is a waste product from the steel industry, but it exists in limited quantities. This is where we can innovate, by looking for other materials to gradually replace cement as much as possible.

How does circular logistics fit in with the zero net land degradation objective?

At VINCI, we use the concept of urban recycling. This involves renovating or rehabilitating a pre-existing part of the city, such as an industrial wasteland. We are currently working on a proposal for an integrated offer on this subject. VINCI Immobilier, the group's developer, has set the objective for zero net land take for 2030, i.e., twenty years earlier than envisaged by the Climate and Resilience Act in France. Added to this is the goal of reaching 50% urban recycling

within the same timeframe. The athletes' village for the Paris 2024 Olympic Games, which is located on a former industrial site in Saint-Denis, is symbolic of this ambition. The site's primary purpose was to supply electricity to the Paris metro system. It is an industrial building that is to be completely rehabilitated. The project is all the more interesting in that it is intended to be reversible: it will become a housing and office space after the Olympic Games.

How should the development of a circular supply chain be promoted?

One of the most important factors is changing standards and habits. We work in highly regulated businesses. While this is necessary, it sometimes hinders innovation. A very interesting advance was made in the concrete industry since technical and environmental performance will now determine norms instead of precise quantities and qualities of the materials to be used. This opens up prospects for innovation and greater use of recycled materials, provided that the performance criteria are met. Another factor is testing and experimentation. To develop the 100% recycled road, we can draw on the expertise of VINCI Construction's Roads and Networks Division and make it available to VINCI Autoroutes. Once we have tested a solution and demonstrated its effectiveness, it's ready to be expanded and hit the market. Scaling up is a real challenge today, and to achieve this, we must successfully reassure people of the performance of recycled products.

How can cultural shifts be encouraged?

We can think about the different marketing approaches. The Sølar product comes to mind, for example on which we don't specify which part of the final product is recycled. We sell, first and foremost, the technical quality of its given use. This is a performance-based approach to circularity. We also need to make the right tools available, such as the R.used digital platform, which encourages reuse by putting unused materials and equipment back on the market once a project is finished. The idea came from some group's employees who noticed a lot of waste.

## "To expand applications of the circular economy, we need to change our standards and habits."

In terms of industry foresight, how do you imagine the near future?

First, it's a matter of expanding applications. We have some good, concrete examples, but we are not ready for use on a mass scale yet. We also need to design supply chains compatible with certain solutions. Logistics today is not designed for circularity. Very quickly, distance and storage make reuse difficult. This means more localised facilities must be developed. Certain avenues of innovation must also be explored. On the subject of cement substitutes, there are technical innovations that have yet to be applied, such as limestone fillers or metakaolin.

A final word?

Let's remember the hierarchy of the circular economy: the priority is to prevent the use of materials, before recycling them. With this in mind, we are developing innovative offers such as Recy(clay)ble Formworks. This is a concrete beam in which we integrate vacuum inserts; when the beam is cast, we will use clay to limit the amount of concrete used. This allows us to use less material without compromising on strength. First is prevention, and only then can we call upon reuse and recycling.
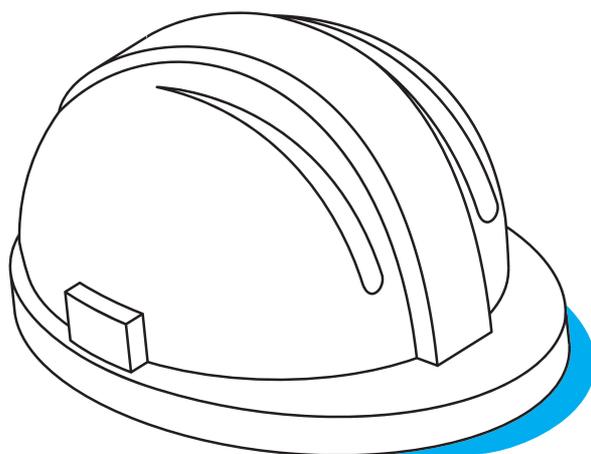
The Huge Challenge of Risk Management at Work

The construction sector is by definition a high-risk sector. From spectacular scaffolding to the most powerful machines and sometimes dangerous products: the slightest deviation can have dramatic consequences. Construction companies have been aware of the danger for decades and have made the reduction of physical risks their number one objective.

The 'zero accident' objective is central to VINCI's strategy and has seen encouraging results. In 2021, 73% of the Group's companies had no lost-time accidents. At the same time, new, diffuse risks (such as environmental, digital, health or psychosocial), are emerging among the industry's companies. Although these threats do not directly impact employees' physical integrity, they require new approaches.

The recurring theme of physical security

Although risk mapping has gained traction, the prevention of physical accidents remains a central concern. Over the course of his or her career, an employee in the construction industry suffers an average of 2.5 work-related accidents. From an economic point of view, eight million working days are lost each year in France due to occupational accidents and diseases. In response, companies are setting up safety training and risk awareness programmes, and striving to make use of technical innovations. Connectivity, artificial intelligence and robotisation promise better safety. The goal of

Robots for Site, a joint venture between VINCI Energies and VINCI Construction, is to use robots to reduce drudgery. The team is currently developing a tiling robot and a drilling robot that uses artificial intelligence, image processing, trajectory calculation, robotic arms, sensors and geolocation tools. More generally, digital security solutions are developing, particularly among the Big Oil supermajors. The startup Nelia offers image analysis technology to assess a site's safety level and propose necessary improvements. Softsystems.ai is developing artificial intelligence-based solutions to reduce the risk of collision between machinery and pedestrians. On the equipment side, smart PPE (personal protective equipment), such as exoskeletons and haptic systems, are promising but still struggle to scale up.

Mental health and quality of life: keeping the company together

Less intuitively, mental health and quality of life issues also affect the construction industry. A study in Canada shows that 83% of construction professionals have dealt with mental health issues. Addressing this

Companies are setting up safety training and risk awareness programmes, and strive to make use of technical innovations.

problem requires a significant cultural shift. In the UK, for example, the NGO Mates in Mind organises 'tea breaks' to open up conversations about mental health. Similarly, the Mace group has called on the Lions Barber Collective for its London sites. The aim is to offer its employees 'haircuts and headspace' with the help of barbers trained to recognise signs of mental health problems. A natural extension to the subject of mental health, initiatives to improve the quality of life at work are also increasing in the industry known for its difficult conditions. To address disengagement and ensure employee well-being, companies are taking action. At VINCI, this is reflected in an advantageous shareholding plan called 'Castor', by policies dedicated to diversity and parity (such as the Equality plan at VINCI Construction), as well as training and e-learning programmes designed to guarantee the employability of staff.

