EPFL

Annual Report

2021

ENAC

School of Architecture, Civil and Environmental Engineering

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Foreword

Last year, the Covid-19 crisis continued to shape our way of working together. It is fascinating how fast we learn and adapt to new circumstances, how creativity is triggered, and how new ideas for research, teaching and innovation emerge. The moment we were able to return to campus felt great, showing us that sharing, discussing and creating, together with our colleagues, are not things we can take for granted.

Looking back on 2021, I must say it was a creative year. Impressive progress was made on many ENAC-led initiatives addressing sustainability challenges in the natural and built environment. None of this would have been possible without the enduring support of the ENAC management team, the ENAC Dean's Office, the ENAC faculty and our students. Thank you all for your ideas, energy and dedication!

In 2021, it was very pleasing to see so many research projects bolstering ENAC's reputation for disciplinary and interdisciplinary excellence. Many researchers secured funding from prestigious organizations. Furthermore, we were able to award three interdisciplinary Cluster Grants and seven CLIMACT Grants in our three key challenge areas – climate change, digitalization and urbanization – allowing our faculty to work on cutting-edge research projects. It was particularly exciting to see established researchers working alongside young assistant professors, bridging not only disciplines but also generations.

In teaching, we recently launched, together with the School of Engineering, a Minor in Engineering for Sustainability, which is open to EPFL Master's students and enables future engineers and architects to address sustainability challenges in their field. We also started a Master of Advanced Studies (MAS) in Urban and Territorial Design in partnership with ETH Zurich, meeting the challenges of a sustainable transition in the urban space.

Following an initial series of workshops, the Diversity Office at ENAC, which was founded in 2021, produced a number of useful resources, including an in-house guide on inclusive language and a series of videos designed to combat stereotypes and promote inclusion. The team also held a workshop on respect and inclusion, and carried out a survey and analyzed our hiring processes with a view to drawing up practical recommendations. These early achievements underscore the important role that the Diversity Office is playing in making ENAC a more inclusive place for all.

We continue to push ahead on open science through a number of initiatives, including the ENAC-IT4Research team, which was formed in 2021 to help the ENAC scientific community leverage its research data. The examples presented in our annual report show the variety of services the team offers and point to strong demand from our scientists, who are working to make science more accessible.

Claudia R. Binder
Dean, ENAC

Another goal relates to strong partnerships and innovation. On this front, no fewer than six ENAC-led startups were founded last year. In 2021, an association called Future Sustainable Territories, Infrastructure and Cities (FUSTIC) was created to promote the societal and ecological transition within both ENAC and EPFL. The association has already held around a dozen events in an effort to publicize our expertise to key organizations in the public and private spheres. Also last year, seven projects addressing key challenges in public health and sustainable construction received funding through the ENAC Innovation Seed Grants program.

Finally, communication will remain a priority for ENAC in the years to come. Thanks to our sustained efforts in this area, we have secured extensive coverage in the press and on social media, helping to strengthen our position as a key contributor to a sustainable future of the built and natural environment.

I'm looking forward to 2022 – to working together on campus, fostering collaboration with our industry partners and welcoming our new faculty members, who will help us shape the future of ENAC!

Claudia R. Binder

An integrative approach to tackle major sustainability challenges

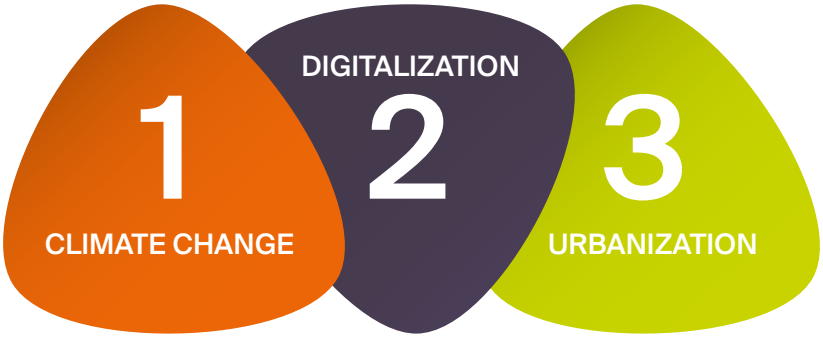
The School of Architecture, Civil and Environmental Engineering (ENAC) is the leading faculty addressing sustainability challenges in the built and natural environment.

In Switzerland and beyond, issues such as infrastructure upkeep and renewal, rapid urbanization, energy-intensive lifestyles, and the threat of ecosystem collapse require holistic responses.

ENAC takes an integrated approach to major global challenges such as climate change, digitalization and rapid urbanization while also considering economic, technical and social demands.

With the joint expertise in architecture, civil engineering, and environmental sciences and engineering, ENAC has a unique capability – and indeed a responsibility – to present visions and develop solutions for the future.

THREE SUSTAINABILITY CHALLENGES



CLIMATE CHANGE

Who will be affected by climate change and how can we act on it? ENAC develops knowledge, technologies and tools to anticipate, mitigate and adapt to climate change. We aim at understanding climate change impact in polar environments, health impacts in cities as well as innovating in the areas of CO_2 sequestration, renewable energies and their deployment.

DIGITALIZATION

How can digital tools support the transition towards more sustainable natural and built environment? ENAC utilizes digital technologies for sustainable design, construction and monitoring. Novel sensor technologies coupled with remote sensing, AI and machine learning provide new ways for managing urban systems and monitoring environmental conditions.

URBANIZATION

How should future territories be designed to assure livable conditions for its inhabitants while maintaining the ecosystems? ENAC adopts a people-centric system-of-systems approach to rethink the relationships between the rural and urban ecosystems. We study the food-water-energy nexus as a way to shape sustainable cities and territories.

ENAC supports knowledge creation and the development of solutions for a sustainable living environment that seamlessly integrates human activities into the biosphere

FIVE STRATEGIC GOALS

1. Disciplinary excellence, Inter- and trans-disciplinarity

ENAC strives for disciplinary excellence whilst being committed to an inter-, and transdisciplinary research and learning culture on climate change, digitalization, and urbanization.

2. Diversity and community feeling

ENAC welcomes all scientific contributors, administrative personnel, partners, and students to its research and learning endeavors seeking a balance in terms of gender, nationality, age, and knowledge.

3. Data driven approaches and open science

ENAC promotes its data science skills and knowledge sharing, in order to contribute to open science in research, education, and innovation.

4. Strong partnerships and innovation

ENAC wants to build a strong network with private and public partners in order to foster innovation and support startups.

5. Integrated communication

ENAC provides relevant scientific information for the benefit of internal and external audiences and increases its own visibility - nationally and internationally.

Learn more

Excellence in disciplinary, inter- and transdisciplinary research

ENAC researchers work at the crossroads of the built and natural environments. They explore the many facets of our world — from underground microbial networks to complex urban mechanisms — with a clear focus on developing innovative, sustainability-oriented solutions.

ENAC researchers are worldwide at the front in architecture, civil engineering, and environmental science and engineering. In 2021, their groundbreaking research has contributed to the key challenges our society has been facing. In the following, some examples will be presented ranging from a better understanding of the mechanisms of how climate change affects the environment (e.g., polar environments, forests, coral reefs); a social distancing monitoring system for the Covid-19 pandemic; the causes of damaging effects of air pollution; and observed recent shifts in messaging to attract voters.

Global sustainability challenges go beyond any single discipline and demand inter- and transdisciplinary research. At ENAC, we support innovative interdisciplinary research ideas at the very early stage, which enabled for example the development of novel systems for a better understanding of travel behavior and urban transportation patterns in a rapidly shifting environment. In 2021, we awarded three new interdisciplinary cluster grants to further strengthen research ties among our three institutes. The selected projects will explore new approaches in the fields of non-invasive thermal comfort, urban cooling and nature-based systems, and building material reuse and construction history. In addition, we work hand-in-hand with other EPFL units and centers – such as VPI, TTO, HRC, CLIMACT, and E4S – that support stakeholder engagement in innovative projects. We hope that these cross-disciplinary measures will unearth new, unexpected avenues for fundamental research and groundbreaking societal and technological innovation, helping us to further achieve ENAC's research and innovation missions.

Better understanding the acceleration in Arctic warming

Author: Rémi Carlier
Photo: Julia Schmale

ENAC professor Julia Schmale is calling on scientists to conduct detailed process studies on Arctic warming and share their data and research findings. She stresses the importance of studying how aerosols and clouds interact, as these highly complex and poorly understood mechanisms play a key role in, and are considerably affected by, climate change. In her view, scientists need to act now in this fast-changing region.

It's clear that rising greenhouse gas emissions are the main driver of global warming. But on a regional level, several other factors are at play. That's especially true in the Arctic – a massive oceanic region around the North Pole that's warming two to three times faster than the rest of the planet. One consequence of the melting of the Arctic ice cap is a reduction in albedo, which is the amount of solar radiation that's reflected by the Earth's clear surfaces like glaciers, snow packs and clouds. As the quantity of snow and ice on the planet decreases, albedo decreases as well and more radiation is absorbed by the Earth, leading to a rise in near-surface temperatures.

The other regional, yet much more complex factor that needs to be watched closely relates to how clouds and aerosols interact. Aerosols are tiny particles suspended in the air; they come in a wide range of sizes and compositions and can occur naturally – such as from sea spray, marine microbial emissions and forest fires (like in Siberia) – or be produced by human activity, such as from agriculture or the combustion of fossil fuels. Without aerosols, clouds cannot form because aerosols serve as the surface on which water molecules aggregate to form droplets. Owing to this role, and more specifically to how they affect the amount of solar radiation that reaches the Earth's surface and terrestrial radiation that escapes, aerosols are an essential element in regulating the climate – and especially the Arctic climate. What complicates the issue further is that both the Arctic climate and aerosols are changing quickly, creating a moving natural baseline.

"A lot of question marks"

In a paper published in *Nature Climate Change* on 8 February 2021, Julia Schmale, the head of ENAC's Extreme Environments Research Laboratory (EERL), alerts the scientific community to the need for a better understanding of aerosol-related processes. "How albedo is affected by ice is fairly well understood," says Schmale. "But when it comes to aerosols, there are many variables to consider: will they reflect or absorb light, will they form a cloud, are they natural or anthropogenic, will they stay local or travel long distances, and so on. There are a lot of question marks out there, and we need to find the answers quickly because the Arctic is changing rapidly." She worked on the paper with two coauthors: Paul Zieger and Annica M. L. Ekman, both from the Bolin Centre for Climate Research at Stockholm University.

The Arctic climate tends to warm fastest in the winter – despite there being no albedo effect during this period of 24-hour darkness. Scientists still don't know exactly why.

One reason could be that clouds present in winter are reflecting the Earth's heat back down to the ground, which would lift temperatures over the Arctic ice mass. However, the extent to which this happens would depend on the nature and quantity of the aerosols that form the clouds, which is complex and very difficult to simulate with models. "Few local observations have been made on this phenomenon because, in order to conduct research on the Arctic pack ice in the wintertime, you would need to have a crew of scientists and research equipment stationed on an icebreaker for the entire season," says Schmale.

Improving climate models

Although many research expeditions have already been carried out in the Arctic during warmer seasons, a lot remains to be explored. One option could be to collect all the discoveries made so far on Arctic warming and use them to improve existing climate models. "A major effort is needed right away, otherwise we'll always be one step behind in understanding what's going on. The observations we've already made could be used to improve our models. A wealth of information is available, but it hasn't been sorted through in the right way to establish links between the different processes. For instance, our models currently can't tell us to what extent natural aerosol sources in the Arctic are impacting regional climate change," says Schmale.

Three steps

In their paper, the research team puts forth three steps that could be taken to gain better insight into the Arctic climate and the role played by aerosols. First, they suggest creating a cross-disciplinary, interactive, open-source, virtual platform that compiles all Arctic aerosol-cloud interaction knowledge to date. This platform could be modeled after Renku, the Swiss Data Science Center's online resource. Second, there is a need to improve existing climate models, "because what's happening in the Arctic won't stay in the Arctic," says Schmale. "These processes can affect weather patterns in other parts of the northern hemisphere, and we're well aware of the effect that melting glaciers and Greenland's melting ice sheet are having on rising sea levels." Finally, the authors suggest conducting cross-disciplinary process studies examining how interactions among the atmosphere, cryosphere, biosphere, oceans and land masses are affecting aerosols and cloud formation and how this is changing with a warming climate.

Funding

Julia Schmale, the Ingvar Kamprad Chair for Extreme Environment Research, sponsored by Ferring Pharmaceuticals, acknowledges funding from the Swiss National Science Foundation (projects 200021_188478 and 200021_169090). A.E. would like to acknowledge the Swedish Research Council (Vetenskapsrådet), DNR2015-05318 and the European Union's Horizon 2020 programme, Grant Agreement no. 821205. P.Z. was supported by the Swedish Research Council (Vetenskapsrådet starting grant, project no. 2018-05045). P.Z. and A.E. also acknowledge support from the Knut and Alice Wallenberg Foundation, project Arctic Climate Across Scales (ACAS, project no. 2016.0024).

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«Aerosols in current and future Arctic climate», *Nature Climate Change*, 8 February 2021. Julia Schmale, Paul Zieger, Annica M. L. Ekman. https://www.nature.com/articles/s41558-020-00969-5

Learn more

A MACHINE DESIGNS NEW SWISS ALPINE ARCHITECTURE AT THE SEOUL BIENNALE

The Artificial Swissness exhibit – a larger than life-sized "design brain" developed by ENAC's Media x Design Lab (LDM) – was displayed at the Seoul Biennale for Architecture and Urbanism. This high-tech machine can generate a virtually infinite number of architectural images of Swiss Alpine cabins.

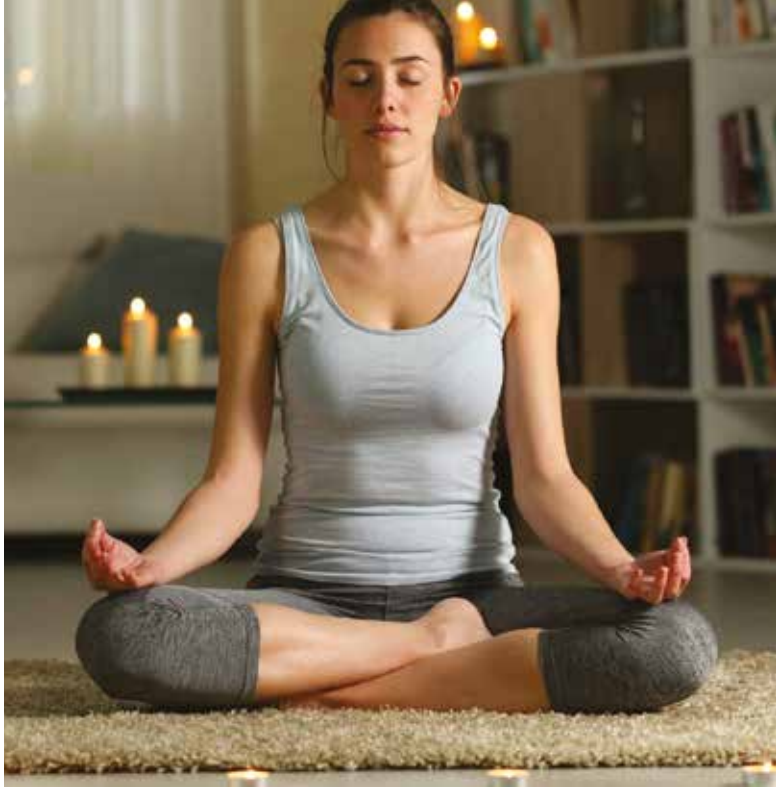
UNTAPPED SOLAR AND WIND POTENTIAL IN SWISS MOUNTAINS

Scientists at ENAC's Laboratory of Cryospheric Sciences (CRYOS) and the WSL Institute for Snow and Avalanche Research SLF have issued recommendations for what type of renewable energy should be produced in Switzerland's various regions, to help achieve the country's goals of carbon neutrality and energy self-sufficiency.