From climate change to energy sobriety

The construction industry is also facing the impacts of climate change. According to a 2021 study published by the Union of Concerned Scientists, outdoor workers' exposure to extreme heat will quadruple in the United States by 2065, with an estimated loss of earnings of 55.4 billion dollars. A report by the French National Agency for Health and Safety (Anses) also considers that 15 of the 17 major occupational risk categories are exacerbated by global warming. In the short term, working conditions must be adapted to protect workers' health. Although modified schedules and additional breaks are already incorporated on a case-by-case basis, the construction industry unions are calling for the introduction of a 'hot weather unemployment scheme[1]'. As far as technical

solutions are concerned, workwear is also being adapted to global warming. VINCI Construction's Roads and Networks Division is developing cooling T-shirts, with fibres made from a mixture of natural mineral materials and fine volcanic rock, providing a feeling of freshness. Within the same division, testing is currently underway on a smart bracelet capable of detecting heat strokes.

During Demo Day, demonstration of Robots for Site.

Health and safety risks affect workers on all levels of the construction industry from psychosocial to environmental and call for immediate, coordinated responses. The issues are complex, from psychosocial to environmental hazards, which require systemic solutions and major transformations in technology, HR, working methods, and regulations.

To find out more: read the report of the VINCI health and safety working group coordinated by Leonard and contact Ludivine Serriere, programme manager at Leonard.

Predictive Maintenance: Industry in the Age of Care

The maintenance of equipment and infrastructure rarely makes headlines, as maintenance professions leave the forefront to idealistic innovation and dreams of disruption, glorifying transformation and permanent renewal. But for manufacturers, it's a major concern in the secrecy of factories or bustling construction sites. Long associated with repairing, it is now used to anticipate issues, optimise interventions and help "maintainers", using Artificial Intelligence.

Innovating maintenance!

In a fascinating series devoted to its 'maintainers[1]', Toyota summarises the shift from corrective to preventive maintenance of its industrial equipment, which culminates in today's ideal, predictive maintenance. The principle behind this new form of maintenance is very simple: Instead of intervening in broken equipment, the goal is to prevent breakdowns and downtime by anticipating malfunctions as accurately as possible. To do this, predictive maintenance relies on sensors that gather data in real time, and on AI that analyses this data to adapt maintenance protocols in real time. In practice, this transformation drastically increases the profitability and lifespan of industrial infrastructures. According to McKinsey, the new predictive models can increase asset availability by 5 to 15% while reducing maintenance costs by 18 to 25%.
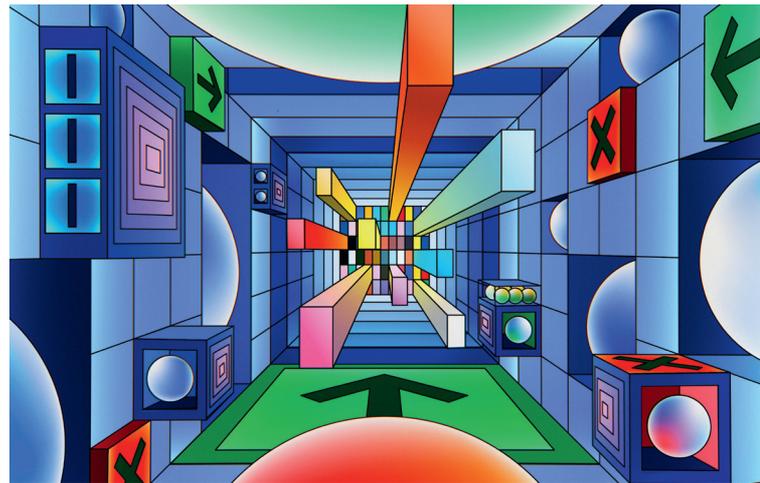
Maintenance is central to Leonard's AI program

The task of Leonard's AI program is to define AI use cases within the VINCI group. Naturally, maintenance occupies a significant place in the program, which yields several exemplary projects, all of which help to optimise industrial operations.

1-https://toyotatimes.jp/en/series/masters/055.html

Lisea and Mesea are optimising the life cycle of railway lines

The solution developed by Lisea (concessionaire) and Mesea (maintenance company), resulting from the 2021 programme, is designed to improve the maintenance of high-speed railroad tracks. The challenge is all the more crucial as the maintenance of railway tracks paradoxically accelerates their deterioration. Optimising maintenance is therefore imperative to avoiding repeated interventions. The solution proposed by Lisea and Mesea is based on data collected by a measurement wagon called 'DRING' (towed track geometry inspection device). This large rolling sensor collects data, which is then used to model track degradation. Machine learning technology facilitates decision-making and assists experts in planning track-geometry operations. In addition, it helps experts better understand track degradation, and reduces time spent monitoring and the frequency of maintenance operations.

Gutenbrain is revolutionising industrial documentation

Managing documents related to industrial equipment is a time-consuming activity. Firstly, one must manually collate thousands of documents from suppliers and manufacturers to sort and prioritise them. Then, one has to track all the revisions made to the documents, which is a particularly tedious task and sometimes prone to errors. To alleviate this unavoidable process, Actemium and Axians Portugal have developed Gutenbrain as part of Leonard's AI program. The solution meets three major challenges: firstly, it extracts the data contained in files of numerous different formats, such as text, technical drawings, or tabular data; secondly, using algorithms, it selects the most relevant data to constitute critical databases; thirdly, it automates the data reprocessing as the documentation is updated. All of this is brought together in a single interface that reduces teams' manual tasks and provides quick access to the most critical information throughout the project life cycle. To identify, locate, and trace the history of an item (e.g., a PLC) within the entire document base,

a simple query is all that is required: installation, maintenance, product sheet, number of occurrences in the industry in question, are all accessible at the click of a button.

BeeWave is scaling up predictive maintenance

Aeronautical maintenance is central to major economic and industrial challenges. It involves particularly complex tasks and state-of-the-art machinery, and the consequences of breakdowns or failures quickly become substantial. Optimising equipment reliability is therefore naturally an obsession for Actemium Maintenance Toulouse (AMT), which has been able to use AI to serve equipment maintenance, thanks to Leonard's specially designed programme. The result, entitled 'BeeWave', stems from a preliminary study carried out for Airbus for specific use cases: a hydraulic press and an aircraft fuselage assembly robot, whose breakdowns are particularly detrimental. By cross-referencing operating and sensor data and then applying machine learning models to them, AMT was able to refine its understanding of the damage and optimise its intervention scenarios. After its initial success, AMT decided to roll out a no-code solution, 'BeeWave', to give a new dimension to predictive in-house maintenance. The latter prepares the data, identifies the best maintenance models according to the equipment's behaviour, and estimates the amount of time before the next failure.

While extending equipment life cycles has become an industrial priority, preserving existing equipment is taking precedence over permanent replacement. Over-consumption is becoming the principal adversary of a world that's reached its limits. Maintenance is being reinvented, becoming smarter and more efficient.

To find out more: contact Bruno Daunay, head of the AI program at Leonard.

"Mobility goes far beyond vehicles"

Pierre Delaigue is the director of connected, autonomous and electric mobility projects at Leonard. He discusses the industry's major challenges and the role of infrastructures in developing future mobility.

What is connected mobility?

Wireless communications in connected mobility cover three main functions. The first is digital content: navigation, multimedia, the ability to work by receiving emails, etc. The second, most important to us, is safety. This involves exchanging information between vehicles or with infrastructure to limit risk. The vehicle receives information regarding traffic, accidents or construction, to better anticipate risks. Finally, the third concerns the deployment of autonomous vehicles, which generate and exchange large quantities of information.

What are the iconic projects related to connected mobility?

As far as manufacturers are concerned, all new vehicles are connected, at least by mobile internet. In addition, some manufacturers have already integrated dedicated short-range communication devices to exchange information with neighbouring vehicles and the road. The most iconic is Volkswagen, which has been incorporating the technology since 2019. There are about 800,000 Volkswagen vehicles with dedicated short-range communication devices already on the road. As for infrastructure, VINCI is involved in several innovation and R&D projects. We are working with manufacturers in particular on new use cases. Then we have pre-deployment projects; in France, for example, we have installed several dozen dedicated short-range communication devices in VINCI Autoroutes' highway network.

What are the obstacles in deploying connected mobility?

Coordination between infrastructures and manufacturers is essential. If VINCI Autoroutes partners with an automobile manufacturer, this does not create a grid that's sufficient enough for scaling up. It is imperative to bring the largest car manufacturers and infrastructure operators to the table to draw up a technical blueprint, with support from the Ministry of Transport. Otherwise, we risk getting stuck in a chicken-or-egg dilemma: vehicles wait for infrastructures to be connected, and vice versa.

There is a lot of talk about road mobility. What is VINCI's view on light mobility and multimodal technology?

VINCI is heavily involved in multimodal technology. One of our ambitions is to deploy multimodal hubs on the outskirts of motorways, connecting main roadways to other modes of transportation, such as cycling or public transportation. One great example is the Longvilliers multimodal hub, located a few dozen kilometres from Paris. There is lots of activity in the hub: bus station, carpooling, cycling, etc. VINCI Autoroutes deploys its services using the Ulys application, which consolidates the network's user services. We can use it to locate toll services, for example, as well as electric charging stations.

There was a lot of talk about autonomous mobility, but the subject seems to have died down a bit in the media today. What are the next major events?

The autonomous vehicle has received less media attention but remains a technological priority. Although the automotive industry hasn't fulfilled its initial promises, this isn't just a pipe dream. As far as individual vehicles are concerned, the first models have already arrived on the market. These are models with delegated driving functions, in which drivers no longer have to keep their hands on the wheel or eyes on the road. This is known as 'Level 3' and is already being marketed by Honda in Japan and Mercedes in Germany. The collective shuttle sector has also moved from technical demonstration to the commercial phase. Regulatory and legislative obstacles have been lifted. The heavy haulage vehicle sector is also rapidly developing, particularly with self-driving trucks on motorways in the United States. Finally, it should be pointed out the entire industry is now questioning the highest level of autonomous vehicles. This is Level 5, in which the vehicle is fully autonomous everywhere and in all conditions. There are so many different possible situations to navigate that this objective no longer seems relevant, even in the long term.

What role does infrastructure play in both connected and autonomous mobility?

Mobility goes far beyond vehicles. The conception of connected infrastructure meant to complement vehicle limitations is slowly replacing passive roadways. Four families of contributions can be distinguished. The first concerns physical equipment. Autonomous vehicles use markings and signs, which can therefore be innovated to provide new solutions. Magnetic markings or connected signs could thus be developed. The second contribution concerns connectivity, which we have already mentioned. The third is what we call 'roadside perception'. The sensors on autonomous vehicles can detect up to about 200 metres. At motorway speeds, this corresponds to about five seconds, which is very little. In certain situations, surrounding infrastructure can help vehicles anticipate ability. Finally, the fourth, and most ambitious component, consists of developing 'hyper vision' systems for use in congested areas. The infrastructure then directs each vehicle's speed and position. It increases lane capacity through remotely controlled regulation. The model is quite similar to that used in automated underground lines but applied to motorway lanes.

How do you imagine future mobility?

Given the climate emergency and its consequent regulations, future mobility will be decarbonised. To reach this objective, connectivity and autonomy can be used to develop collective mobility services, such as shuttles or autonomous buses, for use on motorways. Land degradation is another challenge. Fortunately, in France, we have an extensive motorway network. But despite the increased demand for mobility, we cannot infinitely build new motorways. We must therefore do more with existing infrastructures. This requires both the aforementioned technological innovations, and innovative uses. VINCI is actively involved in the collective mobility movement, promoting motorway innovations such as high-occupancy vehicle lanes and lanes reserved for express buses.

"The conception of connected infrastructure meant to complement vehicle limitations is slowly replacing passive roadways."

The Challenge of Scaling Up Green Hydrogen

Hydrogen can be an essential ally in the energy transition, provided that it is created in a process that doesn't involve carbon. Falling production costs and a well structured industry could remove the remaining hurdles to its wide-scale deployment.