USING ALGORITHMS TO IMPROVE CAR-SHARING SYSTEMS

For his PhD thesis at ENAC's Urban Transport Systems Laboratory (LUTS), Martin Repoux examined solutions for improving how car-sharing systems manage their fleets and parking places. The models he created, particularly for a car-sharing provider in Grenoble, France, helped boost service levels and increase profitability.

Learn more

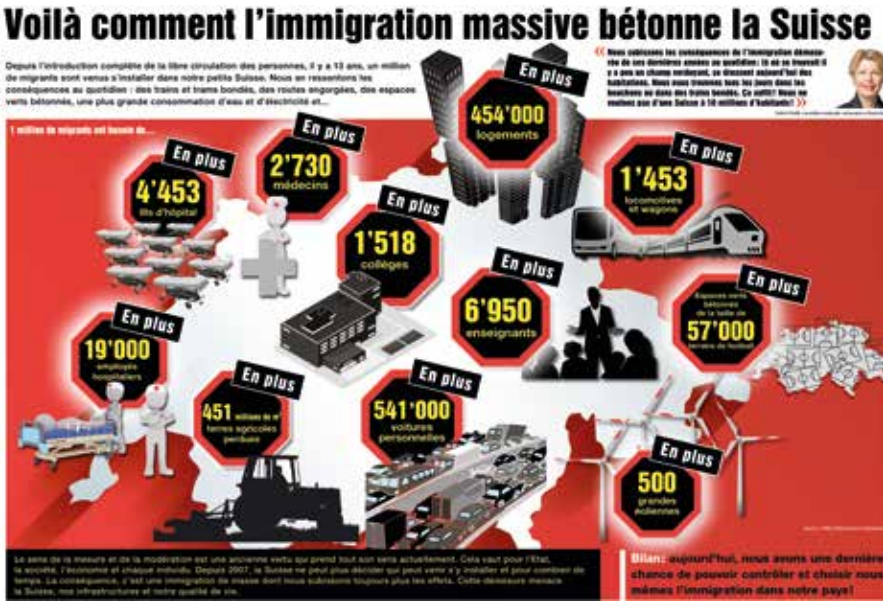


OZONE CAUSES OUR SKIN TO EMIT TINY AIRBORNE PARTICLES

The damaging effects of air pollution are caused mainly by the small airborne particles produced from traffic and coal-fired plants, or through chemical reactions with compounds in the atmosphere. An international research team including Human-Oriented Built Environment Lab (HOBEL) discovered that our very own bodies can also be a source of nanocluster aerosol emissions in places where the indoor air contains ozone.

IS A "GREEN POPULIST" MOVEMENT EMERGING IN SWITZERLAND?

According to two scientists at ENAC's Urban Sociology Laboratory (LASUR), Switzerland's right-wing populist parties have adopted some ideas from green parties in order to attract more voters. In a recent shift in messaging, the populists claim that increased urbanization and growing population density are being fueled in part by immigration, and could wipe out natural areas and expand Switzerland's carbon footprint.



IMPROVING MOBILE COVID VACCINATION EFFORTS THROUGH GIS MAPPING

ENAC's Laboratory of Geographic Information Systems (LASIG) has teamed up with Vaud Canton's Office for Civil Protection and General Health Office to deploy targeted mobile COVID vaccination centers and inform high risk groups about the importance of getting vaccinated in order to stem the pandemic.

3D detectors measure social distancing to help fight Covid-19

Author: Sandrine Perroud
Photo: Alain Herzog

A team of ENAC researchers has repurposed an algorithm they initially developed for self-driving cars to help people comply with social distancing requirements. Their program, which works with a camera, can detect whether individuals are maintaining the right distance to prevent infection – without collecting any personal data. It could be useful for public transport systems, in shops and restaurants, and even in factories.

"When Switzerland went into lockdown last year, we were working on an algorithm for self-driving cars," says Lorenzo Bertoni, a PhD student at ENAC's Visual Intelligence for Transportation (VITA) Laboratory. "But we quickly saw that by adding just a few features, we could make our program a useful tool for managing the pandemic." The VITA lab is headed by tenure-track assistant professor Alexandre Alahi.

After spending several weeks reading up on how the Covid-19 virus is spread, Bertoni and his team began to realize – along with the rest of the scientific community – that microdroplets play a key role in spreading the virus and that it's essential for people to maintain a distance of at least 1.5 meters if they're not wearing a face mask. The researchers therefore began tweaking their algorithm, which was initially designed to detect the presence of another car or a pedestrian on the road and instruct the self-driving car to slow down, stop, change direction or accelerate. The researchers just published their work in *IEEE Transactions on Intelligent Transportation Systems* and presented it at the International Conference on Robotics and Automation (ICRA) on 2 June 2021.

Alexandre Alahi (left) and Lorenzo Bertoni (right) in the Visual Intelligence for Transportation Laboratory at ENAC.

A different calculation method

Distance detectors currently on the market use fixed-place cameras and LiDAR (laser-based) sensors. But EPFL's 3D detector, called MonoLoco, can be easily attached to any kind of camera or video recorder – even those sold by consumer electronics retailers – or to a smartphone. That's because it uses an innovative approach which entails calculating the dimensions of human silhouettes and the distance between them. In other words, it estimates how far apart two people are based on their sizes instead of on ground measurements. "Most detectors locate individuals in the 3D space by assuming they're on the same flat surface. The camera has to be perfectly still and its utility is therefore limited – there are problems with accuracy if, for example, someone is coming up the stairs," says Bertoni, the study's lead author. "So we wanted to develop a detector that was more accurate and wouldn't mistake a streetlight for a pedestrian."

Other innovative features of EPFL's algorithm are that it can identify people's body orientation, determine how a group of people are interacting – and especially whether they're talking – and evaluate whether they're staying 1.5 m apart. That's all because it uses a different calculation method than existing detectors. What's more, MonoLoco keeps the faces and silhouettes of people who are filmed completely anonymous because it measures only the distances between their joints (i.e., their shoulders, wrists, hips and knees). It takes a picture or video of a given area and converts the people's bodies into unidentifiable silhouettes sketched out with lines and dots. This information lets the algorithm calculate how far apart they are and their respective body orientation. "Our program doesn't need to store the original pictures and videos. And we believe that's a step in the right direction with regard to protecting people's privacy," says Bertoni.

Several possible applications

"We came up with several possible applications for our program during a pandemic," says Bertoni. "On public transport, of course, but also in shops, restaurants, offices and train stations – and even in factories, since it could let people work safely by maintaining the necessary distance." And the distance requirement can be configured at up to 40 meters apart, whether between people or objects or both, as can their orientation. The researchers have published their algorithm's source code on the VITA website and are planning an initial deployment in Swiss postal buses through a joint project with Swiss Post.

Reference

Lorenzo Bertoni, Sven Kreiss and Alexandre Alahi, "Perceiving Humans: From Monocular 3D Localization to Social Distancing," *IEEE Transactions on Intelligent Transportation Systems*, 2021. DOI: 10.1109/TITS.2021.3069376

Building out of concrete, but without pouring concrete

Author: Sandrine Perroud
Photo: SXL

ENAC researchers have built a footbridge prototype using reinforced-concrete blocks from walls of a building being renovated. The blocks were cut into individual pieces on site and assembled into a prestressed arch. This project, which marks the first time concrete has been reused in this way, is part of an initiative to substantially shrink the construction industry's carbon footprint by adopting a circular economy approach.

"People are hesitant to reuse concrete due to a variety of concerns," says Corentin Fivet, a tenure-track assistant professor at ENAC and head of the Structural Exploration Lab (SXL) within the Smart Living Lab. "But we wanted to show that those concerns are largely unfounded. Blocks of concrete that are selected for reuse are just as reliable and useful as new blocks."

Fivet has been studying potential applications of the circular economy in the construction industry for years. His team at SXL, which is part of EPFL's School of Architecture, Civil and Environmental Engineering (ENAC), initially looked at metal and now also turns its attention to concrete. This project in particular involved building a 10m-wide footbridge out of 25 blocks of concrete taken from walls destined to be torn down.

Jan Brütting, a recent PhD graduate from SXL who initiated this project, conducted this research as part of his postdoc along with fellow EPFL postdoc Maléna Bastien Masse. For concrete to be reused effectively, new design methods are needed that are based on exploiting existing concrete sections, rather than the conventional approach of pouring fresh concrete in line with each project's specifications. The catch is that the properties of existing sections can vary and are not always known ahead of time. To help engineers employ these new methods, SXL recently developed a computer program that automates the process of selecting reclaimed elements from a given stock and minimizes a new structure's carbon footprint.

Proving its worth in practical applications

In practice, builders are often reluctant to reuse concrete due to the perceived additional risk. But the SXL team believes there are only benefits to be had. That's where their project of building a footbridge prototype comes in: to demonstrate, quickly and efficiently, that the procedure is safe and relevant. "We gave ourselves two months to find a source building in the region and a demolition company that would be interested in working with us," says Bastien Masse. That company turned out to be Diamcoupe, which had been commissioned to renovate a building erected less than 10 years ago; this renovation site was the perfect opportunity to source viable blocks of concrete. "We asked Diamcoupe to cut the concrete into the sizes we needed and to drill holes through them for our prestressing cables. These cables were provided by Freyssinet and used to build the arch," she adds.

The engineers were thus able to obtain 20cm-thick concrete blocks for the footbridge. They added mortar in places to smooth out the slight differences in dimensions, which are inevitable anytime objects are reused. "Arches are actually the ideal structure for repurposing concrete blocks,

since the material is only subject to compression forces" says Brütting.

Opening up new horizons

This project, which received funding from an ENAC Innovation Seed Grant, opens up promising new research horizons for SXL. Fivet explains: "Most buildings in Switzerland are made out of concrete, and producing this raw material accounts for 7% of CO_2 emissions from anthropogenic activity. What's more, concrete makes up 35% of demolition waste. When the material reaches its end of life, it's at best broken down into gravel or granulate to create recycled forms – but that consumes a lot of energy. If we were instead to cut up concrete blocks and reuse them, we could both prevent the need to produce more concrete and eliminate the inert waste. The carbon emissions from this process wouldn't necessarily be zero, but they would be drastically reduced. We would delay the need to downcycle obsolete concrete."

Under this circular economy approach, demolition companies – which until now have been at the end of the value chain – would also become producers, kicking off a new cycle. Fivet, true to his training as an architectural engineer, is also currently studying the factors that lead a building to become obsolete and the architectural characteristics that would facilitate the reuse of obsolete building components.

Calling on the entire industry

The SXL team's project is a call to action for the construction industry. "No other new concrete footbridge has a carbon footprint as small as ours," says Fivet. "Imagine if every obsolete concrete structure out there was cut into blocks and used to meet some of the global demand for new concrete. That would be a big step towards addressing some of the most pressing climate-change challenges."

Watch the video

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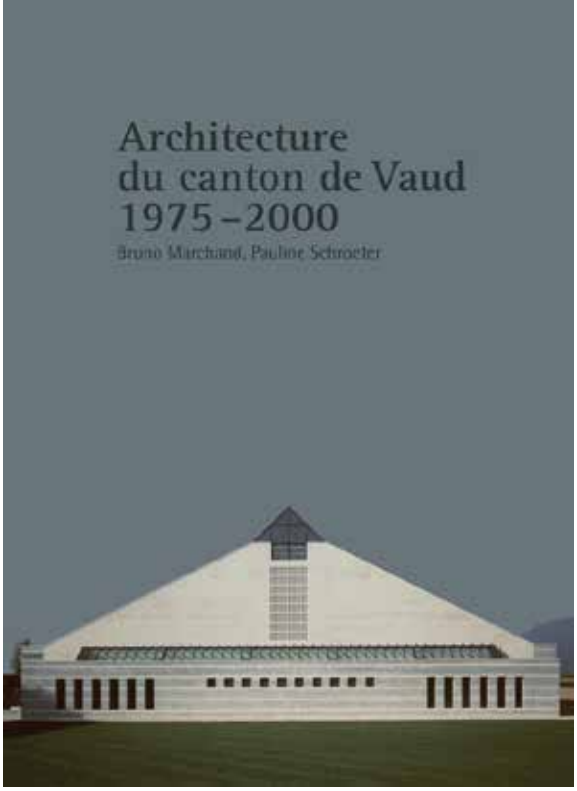
Küpfer C, Fivet C. Déconstruction Sélective - Construction Réversible: recueil pour diminuer les déchets et favoriser le réemploi dans la construction. Federal Office for the Environment FOEN; 2021.

Learn more

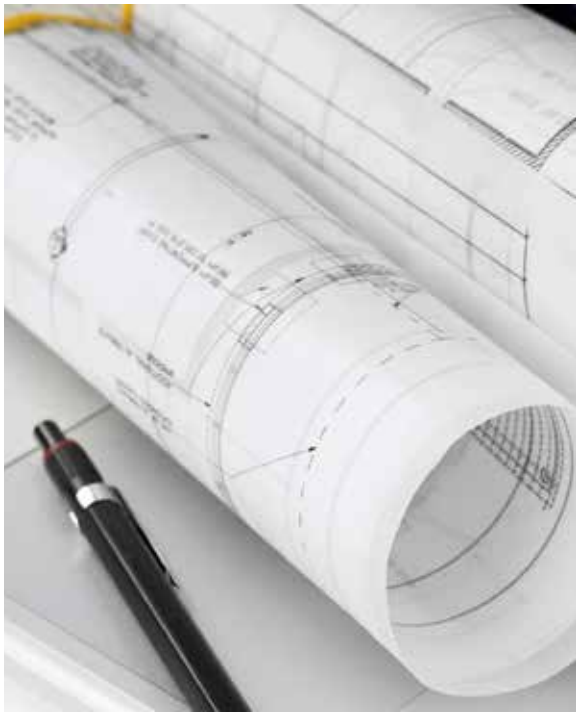


MONOGRAPH EXPLORES A VIBRANT QUARTER-CENTURY OF ARCHITECTURE IN VAUD

In a new monograph, Bruno Marchand, professor emeritus at EPFL and Pauline Schroeter, EPFL scientist, document 25 years of architecture in the Canton of Vaud, from 1975 to 2000.