The hydrogen atom is the most common element in the universe. Electricity can be generated by dihydrogen (H_2) combustion, which produces water. It has an exceptional gravimetric energy density: 1 kg of hydrogen contains as much energy as about 3 kg of oil. A small miracle that prompted Jules Verne to prophesise as early as the 19th century: "Yes, my friends, I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable."[1] Although hydrogen is now widely used in the industrial sector, the promises of Verne's Mysterious Island still seem rather remote. The miraculous molecule is still caught between its high potential and its equally considerable production and transport constraints. Driven by the challenges of climate emergency and consequent energy transformation, we might finally overcome this impasse.

Hydrogen: A long history with new promises

The media hype surrounding hydrogen is largely driven by the mobility sector, which sees the molecule as an alternative fuel. But the industrial history of hydrogen goes back much further: the industrial sector (mainly in refineries and chemical plants) is the largest consumer of hydrogen produced today. Hydrogen produced by steam reforming and gasification is known as 'grey' hydrogen, due to its high ratio of CO_2 generation. But the buzz surrounding hydrogen today is about an alternative production method, water electrolysis. This method, which requires a large amount of electricity (an expected 10% of total electricity consumption in 2030 to produce 1 million tonnes of hydrogen per year in France), can be used to produce 'green' hydrogen, provided it is made using low or no-carbon energy sources. Progress in the energy transition is therefore essential to hydrogen's future success.

Production, transport and storage: A demanding molecule

To date, economic competitiveness is the most important barrier to green hydrogen development. Although more expensive than grey hydrogen or natural gas, green hydrogen is set to become cost-competitive. Newly developed gigafactories (four of which will be built on French territory), will help electrolysers reach economies of scale. This growing, more experimental innovation is opening up new possibilities for hydrogen production in the long run. For example, a turbine designed by Sabella can already transform tidal energy into hydrogen. Similarly,

1. Jules Verne, *The Mysterious Island*, Paris, Hetzel, 1875.

researchers at Nanjing Tech University have finalised an electrolyser which uses seawater to produce the molecule. The development of new energy geographies can potentially make green hydrogen energy more affordable. As detailed in the study "Africa's Extraordinary Green Hydrogen Potential" presented at COP 27, the solar potential in Africa promises a potential hydrogen production cost of €2/kg by 2030. However, the remaining issue of transport is particularly critical. Due to the very low density of hydrogen, it must either be compressed, liquefied, or transformed into a derivative product (methanol or ammonia) before it can be transported. On an international scale, the prospective green hydrogen pipeline between Barcelona and Marseilles is a tentative step towards developing a continental-scale hydrogen pipeline network. On a smaller scale, Toyota's portable hydrogen cartridge hints at upcoming developments for everyday applications.

A new ally in heavy mobility?

Once the main challenges are overcome, hydrogen could become a major player in the heavy mobility sector. When it comes to long-distance road transport, public transport, maritime transport and even air transport, batteries cannot compete with hydrogen's reasonable onboard weight and increased autonomy. Fuel cell-powered trains by Alstom and the Changchun Railway Vehicles Co. are already commercially available. The European Union aims to have 60,000 hydrogen-powered trucks on the road by 2030. At the same time, Iveco, Mercedes and Volvo are making advancements in prototypes. Finally, on a more distant horizon, hydrogen-powered aircraft could considerably reduce air transport's carbon footprint. In 2022, Airbus revealed a fuel cell prototype designed for aviation. This comes two years after unveiling ZEROe, Airbus's ambition to develop the first hydrogen-powered aircraft by 2035. Hydrogen seems to be taking off!

"The first challenge is ensuring the largest consumers transition from fossil fuel-based hydrogen production to that which generates little or no CO_2"

3 questions for Nicolas Dattez

Nicolas Dattez is a hydrogen expert at Leonard. Here, he goes over the present and future challenges of hydrogen use.

Hydrogen is gaining a lot of attention, and a lot of investments are being made in it. Why now?

The biggest change is greater awareness of the climate crisis. It is imperative that we limit greenhouse gas emissions, and hydrogen can bring solutions to many challenges for decarbonisation. To decarbonise the industrial sector, for example, there are few alternatives to hydrogen. The political will and financial resources to address the climate crisis are finally aligning. Four years ago, French Minister for the Environment, Nicolas Hulot offered up 100 million euros; today, France is setting aside 9 billion euros of the national budget for climate action plans.

What are the major applications of hydrogen today? What about tomorrow?

Today, approximately 94 million tonnes of hydrogen are used worldwide each year. The largest consumers are the oil industry, in oil refining, and the chemical industry, in the production of ammonia or methanol. These hydrogen production processes generate a lot of CO_2. The most common is steam reforming, which requires 10 kg of CO_2 to produce 1 kg of hydrogen. This represents 900 million tonnes of CO_2 per year or more than 2% of total emissions. The first challenge is ensuring the largest consumers transition from fossil-fuel-based hydrogen production to that which generates little to no CO_2. The second transition consists of introducing hydrogen into certain production processes to emit less CO_2. Steel mills are beginning to use it for the production of 'green' steel. Hydrogen can also be used to convert CO_2 into gas or synthetic fuels such as methanol. Combined with carbon capture technology, it is a good opportunity

to recycle industry CO_2 emissions rather than burying them in underground cavities. Finally, when hydrogen becomes competitive, it will complement, or even replace, natural gas in industrial furnaces or for heating.

There are also non-industrial uses: hydrogen derivatives such as methanol or ammonia, which are more easily transported over long distances, can be used for shipping. In air transport, it could be used in its liquid form at -253°C as an onboard fuel. It also has great potential for use in rail transport: Alstom recently launched the first hydrogen-powered trains. Hydrogen is also promising for long-distance road transport or fleets of vehicles, such as taxis.

Finally, it can help expand the use of intermittent renewable energies (such as photovoltaic and wind power) by stocking energy in the form of hydrogen during production peaks and converting it back into electricity during demand peaks.

What are the obstacles to be removed for the democratisation of green hydrogen?

Beyond the hefty cost, the challenge will be to develop renewable or nuclear electricity production infrastructures to manufacture hydrogen by electrolysis, with minimum CO_2 emissions. On an international level, it will be important to ensure that hydrogen is low-carbon or renewable by putting in place regulatory certifications.

As for hydrogen road mobility, which tends to attract the most attention even though it will probably not represent its greatest use, we are encountering the same obstacles as during the emergence of battery-powered electromobility. We must simultaneously deploy vehicles and infrastructures to avoid slowing down development due to a lack of refuelling stations, or vice versa.

Words that Spark Debate

Frugal Cities

Contrary to what its name suggests, frugal urbanity can be a source of great satisfaction. The idea is to do "better with less". According to one of its theorists, Jean Haëntjens, the frugal concept is one "that would reconcile ecological ambition with pleasurable urban life and cost control." All this is achieved by taking a transversal approach to city planning.

Urban Rail

Last November, the French President guaranteed the creation of RERs (Regional Express Network) in the ten largest French cities (Paris has already had one since the late 1970s). This would reduce reliance on personal vehicles for travel, and help the country meet its ecological transition objectives. But is this project compatible with "proximity-based" urban planning, supported by most urban planners to reduce travel demand? The debate has only just begun.

Timber Construction

According to some studies, replacing a portion of concrete, cement and steel in future buildings with wood could reduce CO_2 emissions by 100 billion tonnes by 2100. In 2021, an 80-metre-high skyscraper made entirely of wood was erected in Skellefteå, Sweden. While the idea of transforming entire cities into carbon sinks is very appealing, it remains to be seen how to sustainably manage forest plantations, which are less resistant to fire and drought and less biodiverse than the natural forests they might replace.

Living Soils

The term "living soil" applies to several concepts, in particular a sustainable agricultural approach that promotes working with the soil's natural cycle and needs (such as allowing it to rest, and reducing inputs), to prevent degradation and preserve biodiversity. These solutions also enhance carbon sequestration: in France alone, an estimated 3.2 billion tonnes of carbon is stored in soil's surface layers.

Land-Use Conflicts

A land-use conflict occurs when two or more groups have competing views on land use. In ecological terms, the dispute concerns the exploitation or use of a resource. Frequently, the industrial use of a resource (a forest, body of water, etc.) conflicts with its possible use from a conservation perspective. Equally common, urban sprawl encroaches on rural areas, sparking conflicts of use.

Thermal Sieve

A thermal sieve, sometimes called an energy sieve, is a poorly-insulated, energy-intensive building, particularly in terms of heat consumption. Most of these buildings are very old, and landlords now face very strict regulations. For example, since 1 January this year, it is prohibited to rent out buildings whose energy consumption is higher than 450 kWh per m^2. The renovation of such dwellings is therefore inevitable. Not only does it require improving or adding insulation, but it may also entail redesigning heating and/or ventilation systems.

Bioclimatic Architecture

Bioclimatic architecture is a way of designing buildings leveraging the climate and natural surroundings to ensure thermal comfort. This type of design takes account of the local climate conditions - sun, wind, rain, etc., as well as building orientation. Building designs are adapted to these conditions, for example, tiles that store the heat of the sun on south-facing surfaces.

Climate Tech

This term designates an array of technology solutions designed to address climate change and its environmental effects, particularly by reducing greenhouse gas emissions. These solutions include software (for example, by using blockchain technology to reduce CO_2 emissions), hardware, or even biotech. However, climate tech should not be confused with clean tech, which refers to technologies and industrial services that minimise negative impacts on the environment.
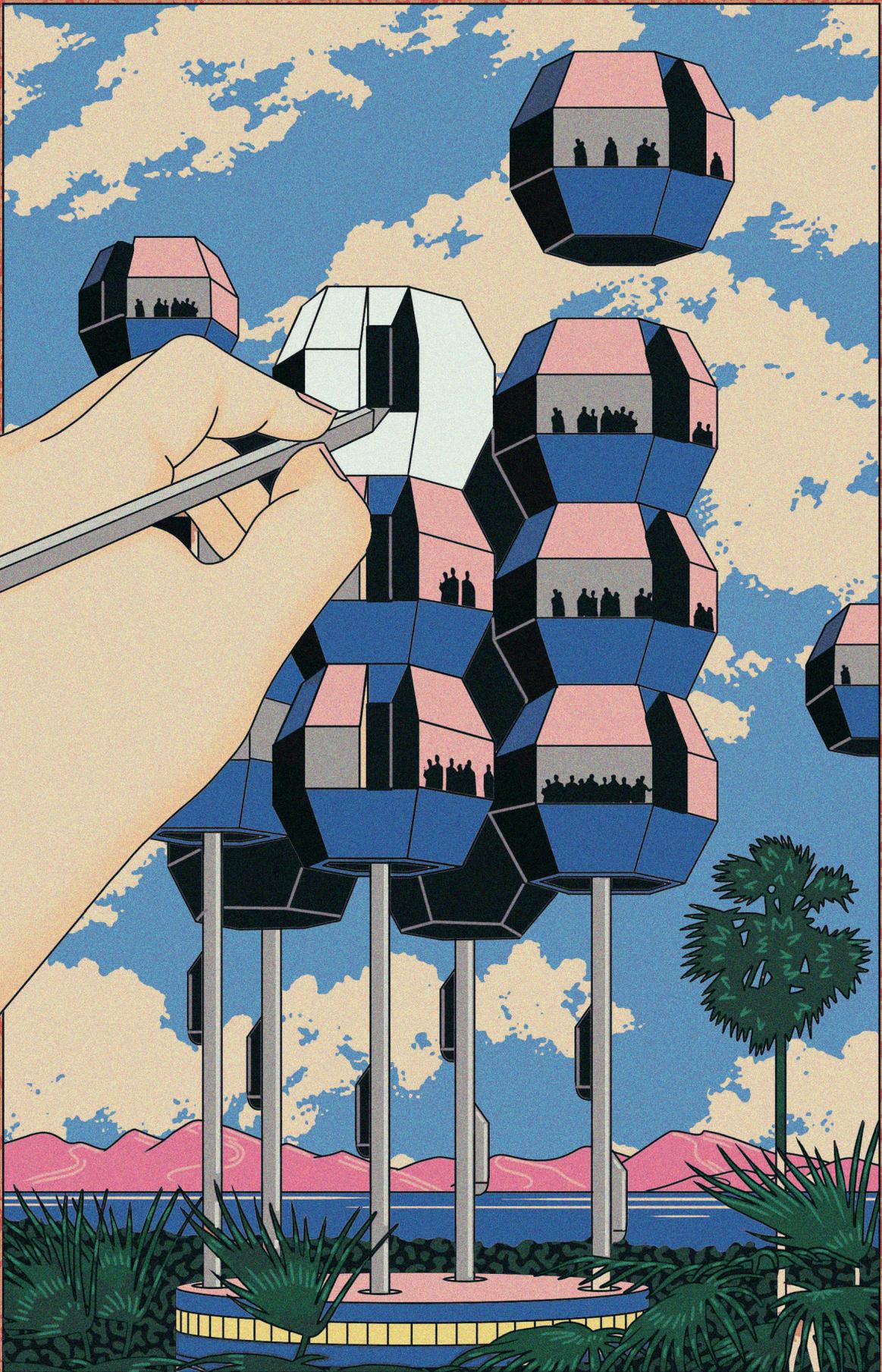
Travellers