MULTIFUNCTIONAL CONSTRUCTION ELEMENTS LOWER BUILDINGS' ENERGY NEEDS

Engineers at Integrated Comfort Engineering Laboratory (ICE) have studied the use of construction slabs that serve both as structural building elements and floor heating systems. Made of composite materials, these slabs could deliver heating performance on par with conventional radiant heating but consume less energy.



WHAT FACTORS INFLUENCE OUR DECISION TO STAY OR MOVE?

What makes a dwelling a place we want to call home? And why do we find it so hard to move, even when downsizing is the logical choice? To answer to these questions, researchers at the Laboratory on Human-Environment Relations in Urban Systems (HERUS) surveyed 968 tenants in Switzerland.

Learn more

USING SCIENCE TO EXPLORE A 60-YEAR-OLD RUSSIAN MYSTERY

Researchers from ENAC's Snow and Avalanche Simulation Laboratory (SLAB) and ETH Zurich have conducted an original scientific study that puts forth a plausible explanation for the mysterious 1959 death of nine hikers in the Ural Mountains in the former Soviet Union. The tragic Dyatlov Pass Incident, as it came to be called, has spawned a number of theories, from murderous Yeti to secret military experiments.

ENAC Interdisciplinary Cluster Grants 2021

These grants are intended to foster new interdisciplinary research collaborations within the ENAC community. Funding is granted to project teams conducting promising research related to our three strategic topics: climate change, digitalization and urbanization.
The three grant winners in 2021 were:

iThCoM

Non-Invasive AI-powered Thermal Comfort Monitoring

- PIs: Dolaana Khovalyg (ICE - IIC) and Alexandre Alahi (VITA - IIC)
- Start date: 1 January 2022
- Duration: 12 months

URBTREES

Disentangling the benefits provided by urban trees for nature-based solution planning: from urban cooling to sociocultural services

- PIs: Charlotte Grossiord (PERL - IIE) and Dieter Dietz (ALICE - IA) and Julia Schmale (EERL - IIE)
- Start date: 1 May 2022
- Duration: 12 months

RE:CRETE Prognosis

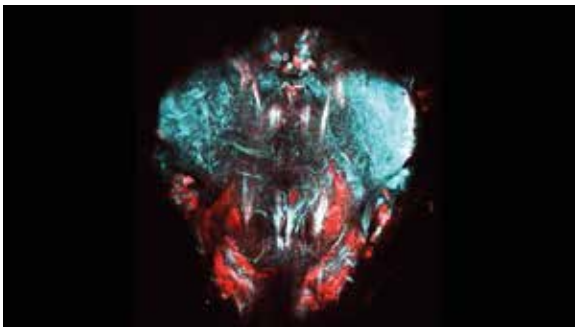
Prognosis of building stock potential for the upcycling REuse of cast-in-place reinforced conCRETE panels.

- PIs: Corentin Fivet (SXL - IA) and Eugen Brühwiler (MCS - IIC) and Franz Graf (TSAM - IA)
- Start date: 1 June 2022
- Duration: 24 months

Active collaborations with interdisciplinary centers

Interdisciplinary research is a core value at our school. ENAC is involved in the work of various research centers because tackling issues holistically is the surest path to innovative new solutions on climate change, digitalization and urbanization.

ALPOLE
The establishment of ALPOLE recognizes the global relevance of changes taking place in high-altitude and high-latitude environments, which are sentinels of climate change.



Center for Imaging
The Center for Imaging aims to strengthen EPFL's position as a world-leading institution in imaging science. Its core mission is to capitalize on our School's exceptional concentration of academic strengths and promote interdisciplinary collaboration in imaging technology.

Center for Intelligent Systems (CIS)
The Center for Intelligent Systems brings together researchers working on various aspects of creating intelligent systems.

CLIMACT Center
CLIMACT is affiliated with the University of Lausanne and EPFL and seeks to promote integrated economic, societal and environmental resilience by developing low-carbon pathways through continuous innovation in societal, ecological and technological systems.

EcoCloud Center
EcoCloud is the only university research center of its kind. It promotes eco-friendly smart data through the development of resilient, efficient, secure and trustworthy data platforms.

ECOTOX Center
The Swiss Center for Applied Ecotoxicology (Ecotox Center) detects and assesses the environmental effects of chemical compounds and develops strategies for minimizing the associated risks.

Energy Center (CEN)
The EPFL Energy Center (CEN) promotes EPFL-led energy research by confronting state-of-the-art technology and addressing society's challenges together, in order to shape tomorrow's energy systems.

Habitat Research Center (HRC)
The Habitat Research Center is a cross-disciplinary research platform designed to explore urban phenomena and outline visions, strategies and projects to address this fundamental topic.

Limnology Center (LIMNC)
The Limnology Center was established to conduct socially relevant, multi-disciplinary research to ensure the sustainable use and conservation of natural water resources at both the national and international levels.

Smart Living Lab
The Smart Living Lab is a research center for the built environment. Its aim is to create technology for achieving energy efficiency, support the digital transformation, and enhance the well-being of building occupants.

Swiss Polar Institut (SPI)
The Swiss Polar Institute (SPI) was created to provide services to and promote synergies within Switzerland's polar community.

Transportation Center (TRACE)
The Transportation Center sits at the interface between EPFL and society when it comes to issues related to transportation and the movement of people and goods.

The Center for Climate Impact and Action (CLIMACT)

Authors: Aïcha Besser & Nicolas Tetreault

The Center for Climate Impact and Action (CLIMACT) is a joint center between EPFL and the University of Lausanne (UNIL). It promotes interdisciplinary, interinstitutional research and implements initiatives that address the societal, scientific and technological challenges associated with the transition to a sustainable future.

Opened in June 2021, CLIMACT aims to have a positive impact on the research community and Swiss society at large through efforts in five main areas:

- Science: Fund joint UNIL and EPFL seed projects and serve as a launching platform for research consortiums while prioritizing a systemic approach to climate change.
- Society: Offer visibility and share EPFL and UNIL's climate research and actions with the general public.
- Knowledge: Train tomorrow's professionals and researchers by incorporating the economic, societal and technical aspects of sustainability into their degree programs.
- Impact: Foster the emergence of high impact, innovative climate-solution projects.
- Community: Strengthen the ties between public-sector, private-sector, community and academic stakeholders involved in climate action.

CLIMACT Starting Grants

2021 was a productive year for CLIMACT. In July 2021, we kicked off our first call for proposals. 30 research groups submitted proposals for 12 cutting-edge projects; seven of them were selected and granted up to CHF 50,000 in funding. The projects started at the end of 2021 aim to deliver rapid, tangible results on the following climate-change topics:

- Alpine lakes and biodiversity changes
- Brain, cognition and mood
- Deep CO_2 sequestration
- Urban soils as carbon sinks
- AI-assisted sensing of forests
- Enhanced weather monitoring
- Permafrost rock instabilities

2021 KEY FIGURES

- 350,000 CHF in seed funding granted
- 1000+ followers on our social media
- 7 projects funded
- 10+ research and on-site projects
- 50+ external speakers
- 40+ affiliated researchers
- 2 SWEET projects
- 4 employees
- 2 academic directors

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Swiss Energy Research for the Energy Transition (SWEET)

CLIMACT, working in association with UNIGE, launched its first SWEET project in 2021, called Enabling Decentralized renewable GEneration in the Swiss cities, midlands, and the Alps (EDGE).

The project is being carried out by a consortium led by EPFL and UNIGE and has secured over CHF 22 million in total funding for the 2021–2027 period. The project is expected to fast-track the expansion of locally sourced, decentralized renewable energy facilities in Switzerland with the goal of ensuring that by 2035 and 2050, when Switzerland's ambitious renewable-energy targets are reached, the country's energy facilities are designed and operated in a technically and economically efficient, secure way and are well-positioned in European markets.

CLIMACT is involved in new demonstration projects through SWEET-EDGE; these include projects to build a renewable energy (wind and solar) park at the Lukmanier pass and to develop systems for agro-photovoltaics.

CLIMACT Seminar Series

We put on an online seminar series in 2021 called How to Move Forward and Act on Climate Change. The seminars were held every two weeks and attracted 100–150 viewers each time. This series contributed to the debate on climate change and led to joint initiatives among key UNIL and EPFL scientists, Swiss politicians, entrepreneurs and other stakeholders.

Community and knowledge

CLIMACT also strives to form value-added joint ventures with a number of other centers and instititutions. For example, we held in december a joint conference with E4S for students in the Master in Sustainable Management and Technology of UNIL-HEC, IMD and EPFL as well as the new minor in sustainable engineering offered at ENAC. Also, we held in May a joint event for the general public with the EPFL Energy Center and E4S on Net Negative Technology. Finally, CLIMACT started a pilot project together with the Zero Emission Group, the VPT, and ENAC, called Climate Change in Courses (3C). The goal was to establish a feedback loop between students and professors who are eager to increase the visibility of climate-related topics in their degree programs.

2022 outlook

We have set ourselves a number of ambitious goals for 2022. We have issued a call for new CLIMACT Starting Grants for May 2022 and have created the CLIMACT Scholar community for young career researchers in the fields of science, engineering and the humanities in order to support their groundbreaking interdisciplinary research and high-impact ideas. We also plan to hold various events and seminars and issue whitepapers to encourage dialogue between science and society, improve mutual understanding between these two stakeholder groups, and set the stage for enhanced collaboration. One goal will be to find joint venture opportunities with businesses and policymakers, to make progress towards Switzerland's ambitious climate goals.

www.climact.ch

Transportation Center (TRACE)

Bringing transportation and mobility issues from society to laboratories

Authors: Anne-Muriel Brouet & Simone Amorosi

The Transportation Center (TRACE) is an EPFL strategic center that works under the Vice Presidency for Academic Affairs (VPA) in the team of Prof. Anna Fontcuberta i Morral. It has been led by Prof. Michel Bierlaire since its opening in 2010. TRACE now has over 100 research labs (about 50 of them have been active in TRACE projects so far) from all EPFL schools.

Transportation systems are undergoing a fundamental shift in how they're structured and operated, as a result of technological advancement (in areas such as self-driving cars, on-demand services, robotics, artificial intelligence, and mobility-as-a-service) and responses to environmental and societal challenges. The problems and issues surrounding the future of transportation are so complex that no single entity can solve them on their own; a cross-disciplinary approach is needed involving many stakeholders.

At TRACE, we build on our experience to increase our impact across EPFL's three core missions (research, education and innovation), drawing on our vision to build sustainable, user-centered, efficient, fair and safe transportation systems.

Our primary role is to serve as an interface among EPFL's various entities (laboratories, schools, VPs, centers and platforms) and between these entities and the outside world for issues related to transportation and logistics (for both people and goods). In this regard, our main objectives are to initiate transportation-related research projects and to raise outside funding to support transportation-related research at EPFL. In 2021, we were involved in a project to develop a drone ambulance service, for example, in association with the Canton of Geneva and the HUG and CHUV hospitals. We were also actively involved in the deployment of an autonomous delivery service on the Lausanne campus through a project called ADORE. In this project, students tested new technology like special low-cost cameras to be used as alternatives to expensive LIDAR systems (the ENAC labs involved were VITA and TRANSP-OR).

We are working with EPFL's Hyperloop team to help develop a modern alternative to rail travel, through our participa-

Clockwise from top: Semi-autonomous flying ambulance for the Canton of Geneva; autonomous delivery vehicle on the EPFL campus; EPFL's Hyperloop prototype. ©EPFL

tion in an Innosuisse-funded project called LIMITLESS. And we continued our outreach initiatives by holding seminars and arranging visits to public agencies (like the Swiss Federal Office of Transportation) and to companies, with the goal of showcasing EPFL's transportation-related research activities.

Our second mission at TRACE is to promote educational initiatives like semester projects and Master's theses in the field of transportation. And our third mission – on top of conducting cutting-edge, cross-disciplinary research and teaching on transportation issues associated with societal challenges – is to boost the visibility of EPFL's research in this area and transfer technology to industry. Our Center's strong reputation makes it a key contact point for stakeholders outside EPFL that want to examine opportunities for joint initiatives with our School.

ENAC LABORATORIES INVOLVED IN TRANSPORTATION CENTER:

- CEAT – Urban and Regional Planning Community
- CNPA – Laboratory of Digital Culture for Architectural Projects
- DISAL – Distributed Intelligent Systems and Algorithms Laboratory
- GEL – Geo-energy Laboratory
- HERUS – Laboratory on Human-Environment Relations in Urban Systems
- LAB-U – Laboratory of Urbanism
- LASIG – Geographic Information Systems Laboratory
- LASUR – Urban Sociology and Mobility Laboratory
- LESO-PB – Solar Energy and Building Physics Laboratory
- LSMS – Computational Solid Mechanics Laboratory
- LUTS – Urban Transport Systems Laboratory
- RESSLAB – Resilient Steel Structures Laboratory
- TOPO – Laboratory of Geodetic Engineering
- TRANSP-OR – Transport and Mobility Laboratory
- VITA – Visual Intelligence for Transportation

TRACE also plays a role in promoting transportation systems and technology across our School and beyond. We showcase articles published by research labs, as well as student projects and pilot tests, on our website, on EPFL's website, and through press releases and articles. In addition, TRACE is active on social media (namely Twitter and LinkedIn) where we share interesting scientific articles and events related to transportation in general and to EPFL labs in particular. We set up a LinkedIn page in October 2021 as a showcase page of EPFL's LinkedIn account. Here, we actively promote news articles, research findings and events associated with transportation research at EPFL.

Website

Excellence in Education

Students in our three sections get a world-class education with classes that enable them to specialize in their chosen field of study. A unique feature of ENAC is that our interdisciplinary classes and hands-on design projects combine elements of other ENAC disciplines, allowing the next generation of architects and engineers to deepen their knowledge through a comprehensive approach to learning.

The educational excellence we strive for is illustrated in the three Master's theses described on the following pages and in the six winners – all from ENAC – of the 2021 Durabilis award. Our school is devoted to training architects and engineers who are capable of developing impactful responses to today's sustainability challenges, and thus serve society.

Our interdisciplinary approach is reflected in the two new programs we introduced in 2021: a minor in Engineering for Sustainability, open to EPFL Master's students; and a Master of Advanced Studies in Urban Design, given jointly with ETH Zurich. Last year we also continued to give our students an interdisciplinary education and, through our Design Together and SKIL programs, we helped prepare them for careers in which they'll work on concrete projects with professionals from other disciplines.

Helping engineers better predict clay landslides

Author: Sandrine Perroud

In Kattmarka, buildings and a stretch of highway were washed away by the clay sludge. © NGI

Norway experiences dangerous landslides due to its clay-rich soil. For her Master's thesis in civil engineering at EPFL, Mathilde Metral outlined steps that the country's geotechnical engineers can take to improve the predictive computer model they're currently developing.

The heavy rains that sweep across Europe with growing frequency can be particularly damaging in Norway, where the clay-rich soil is susceptible to landslides. As part of her Master's thesis in civil engineering, Mathilde Metral worked with the Norwegian Geotechnical Institute (NGI) to test the computer model that engineers there are developing to predict clay landslides. "I wanted to apply geotechnical concepts to help prevent natural disasters," she says. "My interest in this topic stems from the challenge of investigating these complex phenomena as well as from the mountaineering activities I enjoy doing." Metral teamed up with ENAC's Laboratory of Soil Mechanics (LMS), headed by Prof. Lyesse Laloui, for her research. The suggestion to work with NGI – known around the world for its expertise in clay soils – came from Alessio Ferrari, a research associate at LMS and Metral's thesis advisor.

Norway has experienced three major landslides in the past 12 years due to the unstable nature of its quick clay. The first event took place in Kattmarka on 13 March 2009, when a landslide carried off several buildings and one section of a highway. Then, on 10 November 2016, a flowing mass of quick clay killed three construction workers in Sorum. And on 30 December 2020 in Gjerdrum, a village with 5,000 residents northeast of Oslo, a landslide leveled 30 homes. That disaster left nine dead, with one person still missing and around 1,000 people having to be evacuated.

A technological challenge

Engineers in Norway have been working for several years to develop a computer model that can predict such catastrophes. But the mechanisms involved are complex, and modeling them involves quite a bit of research, trial and error. Metral's Master's thesis entailed testing the robustness of the engineers' model by seeing how well it could replicate the 2009 and 2016 landslides. She performed back calculations, running the model based on the parameters used at the time to determine what the model would have predicted and what was still needed for an accurate prediction.

"Norway's clay slopes are stable only in marine environments. But since Norway's climate is changing and heavy rains are removing the salt that's naturally present in the soil, the soil can easily collapse like a house of cards," says Metral. "It's a real threat for nearby houses and infrastructure." Much of what makes quick-clay landslides so difficult to predict is that engineers must apply the fundamental laws of fluid mechanics to classical geotechnical substances. The range of variables they have to factor into their equations include soil topography and density, yield stress in the soil's intact and fluid states, and the quality of soil-composition data obtained during ground surveys.

The limitations of software

"I was able to identify where the deposition areas were for the 2009 and 2016 events and calculate the likely time interval for the landslides," says Metral. "The NGI model did a good job of replicating the Kattmarka one. But for Sorum, it was hard to know what the soil conditions were at the time, because the topographic maps there are older and construction work was going on at the time." By testing effects that hadn't been studied previously and that aren't yet operable, Metral helped the NGI engineers refine their selection criteria and better understand the limitations of their software.

These kinds of predictive models are becoming increasingly important as global warming gains pace, according to Ferrari: "Global warming is amplifying phenomena such as extreme rainfall events, permafrost degradation and increased snow melting. As a consequence, the impact of landslides will likely grow in susceptible areas. By developing and refining modeling software – like what Mathilde did for her Master's thesis – we will be better able to anticipate the potential consequences of landslides and mitigate the related risks."

Reference

Mathilde Metral, "Runout of landslides in quick clay zones," co-directed by Dr. Alessio Ferrari of EPFL (Lausanne, Switzerland) and Dr. Håkon Heyerdahl and Dr. Zhongqiang Liu of NGI (Oslo, Norway). Laboratory of Soil Mechanics (LMS) at EPFL and the Norwegian Geotechnical Institute (NGI), 25 June 2021.

3D modeling of the Flon river helps engineers plan a new metro line

Author: Sandrine Perroud
Photos: Leona Repnik

Lausanne will soon be getting a new metro line, the m3, but question marks remain over the best way to build the tunnel at the Flon station – already one of the busiest metro stations in French-speaking Switzerland. Leona Repnik, who just graduated from EPFL with an environmental engineering degree, studied this problematic for her Master's thesis and put forth a feasible solution to this complex problem.

Leona Repnik combined her longstanding interest in ecology and river restoration with a specialization in hydraulics for her Master's degree in environmental engineering at EPFL. Driven by a desire to learn as much as possible about hydraulic modeling, and by the great enthusiasm of her thesis supervisor Giovanni De Cesare, Repnik set herself an ambitious research goal: to develop a 3D numerical model of the Flon river flowing underground through the city of Lausanne, in order to help engineers design the new m3 metro line scheduled to open in 2030. Her work, whose excellence earned the kudos of the jury, showed that building the m3 line won't be easy – but that solutions do exist.

A hidden river

"Many people in Lausanne don't know that there's a river flowing beneath them," says Repnik, who researched the Flon's history for the introduction to her thesis. "The Flon valley was a thriving area in the 19th century. It was lined with merchants, who used the river to generate the energy they needed. But city officials later decided to bury the Flon to limit the risk of contamination and the spread of disease arising from the waste released into the river."

Old paintings of Lausanne show the Flon valley in the 1800s. The Grand-Pont, which is the large bridge running across Place de l'Europe, was built with two rows of arches. When the Flon valley was filled, the lower row of arches was buried underground, leaving only the top row of arches visible today. Repnik discovered in her research that the underground river is now part of the city's sewage network, carrying wastewater from Lausanne to the wastewater treatment plant in Vidy and eventually releasing it into Lake Geneva.

View of the Flon River valley and the Grand Pont bridge around 1845. The bridge is characterized by two rows of arches. The bottom row of arches was placed underground when the Flon valley was filled. The top row of arches is still visible today at Place de l'Europe. © Musée Historique Lausanne

Lowering the ceiling

Repnik's 3D numerical model focuses specifically on the Flon metro station in the center of Lausanne. The current plan is to run the m3 line underneath Place de l'Europe and just above the existing underground vaulting in which the Flon flows. This would require lowering the height of the vaulting by about a meter to provide enough space for the metro line to pass above.

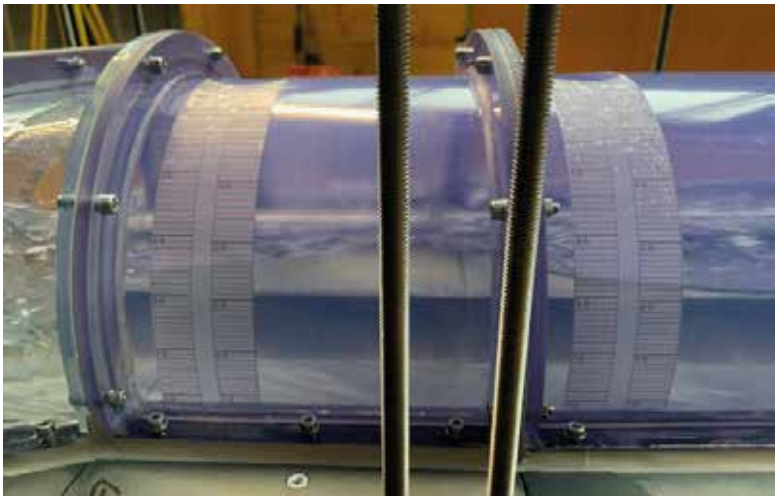
"Our model, which incorporates many different parameters, suggests that this would be a complicated task," says Repnik. "The vaulting must maintain its capacity to handle a 100-year flood event, which would not be possible if the ceiling is lowered according to the current plans. One possible solution would be to lower the bottom of the vaulting. That would allow the m3 line to be built underground without compromising on safety." In other words, her idea is to take the work done by engineers from past centuries one step further by burying the Flon even deeper underground.

The study's conclusions are based on a hybrid approach combining the 3D simulations from the numerical model with theoretical calculations and a physical model built at ENAC's Platform of Hydraulic Constructions.

Physical model provides a reality check

Repnik's numerical model let her define different parameters, such as the height and width of the vaulting, air and water properties, surface roughness and flow turbulence. She then used a physical model to verify the computer's results. "It was really rewarding to see the results of my numerical simulation play out for real as the water flowed through the physical model," she says. With her degree in hand, Repnik is now employed by an engineering company in Bern that specializes in river hydraulics.

The physical model in the hall of the Platform of Hydraulic Constructions. The model was built at a reduced scale of 1:20, with a total length of 7.6 meters. The railings on the sides were used for taking measurements.



Water flowing through the physical model. The scale bars were used to determine the water level.

"This was a great opportunity for Leona to experiment with a physical model and take part in a real-world hydraulic engineering project, in conjunction with an engineering company and a client," says De Cesare, who heads up operations at the Platform of Hydraulic Constructions and teaches classes on hydraulics. "It's always an enriching experience for a Master's student to actively help transfer technology to industry and gain direct experience in the business world."

Repnik presented her Master's thesis at the 2021 SimHydro conference in Nice, and her work appeared in Advances in Hydroinformatics – a collection of papers from the conference, to be published by Springer.

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How can we make our housing less heteronormative?

Author: Sandrine Perroud
Photo: Murielle Gerber

An EPFL architecture student's radical new approach to the layout of typical city-center buildings in Lausanne, and how we inhabit the spaces we live in, may just revolutionize our ways of thinking.

A washing machine as a living room's centerpiece. A walk-though closet that becomes a door – and doors that become mirrors. An open-air space on the roof for entertaining. A "communal kitchenless kitchen." Glazed facades that reveal the interiors of buildings, above all the basement. Welcome to the "queer" house – or at least one that's less heteronormative, as conceived by a young EPFL graduate in architecture.

Let's face the facts: the ways in which our living spaces are arranged has not changed much for the best part of two centuries. The same cannot be said, however, of our lifestyles. What's worse is that the way in which our rooms are laid out, as originally designed by men, limits the way we live. That's the theory put forth by Claire Logoz, whose Master's thesis explores heteronormative architecture. EPFL's DRAG Lab association, of which she is a member, plans to develop a new class that explores architectural norms – a topic currently missing in EPFL's architecture curriculum.

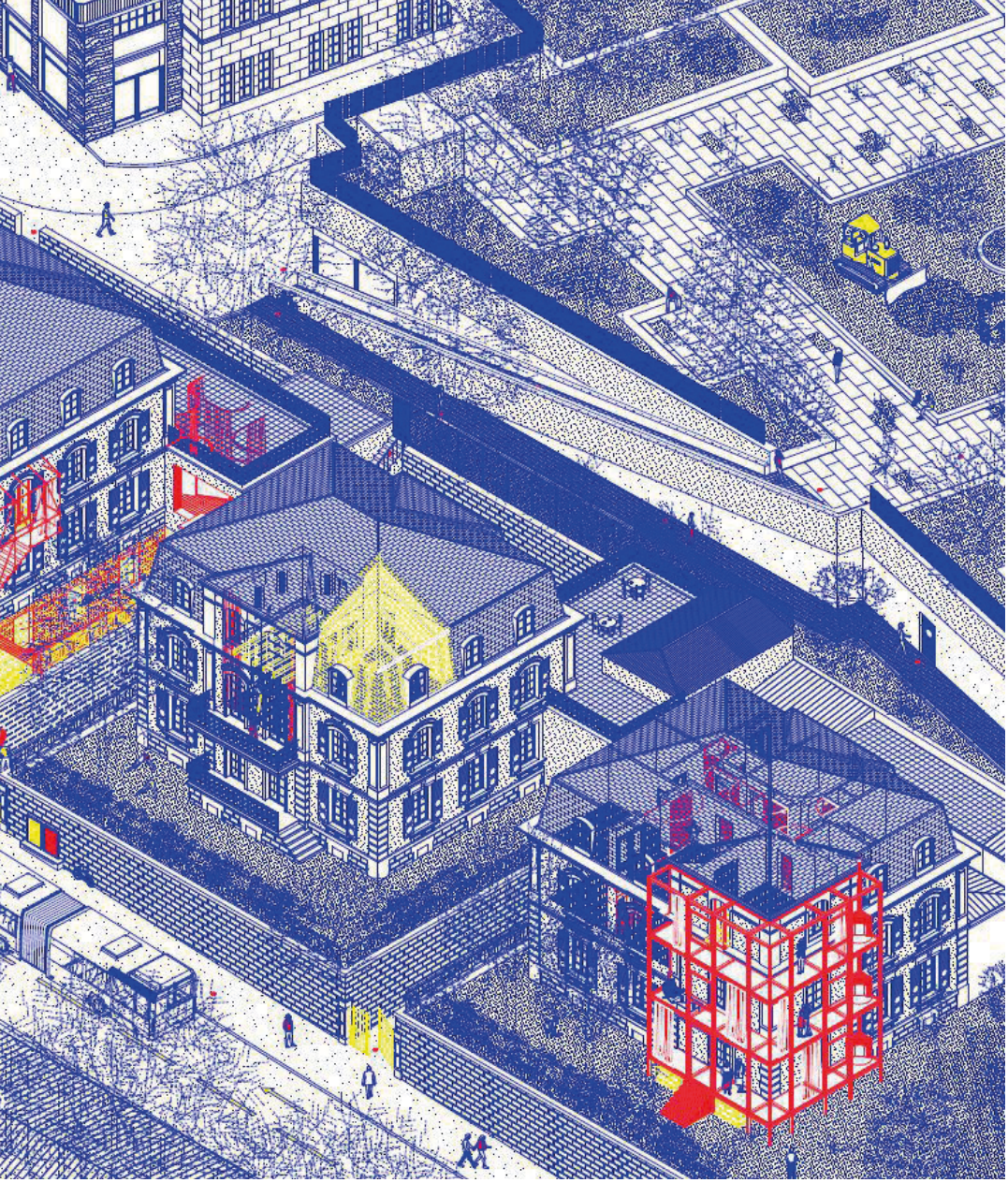
An inclusive vision

Everything evolves with time: language, which has become progressively more inclusive, and social attitudes, as reflected in new laws that address inequality towards minorities. But what about our homes? "I believe that the design of our homes has a direct impact on our way of living. Architecture exerts a social power over us; it's clear that we're shaped by the spaces around us," says Logoz. A feminist since childhood, even before she knew what the word meant, Logoz decided to channel her activism into academic research. "I read everything I could get my hands on about the relationship between gender studies and architecture. The first articles date back to the 1990s, but nothing has really been done to turn those ideas into concrete projects. That's kindof surprising."

After spending a semester conducting theoretical research, Logoz decided to apply her findings to four villas urbaines – a type of housing specific to 19th-century Lausanne. In her work, she completely redesigned the layout. "My final design is for everyone, not just young free-thinking urbanites. Traditional families could also comfortably live in these spaces," says Logoz.

Honing reflections with humor

As a theater-lover, Logoz's ideas for "alterations" naturally have their roots in set design. Some changes she proposes are symbolic, such as walk-through closets that serve as doors, alluding to the fact that "the closet" has for decades been a symbol of the shame of homosexuality. She has humorous ideas as well, such as replacing a fireplace with a washing machine to create a "living laundry room." For all its playfulness, however, Logoz's offbeat approach intends to hone our ways of



© Claire Logoz - 2021 EPFL

thinking. “American architect Frank Lloyd Wright moved the fireplace to the center of the living room to make it a space for relaxation. But only men were able to enjoy this, because the women were busy with household chores,” says Logoz. By placing a washing machine at the house’s center, she pays homage to the materialist feminists of the 1960s who decried the “invisibility of domestic work.”

Inspired by Playboy

Surprisingly, Logoz also found inspiration in architects featured in Playboy magazine, who attempted to “liberate the playboy” from architecture designed for a nuclear family. “For the building’s pool, I replaced the voyeuristic windows favored by these architects with mirrors, to reflect back positive body images to its users. And the changing rooms are, of course, gender neutral.”