How could our new worlds exist without the women and men who inhabit them? To navigate these new worlds, we must first envision them. For this, we will need new players to explore and map out these new territories as clearly as those of the past. The construction industry is full of promising innovations. Leonard provides project leaders and experts in the field with the necessary means to develop solutions, nourishing this entrepreneurial ecosystem. There is reason to have hope, as investments in innovative climate change solutions are gaining traction. More than 50 billion dollars, i.e. a little more than a quarter of all venture capital funds, were invested in climate tech startups in 2022. Despite macroeconomic and geopolitical road bumps, the momentum is still going strong. Finally, among those forging the new worlds of the energy transition, we mustn't forget the artists who have proved their ability to outline new futures. More than ever, art serves as a "thought experiment" that captures the changing world and creates new dreams.

Open Innovation Tested in the Field

Leonard supports developers of innovative solutions in their deployment, providing them access to the entire VINCI ecosystem to test their solutions in real conditions and optimise them with real users. Here's a look at three of these experiments.

Softsystems.ai

Solution 1
SOFTSYSTEMS.AI

Tested by Pascal Milon, prevention officer, VINCI Construction Terrassement

LEONARD PROGRAMME Catalyst 2022

THE NEED
Construction on the Nantes to Brest canal maintenance site takes place on former towpaths, popular with pedestrians and cyclists. Site perimeters are secured to prevent access; however, residents and pedestrians still venture near the machines. Team members must be especially vigilant to avoid collisions.

THE SOLUTION
LifeGuard was developed by Softsystems.ai to prevent collisions between vehicles and pedestrians with the use of artificial intelligence. An LCD screen, linked to a camera, allows the driver to visualise the entire area of intervention, who is then alerted of an approaching pedestrian. A loudspeaker system warns the pedestrian to move away.

FEEDBACK
The software allowing users to calibrate safety limits makes the solution very easy to use. The camera allows the operator to concentrate on the task at hand, while the loudspeaker simultaneously warns pedestrians, who move away spontaneously. The cost/benefit ratio is attractive.

POSSIBLE IMPROVEMENTS
Add a loudspeaker near each camera so that pedestrians can hear the warning message perfectly from all angles.

BONUS
AI-powered pedestrian detection (which can differentiate pedestrians from obstacles) and the calibration of the safety limits.

Solution 2

R.USED

Tested by Lucie Docimo, Construction Engineer, VINCI Construction

LEONARD PROGRAMME Intrapreneurs 2022

THE NEED
To accommodate the temporary pavilion for the 'Aqua Mater' exhibition at
La Défense, we had to install a double base made of concrete and polystyrene.
When the installation was dismantled, these two bases were destined for reuse
or destruction. But finding an opportunity for reuse is only done informally, often
by word of mouth. Most dismantled site elements are thrown away.

THE SOLUTION
R.used works like an internal classified ads website at VINCI. It's a marketplace
network that enables the re-use of materials, equipment and resources between
sites. R.used therefore makes it possible to extend the life of materials while
saving money.

FEEDBACK
The experience was extremely motivating: my concrete slabs are used on a site in
Paris, and my polystyrene slabs are reused as backfill on another project. R.used
makes it easier to form new habits: rather than systematically buying something
new, reusing materials is made easier. The application integrates everything,
including search functions, adv publishing, and issuing delivery notes.

POSSIBLE IMPROVEMENTS
Suggested ads by trade or by profile to provide ideas even before a need is
identified.

BONUS
The ease of the connection and fully integrated user process.

machine26

Solution 3

Machine26

Tested by Nordahl Grenier, Equipment Director, Eurovia Germany

LEONARD PROGRAMME SEED 2022

THE NEED
To help our field teams, especially our equipment managers, manage and inspect machinery and then either make it available internally or sell it externally.
Until now, this initiative was limited in scope, as everything was done through heterogeneous forms, and the bulk of our resales relied on brokers.

THE SOLUTION
Machine26 is a platform dedicated to the resale of used machinery. Its integrated software streamlines machine evaluation and advert distribution, and provides a network of external dealerships through its standardised and secure procurement process.

FEEDBACK
We first sought out Machine26 in 2020 to test the digitalisation of our valuation process. Their platform is very instructive and very user-friendly, and its standardisation streamlines our listings for seamless distribution. We're so convinced by the solution that we are adapting our organisation accordingly, first from a local to a regional level, and soon to a global level. In two years, we have already made more than 1 million euros in sales through the platform. The more it expands, the more buyers we will attract.

POSSIBLE IMPROVEMENTS
We are working with Machine26 on an in-house machine provisioning stage and a wider roll-out to other European countries.

BONUS
Control over our marketplace from start to finish, particularly in regards to buyer compliance criteria, seamless ad distribution, and creating easy-to-read ads.

Business Acceleration: a Multi-Faceted Story

Leonard supports players in the innovation ecosystem by forming long-term partnerships with initiatives to encourage project leaders. Let's take a closer look at two of them.