Logoz has also turned stairways into «stairs of interaction:» places where residents can meet socially and relax. A system of pivoting doors and curtains enables them to create private spaces and independent entrances for apartments. These imaginative designs allow the layout of an entire building to be modified according to individual needs. “Today’s families are made, split apart and formed again in new ways. It’s time architecture caught up with that,» says Logoz.

Watch the video

Reference

Claire Ana Logoz, «Catalogue non exhaustif d’altérations performatives», supervisé par Dieter Dietz, Jo Taillieu, Quand-vinh Linh, Julien Carboni Lafontaine, September 2021.

Three climate-related ENAC projects win the 2021 Durabilis Awards

Author: Emmanuelle Marendaz Colle
Photo: Alain Herzog

The Durabilis Awards, introduced in 2007, are open to all Bachelor's and Master's students at EPFL and UNIL, and are awarded to projects that explore issues related to sustainable development. This year, all six winners are from ENAC's environmental sciences and engineering section.

The winners of the Durabilis Awards are selected by a panel of judges comprising representatives from the University of Lausanne (UNIL) and EPFL, a cantonal forest inspector and a journalist. In this 15th year of the awards, the judges reviewed 33 applications and selected three projects. All the winning students are from ENAC's environmental sciences and engineering (SIE) section, within the School of Architecture, Civil and Environmental Engineering (ENAC).

The awards were handed out at a ceremony at EPFL on 2 December 2021. During the ceremony, Augustin Fragnière, chair of the selection panel and deputy director of UNIL's Competence Center in Sustainability, explained that this year's winning projects all suggest practical methods to help combat climate change. He also thanked the mayor of Ecublens, who attended the ceremony, for supporting the awards.

A strategy for offsetting carbon emissions

Julie Reznicek, a Master's graduate from EPFL's Laboratory of Environmental and Urban Economics, won a Durabilis Award for her thesis titled Developing a Strategy to Offset Carbon Emissions at EPFL. She conducted her research as part of EPFL's Campus Climate Plan, examining five different carbon-offset methods that could potentially be used in Switzerland: producing biochar, an organic charcoal-like material that is made by burning biomass; restoring wetlands by reintroducing water to dried-out areas, which limits decomposition and thereby reduces methane production; improving how forests are managed and increasing the production of Swiss wood products; installing solar panels as part of a Virtual Power Purchase Agreement (VPPA) whereby any unused electricity is fed back into the grid; and finally, instal-

ling a geothermal heat pump, which transfers heat from the ground to warm buildings.

Reznicek's initial aim was to identify the best strategy for EPFL, but in the end she shifted her focus to a much broader question. She examined whether investing in carbon-offset systems was the best way for an engineering school to achieve carbon neutrality – and she gave a very clear answer during the award ceremony:

«An engineering school like EPFL would be better off exploring innovative technological solutions rather than focusing solely on carbon offset projects»

Julie Reznicek, SIE Master's graduate and winner of a Durabilis Award

The judges praised Reznicek's analyses for being "thorough and accurate" and concluded that her research would help "improve EPFL's climate policy."

A tool for managing urban ecosystems

Marine Manche and Quentin Chiche, both Master's students, received a Durabilis Award for a project they completed during the Design Project module of their Master's program. Their aim was to develop a method for monitoring sustainability in Fribourg and evaluating the resilience of its urban ecosystem. They worked hand-in-hand with local stakeholders and identified 17 key issues along with 38 indicators. They compiled these key issues and indicators into a "sustainability wheel" – a tool that policymakers can use to visualize each indicator and track how it changes over time.

«By taking a collaborative approach, we discovered things that, as engineers, we hadn't previously considered.»

Marine Manche and Quentin Chiche, SIE Master's students and winners of a Durabilis Award

According to the judges, the wheel design is "ingenious" and "makes it easier to understand the various aspects of sustainability." They added that it could easily be adapted and used in other contexts.

Concrete ways to reduce our carbon footprint

The third winning group was made up of Alexis Barrou, Edouard Cattin and Blanche Dalimier. As part of their life-cycle analysis class, they worked on a project called Annual Carbon Footprint of an Average Swiss Resident and his/her Key Actions, with the goal of identifying concrete steps people could take to reduce their carbon footprint.

The students began by identifying four main sectors that contribute to consumers' carbon footprint: food, transportation, housing, and goods & services. These sectors were selected because they encompass most aspects of daily life. In analyzing the emissions of each sector, they found that a Swiss resident produces an average of 11.6 tons of CO_2 equivalent per year. In Switzerland, 60% of total emissions are generated by the transportation and goods & services sectors (30% each), while residential heating accounts for 12.5%. The goods & services sector includes many subsectors – in some of them (like healthcare) it would be hard for consumers to reduce their carbon emissions, but in others it would be possible by making certain lifestyle changes, such as by opting for more sustainable clothing or buying fewer digital products. All the potential actions identified by the students and their detailed calculations will soon be published on the Climpact website.

«Drinking bottled water for a year produces more CO_2 emissions than flying from Geneva to Barcelona.»

Alexis Barrou, Edouard Cattin and Blanche Dalimier, SIE Master's students and winners of a Durabilis Award

The judges were impressed that the students had calculated the carbon footprint for an average Swiss resident so meticulously and precisely and were able to suggest around 50 ways for people to reduce their carbon footprint.

According to Fragnière, the three winning projects demonstrate how important it is to address problems in a multi-faceted, holistic way. Just before the award ceremony, Klaus Schönenberger, head of EPFL's EssentialTech Center, gave an inspiring talk on this very topic. He stressed that taking a cross-disciplinary approach will be crucial if we are to use innovation to achieve the goals of sustainable development, social justice and peace.

Design Together: students join forces out in the field

Author: Melanie Studer
Photos: EPFL-ENAC

At the 2021 ENAC Week, 267 second-year students got their hands dirty by taking part in 13 workshops designed to give them experience in working jointly with students from other sections.

Participants had a chance to try their hand at stone cutting, redesigning Piccard Avenue on the EPFL campus, building shelters for refugees, and assembling changing rooms out of recovered-waste materials, for example.

In addition, 166 third-year ENAC students took part in nine different ENAC teaching units where they strengthened their interdisciplinary skills by working on group projects, such as to design a sustainable neighborhood in Morges, to outline long-term urban planning ideas for the developed world, and to devise a habitat on Mars.

At the Master's level, 85 ENAC students worked on interdisciplinary semester projects under the supervision of one or two teachers.

And finally, we held three summer workshops on the ecological transition in urban environments, the resilience of mountainous systems and the prototyping of textile concrete pavilions.

Student Kreativity and Innovation Laboratory - SKIL

Author: Samuel Cotture
Photos: SKIL

Nearly 1,000 students worked in our Student Kreativity and Innovation Laboratory (SKIL) in 2021, and professors at the lab supervised over 15 semester projects.

Last year we saw that students were increasingly interested in low-tech projects and in developing sustainable systems, especially for recycling and reuse.

This growing concern for the environmental and social impacts of technology was also reflected in the ENAC-wide Design Together program for Bachelor's students and in the project ideas submitted for EPFL's MAKE program. This latter program supports interdisciplinary projects across EPFL and, in 2021, a number of projects selected for the program were closely tied to ENAC (e.g., AgriFood and research on carbon removal, the reuse of waste and low-tech systems for urban areas). These projects are driven purely by students' own initiative and motivation.

In addition, EPFL's Associate Vice President for Education set up a project-based learning committee to outline initiatives for promoting interdisciplinary, hands-on educational methods. The committee identified SKIL as a crucial aspect of EPFL's broader efforts to provide a project-based education. The experience and knowledge gained through the implementation of SKIL is being applied elsewhere at EPFL. For instance, SKIL is being used as a valuable template for a new prototyping workshop in mechanics and electronics that will serve a larger segment of the student community encompassing all EPFL schools. The new workshop will draw on SKIL's example of giving students access to state-of-the-art equipment and personalized support. It will also give ENAC students an opportunity to engage in more hands-on projects and encourage students across EPFL to work with peers in other fields through a cross-disciplinary approach.

New Minor in Engineering for Sustainability

Author: Melanie Studer

We introduced a new Minor in Engineering for Sustainability, offered in association with EPFL's School of Engineering, at the start of the 2021–2022 school year.

This Minor, created at the initiative of EPFL's Associate Vice Presidency for Education, is hosted by the Environmental Science and Engineering Section and supervised jointly by Pierre-Yves Gilliéron and Yves Leterrier, with Melanie Studer serving as coordinator.

The program aims to give students the skills they'll need to address the sustainability challenges in their careers and as responsible citizens. It develops students' know-how in engineering, the natural sciences, innovation, technology, and the social sciences, so as to encourage a holistic view of sustainability.

The Minor includes three groups of courses:

1. Foundations, tools and methodologies,
2. Materials, processes and infrastructures,
3. Environmental and human systems.

It also includes a mandatory interdisciplinary project (worth 10 ECTS credits) in which students apply the theory they learn in class.

The main goals of our new Minor are to:

- Heighten awareness of sustainability-related challenges and the interactions between them.
- Teach students the skills and methods needed to address these challenges.
- Build a common understanding and interdisciplinary view of sustainability across nearly all EPFL Master's programs.

New post-graduate program: MAS in Urban and Territorial Design

Author & photos:
Valentin Bourdon

In September 2021, the ETH Zurich Insitute of Landscape and Urban Studies and the EPFL-ENAC Habitat Research Center jointly introduced a new Master of Advanced Studies (MAS) in Urban and Territorial Design (UDT).

The first cohort of students in the program will present the results of their fall-semester work on the Lausanne campus in late January 2022; the students will then join ETH Zurich in February for the spring semester.

This MAS addresses the ecological, societal and economic transition as its main field of critical and imaginative investigation. By examining the transformation, reuse, regeneration, reparation, and transition of habitats and ecosystems, the MAS will teach students how to deploy urban and territorial design as a crucial element of knowledge production across scales.

The first research conducted under the program looked at the Greater Geneva area. Students carried out an advanced study of the ecological functions supported by the area's major landscape structures. They ran five analyses, taking the area's hydraulic systems and the watershed scale as structuring frames of reference, and came up with five design proposals. Each proposal hopes to inspire a tangible paradigm shift towards a socio-ecological transition encompassing policymakers, urban planners and society at large. Greater Geneva's urban planning department has already reviewed the studies and given positive feedback; the studies will soon be available on the program's website.

Diversity

ENAC's Diversity Office (DO@ENAC) was set up in 2021 to succeed the ENAC Gender Equality Group. Our School strives to be inclusive and celebrate diversity and, in so doing, attract the best and the brightest. DO@ENAC's role will be to make sure that ENAC provides an environment where people can flourish regardless of their gender, background or any other personal characteristic.

The DO@ENAC is designed to capture the diversity of ENAC, both thematically and in terms of position. Thus, it is populated with representatives of the various groups that make-up ENAC: Bachelor's, Master's and PhD students, postdocs, administrative, scientific, and technical staff, as well as professors and MERs. It also includes members from all three Institutes and Sections as well as ENAC Central services. DO@ENAC currently has a total of 37 members.

The DO@ENAC is organized in three Working Groups (WG). The first, the Recruitment and Retention WG is focused on the recruitment process and whether there are ways to enhance diversity in hiring. Retention of permanent staff is also a topic of importance for this WG. The second is the Communication and Information WG which is tasked with gathering and sharing information about diversity at ENAC, raising awareness of diversity, organizing diversity-themed events, as well as ensuring gender- and diversity-aware communication. Lastly, the Onboarding and ENAC Culture WG aims to help ensure that ENAC is an inclusive and respectful work and study environment for everyone. Thus, an emphasis on training and awareness-raising characterizes this WG.

Naturally, DO@ENAC works closely with EPFL's Vice-Presidency for Responsible Transformation (VPT) to coordinate actions on diversity, inclusiveness, and respect.

Women at EPFL: (civil) engineering the future

Author: Rémi Carlier
Photo: Alain Herzog

International Women's Day Series - Like EPFL's other branches of engineering, its civil engineering program struggles to attract female students, who account for approximately 25% of total enrollment. Nonetheless, the department is determined to boost the appeal of this discipline and the wide range of professions for which it prepares graduates. We interviewed women in Bachelor's and Master's programs about why they chose civil engineering and how to bring more women on board.

After earning her *matura* (a Swiss school-leaving certificate) from Collège de Saint-Maurice, Méryl Schopfer knew exactly where she wanted to study – EPFL. Ever since childhood, she had been fascinated by how buildings are constructed and, given the high grades she received in mathematics and physics, she felt drawn to civil engineering. "I find everything about the world around us so interesting, and I thought this would be a good way to answer many of my questions." Now in the first year of her Master's degree, Schopfer has never regretted her decision. Although all this seems natural to her, her choice was quite exceptional: in high school, the physics & applied mathematics option she chose consisted mostly of boys, and she was the only girl to choose engineering.

While the gender ratio has improved considerably over the last few decades, engineering programs, including civil engineering, still find it difficult to attract female students. At EPFL, between 20% and 25% of Bachelor's and Master's students in civil engineering are women, a percentage that never seems to rise. There are many reasons for this, ranging from popular perceptions of the profession to societal stereotypes and concerns about working in a predominantly male environment.

"Engineering involves a fair amount of hard science – math and physics – that, starting in high school, tends to attract more boys than girls. Civil engineering also is stigmatized by the cliché image of cement mixers at construction sites which, while it might appeal to some, drives many others away. Part of the solution lies in conveying a more accurate picture of what civil engineering is about, which in turn may help to open up the profession," says Professor Lyesse Laloui, head of EPFL's civil engineering section.

Beyond just construction sites

Civil engineering encompasses a wide range of fields that involve digital technology, modeling and artificial intelligence – such as dam construction, material flows, autonomous vehicles, energy and carbon storage. This is very far indeed from the stereotypical image of a construction site, which is still viewed primarily as a masculine setting. "At school, I was rather interested in architecture, but found that it was too artistic for me. So I turned instead to

Méryl Schopfer and Julie Devènes, Master's students in Civil Engineering at the EPFL, in the hydraulic hall where a dam project on the Rhône is being tested.

civil engineering, which seemed a good compromise with science even though I didn't really know much about it. My original impression was that civil engineering is all about concrete and building sites, which doesn't really appeal. But in the end, I discovered a wide range of areas that are really interesting," says Julie Devènes, who is in her second year of a Master's program in civil engineering.

Devènes also remembers choosing the math & physics option at her secondary school in Bussigny, something exceptional for a girl. "That option was already a big step, since nearly all of my friends were doing something else. In high school, there were only 8 girls studying math & physics out of a class of 24." But that wasn't enough to make her change course: "The most important thing for me was to do something I felt comfortable with," Devènes says, smiling.

It's hard to say why girls are less likely than boys to focus on math and physics. Both home and school environments likely play a role, along with societal conceptions of these subjects. Halime Wawa Dahab, who studied science at a French *lycée* before earning a place in a prestigious preparatory math & physics program in Paris, offers an example: "My main teacher at the lycée told me that, despite my good grades, I would never get into the preparatory program. I don't know if that was because he didn't believe in me, or because he thought I wouldn't do well, but I noticed that he was less hard on the boys who chose the same path. In the end, I got in and they didn't," says Dahab, who is now a third year Bachelor's student in civil engineering.