Construction Startup Competition: Contech goes all out

For the third consecutive year, Leonard has partnered with the construction industry's most important global innovation competition. The Construction Startup Competition recognises new players who propose the most successful and sustainable solutions for improving productivity and construction supply chains, and for new materials and methods. In three editions, more than 2,000 startups have already been selected. Finalists are invited to a 'Pitch Day' to present their solutions to well-known companies and investors in the Contech industry (construction technology). In 2022, Pitch Day took place at the closing of the Groundbreak conference in New Orleans.[1]

Fairer innovation with French Tech Tremplin

In 2022, Leonard welcomed three new startups as part of the French Tech Tremplin programme: Collab, Green Unit and Deadline. This programme, run by Mission French Tech, aims to promote diversity and equal opportunities in the French innovation ecosystem. It is organised in two phases: the 'prep' phase, which helps project leaders to launch their company, and the 'incubation' phase, which develops the startup thanks to financial assistance and support from a network of partner incubators and accelerators.[2]

1. https://www.cemexventures.com/constructionstartupcompetition/
2. https://lafrenchtech.com/en/how-france-helps-startups/tremplin/

Financing: Is Climate Tech Crisis-Proof?

The combination of macroeconomic and geopolitical factors (the global health crisis, inflation, rising interest rates, the war in Ukraine, disruption of supply chains, etc.) heavily impacts investment dynamics. But we must not let this global context overshadow the diverse regional and sectoral conditions. One sector, in particular, seems to be doing well: Climate tech, which invests in sustainable climate innovations.

According to a PwC study, more than 50 billion US dollars, or just over a quarter of all venture capital funds, has been invested in climate tech startups by 2022. Interest in the sector is steadily growing, perhaps even accelerating. However, this phenomenon benefits above all early-stage startups rather than more mature structures, which struggle to continue raising funds.

What makes it so appealing? Regulations in all sectors are tightening in Europe, since the RE2020 environmental regulation on construction was put into place, which limits the carbon footprint of new building construction. However, since current building practices do not meet the regulation's higher thresholds, which will only become stricter until 2030, investing in innovation is essential for contech's financial backers. We can also note the ripple effect of public investment plans (renewable energy policies, France 2030, U.S. President Biden's climate bill, etc.), that results in increased funding for the ecological transition. Lastly, we must not overlook the dry-powder phenomenon: investment funds have significant reserves, a large part of which is already earmarked for climate tech.

A WORD FROM THE EXPERTS

Mauricio Weiss, Zacua Ventures

"Our latest study shows that a majority of contech's investment funds are intended to increase their investments in sustainability. 30% would like to increase their investments in new construction materials. Regulatory pressure has a direct effect on investment priorities. Market uncertainties, on the other hand, are forcing investors to refocus on their core business and key regions, which means that attracting funds from international or multiple verticals requires more effort."

The startup to watch out for: Ecoworks offers an innovative and industrialised approach to large-scale thermal and energy efficiency with the creation of a 'second skin' to reduce buildings' carbon footprint.

Mathias Flattin, Axeleo Capital

"As the number of crises accumulates, priorities are changing: less 'nice to have', more 'must-have,' i.e. focusing more on real needs and essentials, and less on speculative needs. For entrepreneurs, this means being able to demonstrate a real impact, to attract investments from the start by providing innovative solutions to societal and environmental problems."

<u>The startup to watch</u>: Oculai, which uses computer vision to make construction not only more efficient but also more productive, helping site managers organise subtractors and prevent errors.

Three startups that benefitted from support and funding through Leonard's SEED programme discuss how they obtained funding.

CAELI ENERGIE
Rémi Pérony, president and founder
Established: 2020.

Elevator pitch: We design and manufacture a low-carbon air conditioning system.
Personal background: Building engineer, then a master's in business (Grenoble School of Management), business development in the Asian energy sector (Business France), Tech Representative of the French Atomic Energy Commission for India.
Reason for undertaking: Not truly fulfilled in my salaried job, I wanted to contribute, to bring something, to find solutions. The environment is the responsibility of our generation. In India, the problem jumped out at me, and the intersection of my different professional experiences took care of the rest.

How they obtained funding: The first foot in the door was the 200,000 euros provided by regional public support funds for deep tech during the pre-creation phase, then the French Tech Emergence grant and an honorary loan from the Entreprendre Isère network, Deeptech financial aid and first bank loans. The early stage is quite fluid when you tick the 'right boxes' in the French investment ecosystem: a credible scientific and technological background, a large potential market and a good team. These public funds have a very clear ripple-effect. But then you have to quickly raise funds, and that's more difficult because investors are still focused on questions that deep tech startups don't have answers for, especially time-to-market. Little by little, however, we are seeing a renewed interest in hardware and risk. The entire investment sector needs to evolve towards other types of decision-making metrics: today's metrics are still based on digital companies with a clear path.

OSTREA
Tanguy Blévin, co-founder
Established: 2022.

Elevator pitch: An industrial startup that recycles shellfish waste (oysters, mussels, scallops) into innovative, low-carbon materials.
**Personal background:** University technical diploma in business management (Rennes), master's degree in purchasing and logistics management (ESC Pau), then purchasing manager for large international hotel groups and business development manager.
Reason for undertaking: Four childhood friends with different but complementary profiles who always wanted to do something together if the right idea came up one day. I spent the first lockdown working with my brother, who is an oyster farmer in Brittany, and the problem of production waste and its lack of recovery gave us the idea as well as the desire to find solutions.

How they obtained funding: Pre-creation aid of 50,000 euros from the Emergys grant from Bpifrance and the Brittany Region, then we joined the regional science park, which enabled us to develop the first version of our material and to test its appeal with the first prospective customers. Then we raised debt from banks and received regional government aid and donor loans from Entreprendre et Initiative networks to set up our first small factory and start marketing. Today, we are preparing our first round of financing, 90% secured, to adapt our production resources, and recruit and invest in R&D. What has made the difference is the support and our regional base: there are many public aid solutions and funding schemes, but the application process is difficult to understand. Our mentors at the technology park and the local business angel networks have been invaluable in helping us achieve our ambitions and find the right funding. It's a full-time job, but it pays off: the support of innovation organisations and the regional government gave us almost immediate credibility. This is a big issue for the Breton oyster sector and the region, and we were able to quickly get involved and prove our benefit.
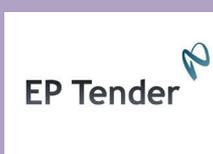
EP TENDER
Jean-Baptiste Segard, CEO and founder
Established: 2012.