"They say that math is really more for boys. But that's not true at all. Look at me, I'm a girl and it interests me as well," says Rosa Schnebli, who is a second-year Bachelor's student in civil engineering. The fact that she originally chose a language option in her Zurich high school is proof that it's possible to change direction. "Everything was new at first, and it would have perhaps been a bit easier if I had already known the basics. I struggled a bit with analysis, algebra, and physics – but now I'm not having any trouble, and it makes no difference that I previously majored in languages."

"On an equal footing"

Once they enter university, no distinctions are made between male and female students. "In my experience, women don't need to worry that they'll be up against female stereotypes in our civil engineering program. At EPFL, there are no disparities, and for a long time, women have been on an equal footing with men. I don't see any differences in the classes, student representatives or the Teaching Committee. There's total equality," says Lyesse Laloui. When EPFL's civil engineering program is presented at Swiss high schools, the presenters make a point of stressing that the field is perfectly suited for both women and men, and that motivation is the only thing that matters. Further, women often earn higher grades on their Master's projects.

"When it comes to results, both sexes perform equally well. There's a mix of male and female students in the classroom, as well as in project groups," says Marie Violay, a tenure track assistant professor in civil engineering.

A need for more women professors

The slow – and fairly recent – increase in the number of women in the profession is also reflected in an under-representation of women on the faculty. At EPFL, including at ENAC, major efforts are underway to encourage women to apply for vacant positions. A 2020 report commissioned by EPFL on the status of women faculty lists 16 measures that can be taken to improve their status – and the new Vice Presidency for Responsible Transformation has taken note. But such a shift will not happen overnight.

"To increase the number of women professors, you need a lot of women PhD graduates. You have to train people, and this is not necessarily a given because of the restricted number of female students. Thus, since the pool is limited, it's not that easy for us to recruit women professors," says Violay. Schopfer adds: "Women now account for 20% of total enrollment, but this figure was much lower when our own professors were themselves students. Although it's motivating and inspiring to have women professors, I take it in stride that the current faculty reflects this lack of diversity."

The increased presence of women on the faculty and in the various fields of civil engineering may also help to bring in more female students, who will more easily identify with these role models. "It's hard to see yourself joining a profession when all the people you talk to about it are men," says Devènes. "I hope that there will be more and more women in leadership roles. We have to pave the way."

Initial achievements of our Diversity Office's working groups

Author: Rizlan Bernier -Latmani
& Olivier Burdet

The initial activity for each working group was to identify the most important issues to tackle and to decide on appropriate actions.

The Recruitment and retention WG settled on hiring practices. A prerequisite for the continued increase in diversity at ENAC is to ensure that hiring practices are optimized to target and attract diverse, highly qualified applicants. Thus, the goal of the WG was to evaluate hiring practices (specifically non-professor hires as a first phase) and to assemble recommendations for possible improvements. First, a literature review of best practices was performed in order to provide an adequate background to WG members and to understand what is being done elsewhere. In addition, a survey was assembled under the leadership of Garance Clément (a Postdoc at the Institute of Architecture) and Camille Dross (a Master's student in environmental engineering) and refined in collaboration with members of the WG. This survey will be addressed to those responsible for hiring at ENAC (i.e., professors, MERs, and heads of units), and aims at identifying current hiring practices. It will be sent out this spring and the results of this survey along with the review of hiring best practices will be followed by the formulation of practical hiring guidelines for ENAC (and beyond).

The Communication and information WG decided to focus on two topics: combatting stereotypes and judgmental behavior as well as the establishment of inclusive communication.

In order to combat stereotypes and promote inclusiveness, it is crucial to emphasize the similarities rather than differences amongst people of diverse backgrounds. One way to do so is to portray the lives of people and their experiences and, in essence, capture their common

Student, Staff, post-doc and professor representatives from all parts of ENAC at the Diversity Office. Find the composition of the working groups on the Diversity Office website.

struggles and experiences irrespective of gender, race, disability, sexual orientation or any other characteristic. The WG decided to present to the EPFL public a series of thematically distinct movies that all focus on a group of people that have faced discrimination. The format is to have a viewing of the movie on campus and to hold a discussion, led by a moderator with expertise in the topic. There are three movies planned. One, under the leadership of Salvatore Aprea (a scientific staff member in architecture), will tackle gender equality and the experience of women. Another will focus on sexual orientation and the event will be organized under the leadership of Gianna Ledermann (a PhD student in architecture). The third will be centered on racism and racial identity. The movie schedule will be advertised in the spring of 2022 and will extend into the fall.

In addition, the Communication and Information WG has selected to establish a standard of inclusive communication. The language we use every day is important as it can unwittingly transmit biases. Arthur (Türi) Adams and Ghislain Motos (both postdocs in environmental engineering) have developed a website, which complements the pages provided by the VPT, with a focus on the use of inclusive language in English. The goal of this website is to serve as a tool to help people at ENAC (and beyond) use language that is neutral. Specifically, it offers alternatives to the most common pitfalls in everyday situations (e.g., in emails, job advertisements) in the form of a glossary of dos and don'ts in inclusive communication.

Finally, this WG is also working on compiling the statistics of gender distribution across units at ENAC. Our HR and the sections were approached to obtain gender distribution data for employees and students for the period 2017-2021. The dataset is currently being processed and the results will be communicated to the ENAC community in due time. This project is led by Olivier Burdet (deputy head of DO@ENAC) with support from Charlie Weil (from ENAC-IT4Research)

The Onboarding and ENAC Culture WG has chosen to communicate ENAC values and to raise awareness about inappropriate behavior and provide strategies for responding to it. Fatima El-Zein and Shadya Gamal (both Bachelor's students in environmental engineering), Daniela Brito Melo, and Cristiano Trevisin (both PhD students in environmental engineering), and Savvas Saloustros and Eleni Stavropoulou (both postdocs in civil engineering) are preparing a workshop to help participants identify and respond to inappropriate comments that propagate stereotypes and denigrate individuals. The first workshop is designed for class delegates and will take place in the spring of 2022. Subsequently, it will be offered again to other target audiences, for instance, students or staff members. The essence of the workshop is to build on the EPFL core values put forth by the VPT and bring them to life in a participatory fashion. The participant will work to identify inappropriate language and will be provided with the tools to intervene in order to moderate and/or deflect a biased interaction. The final goal is to make the ENAC community more welcoming to all.

DO@ENAC website

Research Data & Open Science

2021 was a key year for our third strategic goal: to disseminate our research data and foster open-science practices. We set ambitious open-science objectives for our faculty during the year and introduced a new tech support service specifically for researchers, called ENAC-IT4Research.

Encouraging data-driven approaches and open science is a key aspect of our strategy and will entail leveraging the trend towards big data and the growing awareness of the importance of open science.

Our scientists and engineers collect unique data sets in their labs and out in the field – data that will be essential for tackling the major challenges ENAC strives to address. Furthermore, the advent of big data calls for sophisticated data-driven approaches in order to exploit the data's full potential and share them openly and effectively. However, such approaches require technological skills and efforts that are beyond the main focus of many researchers. That's why we decided to set up ENAC-IT4Research, a service that can support our researchers throughout the data lifecycle.

By sharing knowledge in an impactful way consistent with the FAIR* principles, we can accelerate our impact on key global issues like climate change, digitalization and urbanization while taking into account economic, technological and societal needs and constraints. This year we developed an ambitious strategy that addresses aspects of open access, open-source software, open data and open education, pioneering direct support for open science across our school, such as through our new ENAC Open Software Grants. We took steps to showcase our open-research outputs, incorporate open-science awareness and skills into our Master's and PhD programs, provide services to support open research data and open software and support technology transfer based on open-science research outputs.

* The FAIR principles of Open Science state that research outputs should be findable, accessible, interoperable and reproducible.

Our open science strategy

Author: Charlotte Weil

In 2021, we developed and started implementing an ambitious strategy to adopt open-science practices. The strategy document defines open resources as those that "anyone can freely access, use, modify, and share [...]" (Open Knowledge Foundation); it spells out five goals for our research outputs in the broadest sense, including not only publications but also data, pipelines, software, hardware and educational materials.

Goal 1. Showcase all open science outputs from ENAC researchers

Engaging in open science means sharing research outputs beyond the written findings. To showcase our researchers' contributions to open science, we set up a new webpage listing ENAC's open scripts and software, open educational materials (starting with MOOCs), open datasets, and open research highlights. Furthermore, we recognize open-science outputs as important academic contributions in the activity reports of our labs.

Goal 2. Adopt open-access policies

Switzerland's open-access strategy sets the target of having all the country's scholarly publications be available in open-access format by 2024. EPFL, and consequently ENAC, has a duty of working towards this target as a member of swissuniversities, the body that officially adopted the strategy.
We are currently examining how our new read & publish agreement will affect open access at our school and whether any services are needed in addition to those provided by the EPFL library to help our scientists and engineers adopt open-access practices.

Goal 3. Incorporate open science into our Bachelor's, Master's and PhD programs

We expect that open science will influence many aspects of our students' education and careers, within or outside academia. Our degree programs should prepare students to contribute to open science and take advantage of the possibilities it offers all along the different stages of their education and careers.
In 2021, we spearheaded efforts to organise an Open Science Summer School; seven PhD students from EPFL and ETH Zurich, including three from ENAC, wrote a proposal for the Summer School which was recently approved. The Summer School will therefore take place in June 2022 and will be open to Master's and PhD students at ETH Domain schools. In 2021, we also began offering a Master's class on research skills that also covers the core concepts of open science. In 2022, we will explore ideas for incorporating open science more broadly into our curricula.

Goal 4. Provide services to support open Research data and open software

ENAC researchers who are looking to improve their research data management (RDM) practices or open up their data should be able to draw on field-specific, easy-to-use and powerful services and IT systems across the entire data lifecycle. Our goal here is to lower the technical barriers to good RDM and open research data practices by helping scientists and engineers use existing services and by making these services interoperable. ENAC-IT4Research, introduced in 2021, is one step in this direction. This new service helped over 30 ENAC labs across our three institutes and three campuses with data-related issues such as writing grant applications, running computations, using data-analysis software, writing code, installing data software, and more. In addition to operating a data help desk, ENAC-IT4Research also provides advanced services tailored to labs' specific needs in the areas of data analysis, data visualization, databases, and web apps.
In 2021, we pioneered direct support for open-source code development and maintenance at a school-wide level by introducing the ENAC Open Software & Research Scripts Grants. These grants include tech support from software engineers for maintenance, scalability, open software, research script publication, open research principles, and software best practices. This new grant makes ENAC the first EPFL school to directly fund open software.

Goal 5. Support technology transfer based on open science research outputs

With this goal, we aim to expand and accelerate technology transfer using open-science materials, and to communicate actively on the technology transfer. This will entail:

- Increasing the impact of our research in both the public and private sector and speeding the tech-transfer process.
- Fulfilling our societal responsibility by openly sharing research findings of societal importance, such as those related to sustainability challenges.
- Exploring new avenues of tech transfer based on open-science materials, such as through the FUSTIC association.

Book celebrates 10 years of research in open access

Author: Sandrine Perroud
Photo: Alain Herzog

The authors at Luterbach-Attisholz (SO), a Swiss site presented in their book. Martine Laprise, Sophie Lufkin, Emmanuel Rey

ENAC's Laboratory of Architecture and Sustainable Technologies (LAST), headed by associate professor Emmanuel Rey, published its first open access book in 2021: *Neighbourhoods in Transition: Brownfield Regeneration in European Metropolitan Areas.* The book, which is part of The Urban Book Series, draws on 10 years of research at EPFL and explores the steps involved in regenerating urban brownfield sites and the crucial implications for sustainability. In this interview, Martine Laprise, a LAST scientist who co-authored the book alongside Rey and fellow LAST scientist Sophie Lufkin, reflects on her experience of handling the open-access side of publication.

Why did you choose to make this book open access?

We wanted to follow the Swiss National Science Foundation's (SNSF) recommendations and EPFL's Open Access policy. The book compiles three theses and summarizes 10 years of research, so it made sense to open it up to the widest possible audience. There's also the fact that, even in architecture, most research is now done online. People who prefer printed books can still order a hard copy, while those who don't mind reading on-screen can download it from our website or the publisher's site.

What challenges did you face?

Since this was a first both for us and for our publisher [Springer], we supported each other through the whole process – from drawing up the contract to publishing the book online. Personally, I had to familiarize myself with open science terminology. The EPFL Library has a special open-access website which really helped me understand the concepts. But we lost a lot of time applying for SNSF grants to cover the book processing charges, which was one of the publisher's requirements. The current grant criteria are geared towards scientific publications, not architecture books, so we had to pay these costs – around CHF 15,000 in total – ourselves. Fortunately, we received a grant of CHF 2,500 from the EPFL Library.

The book is packed with photographs and illustrations. How did you handle the copyrights?

Publishing a book in open access doesn't mean all the illustrations automatically fall under the Creative Commons license. Luckily, most of the photographers and architecture firms we contacted agreed to waive their copyrights. But that's very much a personal decision, which is why some images in the book are copyright-protected. Requesting copyright waivers didn't take any extra time because searching for images is part and parcel of the process.

What are your takeaways from this experience?

We're extremely proud to have gone down this route, which we're now planning to do for our forthcoming publications. Since the book was published online in October 2021, it's been downloaded around 12,000 times – a circulation much larger than what you might expect for a hard-copy publication. This is extremely satisfying from a personal perspective, even though the lack of other open-access architecture books means we don't have a benchmark to compare against.

PhD thesis conducted using only free software

Author: Sandrine Perroud

Anaïs Ladoy, a PhD student at ENAC's Laboratory of Geographic Information Systems (LASIG), is using nothing but free software to carry out her thesis research. She's opted for this approach because she wants her results to be reproducible and open to all.

Where we live affects our health. By investigating the interactions between the environment and public health and identifying vulnerable neighborhoods, geographical approaches can provide key insights that could help shape and guide public-health policy and prevention campaigns. Anaïs Ladoy, a PhD student at the Laboratory of Geographic Information Systems (LASIG), part of EPFL's School of Architecture, Civil and Environmental Engineering (ENAC), is tackling the issue of how to incorporate geographic information for precision in public health. But there's something singular about her research, which she began in 2019 in partnership with the Canton of Vaud: she's using nothing but free software.

A personal challenge

"It all started as a personal challenge," says Ladoy. "When I began working on my thesis, I replaced my old Mac with a new PC. But rather than sticking with Windows, I opted for the Ubuntu (GNU/Linux) operating system. I've long been interested in coding and didn't want to be a passive user." Having embarked down the open-source path, Ladoy decided to persevere, seeking out freely available alternatives for every type of application: word processing, browsing, search engine, image processing, and integrated development environments (IDEs), as well as applications more specific to her research field, such as for mapping and geographic information processing. She relies heavily on a directory compiled by Jean-Daniel Bonjour, the former head of IT at ENAC. For instance, when carrying out geocoding work – the process of converting street addresses into geographic coordinates – Ladoy shunned Google's services in favor of Swiss federal-government databases (geo.admin.ch) and collaborative maps (OpenStreetMap).

An ethical approach to science

Ladoy argues that using free software is an ethical approach to science. "Anyone can access my data and reproduce my results without spending a single penny," she explains. "I think that's particularly important given the applied nature of my research." In 2021, she helped the Canton of Vaud install mobile COVID-19 vaccination centers by targeting places where populations could suffer from information gaps or accessibility barriers. Her decision to use a free geographic information system paid off at the height of the vaccine rollout: during crisis response meetings, civil protection and cantonal government officials were able to dig straight into Ladoy's findings, generate their own maps and decide on a course of action – all without having to stump up CHF 10,000 in annual license fees for the equivalent paid software. "Public- and private-sector organizations could save a lot of money by switching to free software," says Ladoy. "With the growing concerns over the power of the Big Five tech companies [Google, Apple, Facebook, Amazon and Microsoft], now is perhaps a good time to start exploring the alternatives."

A non-issue

According to Ladoy, organizations often cite a lack of technical support as one reason behind their reluctance to abandon paid software. With free applications, users have to rely on the community – rather than a support service they pay for – to fix bugs in the software. But Ladoy describes this as a "non-issue," explaining that the same bugs occur time and again and, in many cases, the fixes are already available online. What's more, most businesses and public-sector organizations have sufficient in-house IT expertise to handle these issues without outside support.

Ladoy cites interoperability as the main stumbling block on the path to wider uptake of free software. Many files still bear proprietary extensions (such as .docx for Microsoft Word and .pptx for Microsoft PowerPoint), and opening these in non-paid applications can lead to layout problems, missing bibliographies and other structural issues. In Ladoy's view, these are minor problems that often stem from conditioning. "Very few people who abandon proprietary software go back," she explains. "Once you've made that choice, you stick with it. For me personally, the gamble paid off. Right at the start of my thesis, I decided I wanted to make my research as accessible as possible. I knew it was the right choice then – and I'm even more convinced now."

Ladoy learned about free software during a class she took at EPFL. Now, she's using her position as a scientific assistant at LASIG to spread the word among EPFL's student community.

Open software highlights

Author: Sandrine Perroud

Open software development and maintenance at ENAC is a long-standing practice. Several labs champion in commitment to sharing their code with their communities. cRacklet, an open software for spectral boundary integral method, is a good example.

Prof. Jean-François Molinari, the head of ENAC's Computational Solid Mechanics Laboratory (LSMS), has developed new modeling software in association with Prof. Philippe Geubelle at the University of Illinois and Fabian Barras, a PhD student at LSMS. The software is named cRacklet – a combination of "crack" and "raclette," a dish typical of Barras's home canton of Valais – and is available in open source. Engineers can use it to model dynamically propagating ruptures resulting from cracks in a solid and to assess the stability of faults, in order to better understand earthquake mechanisms.

Thibault Roch, another PhD student at LSMS, has added cRacklet's code to the GitLab open-source software development platform, with the help of the tech support staff at ENAC-IT4Research. That makes the code easy to access, well-documented and open to contributions from other engineers. The team's research in developing cRacklet has been published in Journal of Open Source Software. "I strongly encourage other software developers to take this open-access approach, even if there's a chance the code could be plagiarized," says Molinari. "By making our code widely available, we got enhanced visibility and prestige and improved the development process for engineering software in general." Molinari adds that it's crucial to have the support of your university and to build a community before you embark on such a project, so that you have the funding to maintain your code over the long term and support the operation of the open-source platform.

Other examples of open scripts and software made available by our labs include:

Open-source Python package for discrete choice models

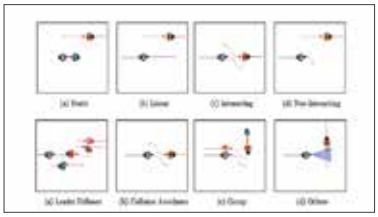
A Python package to generate maximum likelihood estimates of parametric models, with a special emphasis on discrete choice models.

Transport and Mobility Laboratory (TRANSP-OR)

Open software for finite element models

Akantu is a C++ library, for creating accurate finite-element models with high performance computations, available under the LGPL license.

Computational Solid Mechanics Laboratory (LSMS)



Open-data and benchmarks for trajectory forecasting

This machine learning system, with the accompanying data and evaluation codes, is available to the public on Alcrowd.com; all scripts are sared under an MIT license.

Visual Intelligence for Transportation Laboratory (VITA)

OpenPifPaf

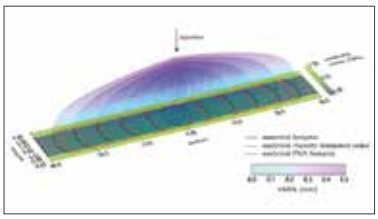
Models, software and code for composite fields for human pose estimation.

Visual Intelligence for Transportation Laboratory (VITA)

Open data & scripts for NLP on satellite imagery

This training dataset is designed to for remote sensing visual Q&A, and is hosted on its own website with accompanying scripts.

Environmental Computational Science and Earth Observation Laboratory (ECEO)



Open software for 3D modeling of fluid-driven fracture propagation

PyFrac is a Python solver for 3D models of fluid-driven fractures propagation, released under a GPLv3 license.

Geo-Energy Laboratory (GEL)

ENAC-IT4Research data services

ENAC-IT4Research helps scientists and engineers bridge technical gaps and bolster their research impact by providing expert assistance in data science and software development.

ENAC-IT4Research was created in April 2021 to support ENAC researchers with all data-related challenges. As a new unit within ENAC-IT, it works with our existing IT systems and support teams, but goes further by delivering personalized technical support to researchers for their specific projects.

ENAC-IT4Research data scientists, software engineers and programmers assist with everything from data acquisition and harmonization to data dissemination. This is done by developing interactive web applications and statistics programs, for example, leveraging the unit's professional expertise to support researchers throughout the data lifecycle.

ENAC-IT4Research runs a data help desk that people can contact at enacit4research@epfl.ch. Here, experts answer all types of data- and software-related questions. The unit also provides advanced support services ranging from one week to several months to help labs with their data pipelines or other specific data projects. These services are billed to labs at the SNSF rate.

ENAC-IT4Research has a team of 4 FTEs distributed among 7 data engineers and software developers to encompass a wide range of skillsets. Its data help desk has responded to requests from around 30 labs from all ENAC institutes and across all campuses, and the team has started 13 advanced services projects for different ENAC labs.

Here are some example of ENAC-IT4Research's advanced services tailored to labs' specific needs.

Steel Database & Web App

Laboratory:
Resilient Steel Structures Laboratory (RESSLab)

ENAC-IT4Research contribution:
Web app re-design and migration to more recent web technology.

Technology deployed:
VueJS and eCharts

RESSLab-hub is an open-science web application developed in 2021 that gives the engineering and research communities open access to thousands of experimental datapoints dating back to the 1970s on structural steel materials and components. The application also includes state-of-the-art interactive modelling capabilities to prognosticate their nonlinear behavior. It was developed by ENAC's Resilient Steel Structures Laboratory (RESSLab), headed by Associate Professor Dimitrios Lignos. The web-based application is designed to be modular and scalable. "We can easily upload the latest advancements in experimental earthquake engineering," says Lignos. "That provides an opportunity to make the unique data and knowledge generated in ENAC's high-quality experimental facilities, as well as data from around the world, accessible. We believe RESSLab-hub will make a significant contribution to benchmarking and minimizing the earthquake risk of steel and composite-steel concrete structures."

Data can be downloaded easily from the application so that researchers, engineers, students and educators can validate their predictive models for seismic risk assessment and contribute to the advancement of design standards.

The technical-support staff at ENAC-IT4Research helped develop the platform, especially the visualization features that enable users to generate customized graphs, spot interesting trends and share data with other users.

The research papers associated with the primary modules of the web-based application are all publicly available. "Such an endeavor is by far the most comprehensive in the field," says Lignos.

Author: Sandrine Perroud

Bacterial data exploration and analysis

Laboratory:
Environmental Chemistry Laboratory (LCE)

ENAC-IT4Research contribution:
Exploratory data (analysis, data harmonization, data visualization plotting trends, etc) along with key statistics.

Technology deployed:
Python

”Living Archives” integration

Units:
Institute of Architecture and the City (IA) and the Architecture Section (SAR)

ENAC-IT4Research contribution:
Supporting external development work and integration into EPFL’s systems.

Pose detection algorithm online demo

Laboratory:
Visual Intelligence for Transportation (VITA)

ENAC-IT4Research contribution:
Development of a front-end interface and back-end servers for user inputs of videos, and of an on-the-fly algorithm.

Technology deployed:
Web interface in Cables.gl, WebGL; backend in Python: FastAPI, PyTorch, Docker, Kubernetes

Image tagging tool for architects

Laboratory:
Laboratory of Elementary Architecture and Studies of Types (EAST)

ENAC-IT4Research contribution:
Development of an image tagging program and catalog for architects, including a custom image tagging scheme and composition functionalities.

Technology deployed:
VueJS, Leaflet and Cloudinary (Images DB)

Interdisicplinary spatial data management & computation pipelines

Laboratories:
Design Studio on the Conception of Space (ALICE) and Geographic Information Systems Laboratory (LASIG)

ENAC-IT4Research contribution:
Set up customized data-management pipelines (shared storage, data organization schemes and a collaborative code repository) and provided support with spatial data processing pipelines by developing and optimizing batch processes and data acquisition pipelines.

Technology deployed:
Python and GDAL

ENAC-IT4Research website

Innovation & Partnership

Our pioneering research at ENAC can make a major contribution to developing innovative systems for a sustainable society. However, the road from an initial idea to a value-added product or service (whether for the public or private sector) can be a long and risky one.

Cities are focal points of major societal and environmental challenges, yet are also important venues of innovation. Over 50% of the global population lives in cities, where they consume 75% of the world's total energy and generate over 75% of its CO2 emissions. That makes cities among the biggest contributors to some of our worst planetary problems: air, water, and soil pollution; diminishing biodiversity; climate change; and the effects of all of the above on human health.

At ENAC, we strive to facilitate the transfer of university research to businesses and local governments by fostering joint research programs to develop innovative systems for the transition to a sustainable, resource-efficient society.

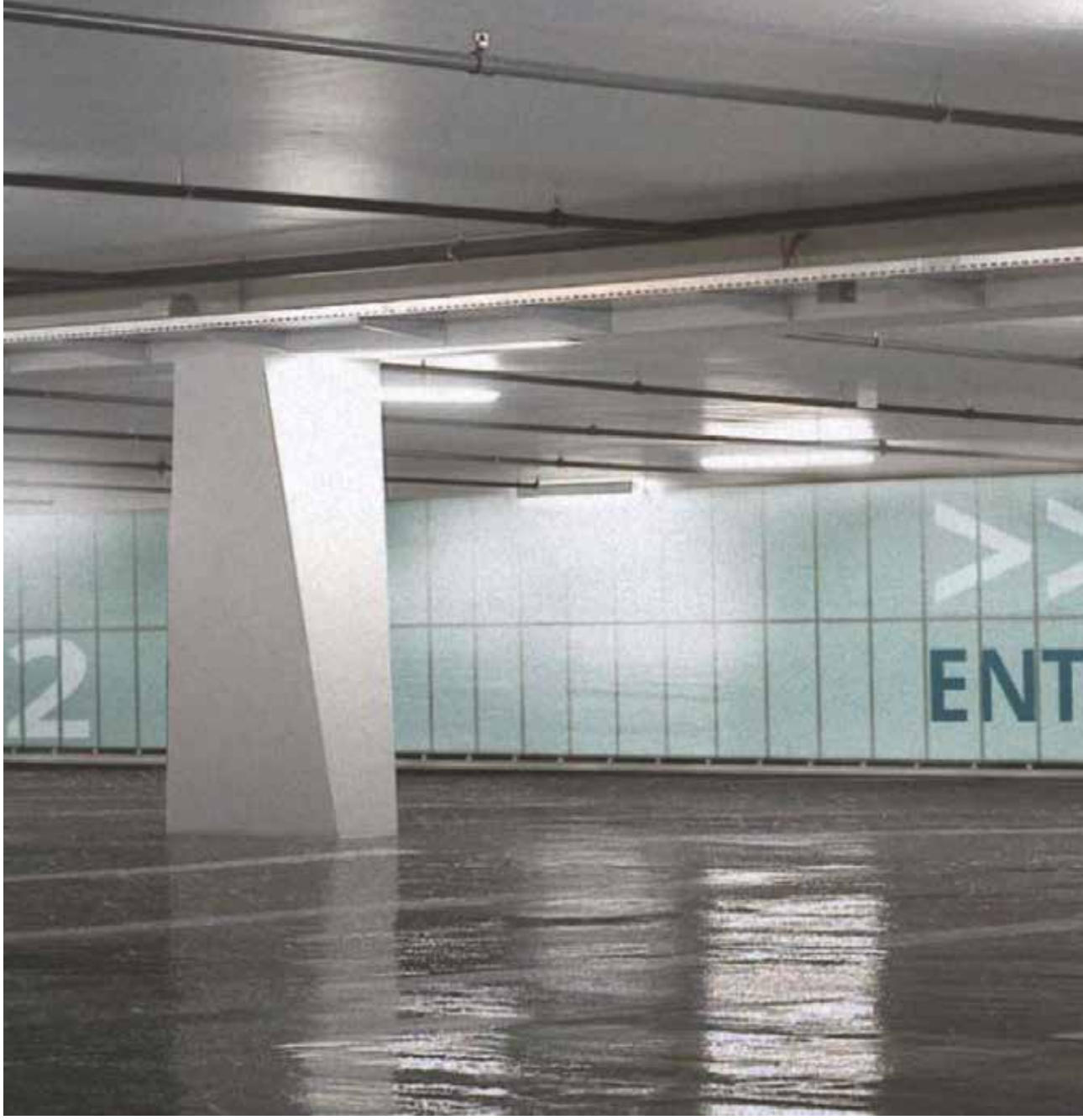
In 2021, we formed and strengthened a number of our research partnerships.

We introduced ENAC Innovation Seed Grants (three application rounds per year). These grants are intended to help our scientists and engineers along the path from fundamental research to prototype development, technology transfer and market adoption and to encourage entrepreneurship within our community so they can explore their most promising ideas.

We also created a new association – Future Sustainable Territories, Infrastructure and Cities (FUSTIC) – that has already paired up over 120 researchers with partner organizations, hosted dozens of events and helped create a project consortium. This association further strengthens our partnership network of businesses, universities and other public-sector organizations.

Using heat from underground parking lots to warm apartments

Author: Cécilia Carron
Photos: Enerdrape



ENAC spin-off Enerdrape has developed technology that can recover heat from underground parking lots and use it to warm the apartments above. Its geothermal wall panels are currently undergoing pilot tests at a building in Lausanne's Sébeillon district.