Elevator pitch: We are accelerating the energy transition of consumer electric vehicles with our smart power bank trailer that can be rented on demand for occasional long-distance travel.
Personal background: Training as an engineer (Ecole Polytechnique Fédérale de Lausanne), then a career in finance from 1986 to 2012 (asset management, creation of pension funds).
Reason for undertaking: I had always told myself that I would only undertake something the day I had a really good idea and where the associated risk made sense. EP Tender is first and foremost a citizen's idea, which was quickly dissected by the engineer.

How they obtained funding: I underestimated the cultural difference between the finance and automotive industries. In finance, risk is an asset, a raw material, with rapid decision-making. In the automotive industry, risk is a factor to be minimised, or even avoided, and decisions are made over the long term and require consensus from the entire organisational matrix. Introducing an external disruptive solution is a daunting challenge. We were able to get through the technical proof of concept and digital market model stages with the help of public support as well as our resources. But there is a gap once you get past these initial stages: VC funds have become very cautious about hardware, especially when it involves a new, unproven business model. We hope to make it by combining public funding, a manufacturer and a financial investor or another player in the sector. Given the environmental and social stakes, it is worth it!

Leonard Financing Innovation

The SEED programme finances and supports startups in the seed phase. Selected for the innovative solutions they offer to the construction, mobility, real estate and energy sectors, they benefit from six months of training by experts at Stanford University, as well as workshops and coaching sessions, and are connected with mentors from VINCI and Leonard's network of investors. In four yearly cohorts, 30 startups have been supported in this way. In 2022, Leonard committed to using BSA-AIR (rapid investment agreement share purchase warrants) to support their development: these warrants allow startups to defer their investors' payment price until the first round of funding, while the quick access to funding allows them to move forward in its development.

Are the New Worlds Works of Art?

For the fifth edition of the Building Beyond festival, Leonard brought together researchers, experts and artists to imagine the futures - both visible and invisible - of cities and territories in transition. The question is: transition towards what? How can art help us understand these new worlds?

Digital data, immersive worlds, and NFT are all intangible concepts, yet their impact on our daily lives and our imaginations is very real. On the other side of the spectrum, infrastructures, soil and biodiversity are tangible realities that we quickly forget. 'Awareness' is the subject on everyone's lips: crises are exploding, and alerts come one after another of disastrous scenarios that are often difficult to grasp. But these 'new worlds', this field of infinite possibilities, are enough to dream about because they remain to be written.

What if art allowed us to pull our heads out of the sand, to bridge the gap between not-so-distant problems and solutions, to show us what could be, to give shape to what we already have but cannot reach? Through art, we question, deconstruct, and reorganise our ways of living, and learn to turn our words into action. In any case, this is the vision that Albertine Meunier and Antoine Bertin, two of the artists invited to the 2022 Building Beyond festival, are advocating.

Antoine Bertin builds his work at intersections, more specifically at the intersection between art and science. A musician and scientist by training, he considers sound art to be a new frontier. In his work, he seeks to tear down the walls between disciplines to explore the invisible world and transform our relationship with the living. His project Species Counterpoint, presented as part of Building Beyond, questions the plant-human relationship through the prism of sound and genetics. In his installation, a mechanical piano plays a melody composed according to the proximity between the genetic code of a plant and that of a human. "Biodata sonification allows us to transform data into sound," he explains. "Listening to data and social and environmental phenomena encourages us to think about them differently to understand them better. The role of art is to sculpt new perspectives, especially digital art, which is a language shared by many disciplines. It has this ability to create bridges, to connect things that don't necessarily seem connected, to reveal relationships that can illuminate our understanding."

According to Albertine Meunier, from the DataDada collective, it is through uncomplicated experiences that complex concepts become tangible. With La Patate Chaude ('The Hot Potato'), a participative performance inaugurated during Building Beyond 2022, the collective embodies NFTs and digital portfolios with a speed typing contest and hides a digital artwork using real potatoes. "The device allows us to create a situation," says Albertine Meunier. "Art provides keys to understanding digital issues. We create a moment, and first, we take the time to play, then discuss it and finally, we get it. Faced with intangible issues, the prism of experience makes the immaterial real. We simplify technical concepts by reducing them to an accessible form of expression."

LEONARD thanks all of its 2022 speakers

Marion Apaire, Paris&Co - Paul Ardenne, art historian - Hélène Barbé, AgroParisTech - Robert de Barrentin, artist - Benoît Baume, Fisheye - Patrick Bazin, Conservatoire du littoral - Aldo Bearzatto, Close-Up Festival - Darren Bechtel, Brick & Mortar Ventures - Andrea Bego Ghina, Valgo - Hélène Bengorine, La Mutuelle générale - Juliette Berthon, Sogaris - Antoine Bertin, artist - Tom Birbeck, ARC Marine - Maxime Blondeau, Alma Mater - Fabrice Boissier, Ademe - Élise Bon, VINCI Autoroutes - François Bouché, Valgo - Cindy Bouchez, VINCI Construction - Yazid Boudjedia, Groupe ID'EES - Antoine Boudon, Agyre - Hervé Bougon, Festival Close-Up - Franck Boutté, Franck Boutté Consultants - Florian du Boÿs, Impala Avenir - Cassilde Brenière, Agence française de développement - Élodie Briche, Ademe - André Broto, mobility expert - Dominique Bureau, Economic Council for Sustainable Development - Fabrice Butty, SRBG - Cabaret contemporain, artists - Vincent Callebaut, Vincent Callebaut Architectures - 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Benjamin Tincq, Marble - Sylvie Tissot, artist - Jérôme de Tomasi, Waste Marketplace (waste market) - Hugo Topalov, Bellastock - Virginie Tournay, writer - Lola Vallejo, Iddri - Eric Veith, Offis - Raphaël Ventre, VINCI Autoroutes - Anne Vial, Cerema - Laurent Vigneau, Artelia - Emma Vilarem, [S]CITY - Felipe Vilas-Boas, artist - Alice Vitoux, [S]CITY - Louis-Noël Viviès, Energy Observer - Anaïs Voy-Gillis, June Partners - Camille Waintrop-Boyon, France Ville durable - Mauricio Weiss, Zacua Ventures - Nicolas Wolff, VINCI Construction - Christian Wörner, VIA IMC GmbH

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