Over a third of the energy used in Switzerland each year goes to heating. And nearly 60% of the heating used in Swiss residential buildings originates from fossil fuels – making Switzerland the biggest such consumer in Europe. The good news is that the country's fossil-fuel reliance should decrease in the coming years, thanks to incentives by the federal and cantonal governments, advances in insulation materials and new technology. A growing number of building owners are installing hybrid systems that draw on different types of energy in order to limit the use of fossil fuels – and Enerdrape's technology is for precisely these kinds of systems. Its geothermal wall panels can be installed in underground structures and recover the heat located in the soil. The panels are currently being pilot-tested at a parking lot in Lausanne's Sébeillon district, where they should be able to supply up to a third of the energy needed to heat the 60-odd apartments in the building above.

Constant heat all year long

Enerdrape's system is designed to make maximum use of underground walls and exploit a natural, sustainable resource in places where it would otherwise go untapped. It consists of ten blue-and-white panels measuring 1.3m x 0.7m and made of a metal no thicker than a painter's canvas. Each panel functions as a heat exchanger that captures both geothermal and ambient energy. A heat pump then circulates this energy throughout the building above, providing a constant supply all year long. "The soil temperature doesn't vary once you get a few meters below ground," says Margaux Peltier, the CEO of Enerdrape. "That means the energy generated by our panels isn't dependent on weather conditions or the time of year."

With their stylish design, the panels give the dreary parking lot walls a facelift. But that's obviously not the reason why Alberto Simonato, director at Realstone – the company that owns the Lausanne parking lot – agreed to test out Enerdrape's technology. Realstone also supported Enerdrape in its application for a BRIDGE Proof of Concept grant from the Swiss National Science Foundation and Innosuisse. "We often encourage startups that are developing innovative technology for reducing CO_2 emissions – an issue on which we take a proactive stance and are one step ahead of Switzerland's federal and cantonal building standards," says Simonato. "We're also working with another EPFL startup to install remote meters on some of our buildings' heating and water systems." Realstone owns five buildings in the Sébeillon district with a total of 356 apartments. "If Enerdrape's panels prove to be as effective as we expect, we could install them on the soil-abutting walls of a 275-place parking lot, or in some of our other buildings," says Simonato.

Enerdrape's cofounders spent two years conducting a range of underground tests at EPFL in order to verify the market potential of their technology. Peltier in particular evaluated different heat-exchange fluids and tube sizes as part of her engineering research at ENAC's Laboratory of Soil Mechanics. In the end, the yield delivered by the panels turned out to be better than expected. It's also true that today's cities generally have more space available in underground parking lots than they do for installing other types of renewable energy systems. And the walls of underground structures often constitute space that otherwise wouldn't generate income, in parts of cities where real estate can be pricey. Enerdrape's panels could feasibly be installed in new and existing buildings over the next few years at a cost that's comparable to other systems and with a yield that's at least as good, if not better. The only catch is that the concrete walls on which the panels are installed must be in direct contact with the soil so that the panels can capture the geothermal energy.

Also useful for train and subway stations and tunnels

Enerdrape was set up in 2019 and has already won several startup grants and awards. Along with the Sébeillon pilot test that will run to the end of this year, Peltier and her staff are putting together a fundraising round and hope to bring in around CHF 2 million by next summer. They intend to use the proceeds to launch a first production run of their panels in order to be fully prepared for market entry.

The company's technology is an example of an "energy geostructure," in which the Laboratory of Soil Mechanics is a pioneer. These systems use underground structures like building foundations as sources of energy. According to the International Energy Agency (IEA), the share of clean heating technology – which includes heat pumps and district heating – needs to more than double to 50% of sales by 2030 to be able to meet the IEA's sustainable development scenario. Enerdrape hopes to play a role in achieving that goal. Its technology can be used not just in underground parking lots, but also in tunnels, train and subway stations. "Our research has shown that our panels can also work effectively when they have a more rounded shape, such as that required for the inside of a tunnel, for example," says Peltier.

Towards a more affordable analysis of air pollution

Author: Sandrine Perroud
Photos: Alain Herzog

ENAC scientists have developed a new method for chemical analysis of fine particles that they plan to extend on a large scale – including in developing countries – through an Innosuisse innovation grant award and a new startup.

Satoshi Takahama and Nikunj Dudani, two scientists at ENAC's Laboratory of Atmospheric Processes and their Impacts (LAPI), have developed an innovative system that could replace the array of instruments typically used to measure air quality by a single device small enough to fit in a carry-on bag.

The pair has just received a CHF 250,000 Innosuisse grant to support their invention's strong market potential. They will use the proceeds to bring the technology to a viable prototype, and create a startup to deploy their device on a large scale, including in the developing world. Their project has received the encouragement of air-quality network representatives in the US and Europe (ACTRIS).

« We wanted to standardize and automate the data analysis step, since existing instruments require a great deal of specialized know-how to be used correctly »
Nikunj Dudani, scientist at ENAC's Laboratory of Atmospheric Processes and their Impacts (LAPI)

Achieving a lofty goal

Air-quality scientists currently use many different instruments to measure the composition of fine particles in the air. At the same time, many types of compounds remain elusive to several methods. With the proposed device, however, scientists will have a single instrument to automatically measure and analyze not just particulate composition but other useful properties as well, and to transmit the data effortlessly.

The scientists' method entails projecting light onto the particles to measure their optical properties, revealing important information about their composition, origin and

other characteristics. The new system offers greater portability and robustness since no bulky pumps are required. It employs infrared (IR) spectroscopy to identify the individual compounds within fine particles at a fraction of the cost of current instruments. Indeed, its low cost is comparable to that of operating air monitoring facilities, but without much of the hassle.

IR spectroscopy is already widely used in pharmaceutical studies, food-quality analysis and the construction industry. “Because our method analyzes particulate composition online, there’s no need to store and ship filters – which can lead to measurement errors,” says Takahama, the senior scientist who is heading the project. “IR spectroscopy also allows particulate matter to be analyzed nondestructively without requiring additional sample transformation steps.” Athanasios Nenes, an ENAC professor and the head of LAPI, adds: “The new system is designed to let engineers characterize particulate composition in a non-destructive, cost-effective way. This is a lofty goal, and for the first time it is now within reach.”

Incorporated data analysis

The new system will include data analysis software in order to give customers a turnkey solution. “We wanted to standardize and automate the data analysis step, since existing instruments require a great deal of specialized know-how to be used correctly,” says Dudani, a former PhD student of Takahama. “This prevents them from being distributed on a large scale for university research or in air-quality monitoring networks.” The aim is for their compact device to be used in laboratory experiments, field measurements, governmental and non-governmental monitoring systems, manufacturing plants, and a host of other indoor and outdoor settings. It could be installed alongside building ventilation systems, for example, or purchased by manufacturers whose operations generate large amounts of fine particles.

The LAPI scientists see considerable potential for their device and are eager to implement it in concrete applications. “Air-quality engineers have been investigating uses for IR spectroscopy since the 1950s. We’re proud to finally have the right people, the right approach and the right funding to bring our idea to fruition,” says Takahama, who has been working on the concept for nearly a decade at EPFL.

The many origins of fine particles

Around 40% of Switzerland’s population is exposed to excessive levels of fine particles. Much of this particulate matter is generated by the oxidation of compounds emitted from human activities and the biosphere. In cities, particles are emitted by diesel engines, wood-burning appliances and open fireplaces. Other sources include car brakes, tires and road surfaces as they are worn down, and the dust kicked up from quarries, gravel pits and construction sites. When we breathe in these particles, the finest ones can enter deep into our lungs and induce oxidative stress throughout the body, eventually leading to cardiovascular disease, stroke and other adverse health impacts. Exposure to air pollution and fine particles are responsible for over 3,700 premature deaths in Switzerland each year, according to a 2020 report issued by the Swiss Federal Office for the Environment.

Using images and artificial intelligence to inspect bridges

Author: Sandrine Perroud
Photos: Alain Herzog

ENAC startup SwissInspect has developed a novel bridge-inspection system that combines structural engineering with drone technology, artificial intelligence and computer vision. SwissInspect is the result of research at Earthquake Engineering and Structural Dynamics Laboratory (EESD) in collaboration with Swiss Data Science Center (SDSC) on the image-based inspection and monitoring of structural elements.The company plans to test its system, which offers major advantages over visual inspection methods, on around 50 bridges in Switzerland.

Switzerland's bridges are currently inspected every two to five years using conventional visual inspection. But SwissInspect hopes to change all that with its new technology, which provides more objective evaluations and could be applied to other types of structures like tunnels, dams and buildings. The company's approach combines structural engineering, computer vision, and artificial intelligence to make infrastructure inspections safer, more objective, and efficient.

The startup has recently won a CHF 300,000 InnoSuisse grant to inspect around 50 bridges across Switzerland over a period of 18 months. SwissInspect has also just won a Venture Kick grant of CHF 10,000, which will help it develop its business. This development work draws on EESD as well as the Geodetic Engineering Laboratory (TOPO) - both at ENAC - providing outstanding expertise on image-based surveys using drones (UAVs).

> *« When it comes to inspection, traceability is critical. »*
> *Amir Rezaie, CEO of SwissInspect*

For maintenance and repair work

"Our goal at SwissInspect is to give engineers and infrastructure owners a system they can use to plan maintenance and repair work more efficiently," says Amir Rezaie, who holds a PhD in civil engineering and is the CEO of SwissInspect. "We do not want to be a data collector or a 3D visualization platform, we transform raw data into actionable information." From images, they detect various types of damage, including cracking, spalling, efflorescence, rust, etc. They also provide a physics-based classification of damage, which is crucial information to evaluate the structural health of a bridge.

Digital twin

"When it comes to inspection, traceability is critical, which we seek to provide by creating the digital twin of bridges", says Amir Rezaie. He also points out that in the future, other sources of information could be added to the digital twins, such as data from sensors installed directly on a bridge.

Another advantage of SwissInspect's system relative to visual methods is that the technology allows inspections to be carried out more frequently. That's especially important in light of climate change, as infrastructure will be increasingly exposed to alternating periods of flooding and drought as well as higher relative humidity levels that could fasten the degradation of materials.

Six ENAC linked start-ups created in 2021

Algaltek iprovides expertise in algae-related technology, including algae production systems, algae bioproducts, and the associated consulting and R&D services.

GR-LUD - IIE

www.algaltek.com

Enerdrape has developed modular, prefabricated and easy-to-install panels that can turn any kind of underground structure (both new and existing) into sources of renewable energy for buildings' heating and cooling systems.

LMS - IIC

www.enerdrape.com

ShadeMe supplies smart blinds and smart shade controllers for commerical properties.

LESO-PB - IIC

www.shademe.ch

REMRETEch has developed proprietary technology for recycling rare earth metals from electronic waste. These metals are essential components of our manufacturing base and our society – for products ranging from cellphones all the way to satellites – and will play an important role in efforts to adopt clean energy, combat climate change, and roll out electric transportation systems.

GR-LUD - IIE

www.remretech.com

SwissInspect provides artificial intelligence systems that can analyze images to detect various types of structural defects and generate physics-based computer models for predicting scenario-based infrastructure responses and for planning maintenance.

EESD - IIC

www.swissinspect.io

Aeternum takes an innovative approach to making buildings more sustainable by fully incorporating circular-economy principles into their design. That means using components which are adaptable and reusable over several lifecycles.

SXL - IA

www.aeternum-tech.com

FUSTIC association, founded in 2021

Author: Frédéric Dreyer

Future Sustainable Territories, Infrastructure and Cities (FUSTIC) was created in 2021 to help connect and transform cities. We use digitalization and sustainability to drive technological and societal innovation, work towards climate neutrality and improve public health and well-being.

Ours is an inclusive association that combines a culture of sustainable innovation and transformation with problem-driven digital solutions. We aim to help shape the future of sustainable regions, cities and infrastructure by joining the efforts of all stakeholders, since no real impact can ever be made by working alone. Diversity makes teams smarter. But designing a sustainable future isn't enough – it also has to be backed by effective implementation.

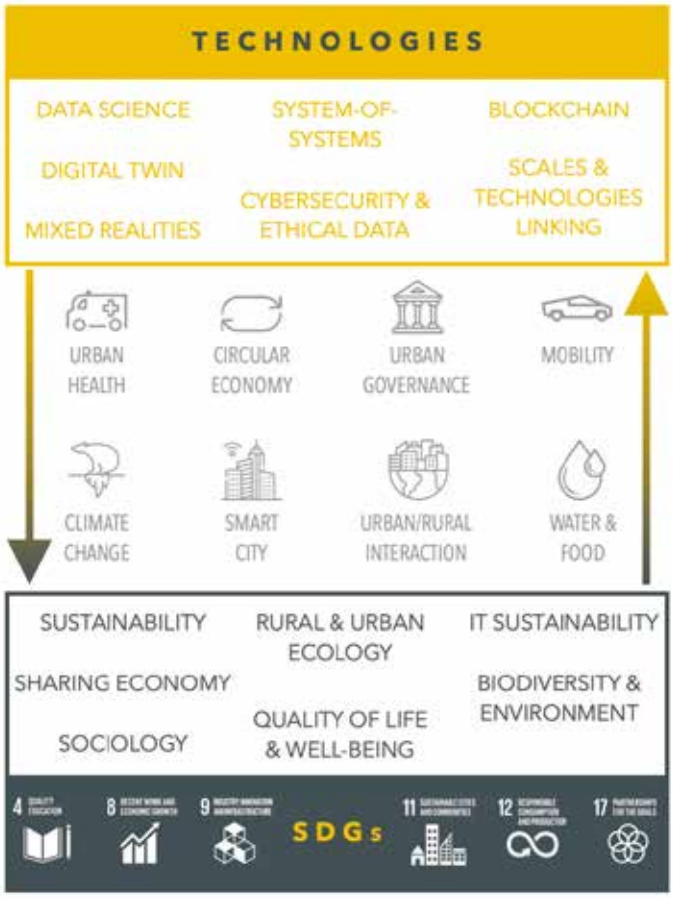
Our association acts as a catalyst to speed the development of responses to global societal, technological and business challenges and to leverage digital technology to bring sustainability to regions, cities and infrastructure. FUSTIC is an orchestrator, facilitator and mediator that will drive convergence between different and sometimes antagonistic viewpoints. We, along with our entire community, are doers and solvers and will help create sustainable solutions to combat climate change and global warming and preserve our vital resources. FUSTIC is a flagship initiative to promote Swiss technology and business excellence at an international level.

Concept

Our association is process-oriented and works with other organizations to support digital technology and innovation-oriented best practices, products, and services that address key economic, industrial, urban-development, and climate-related challenges for a sustainable future.

Objectives

We want to unlock the full potential of digital technology, instill a culture of innovation and transformation, and bring viable solutions to our ecosystem and global markets, putting science and engineering at the service of society. Everything we do is based on inspiring innovation and excellence; this includes scanning the market for emerging trends and technology, leveraging cross-sector initiatives, and harnessing panels of experts for their advice and capabilities.



The UN 2030 agenda cannot be achieved without local action by cities. Our goal is to bring new skills to the Swiss workforce, develop sustainable business models, and promote both incremental and disruptive innovation to address specific societal challenges and market needs in eight strategic areas.

Events in 2021

We took part in nearly a dozen regional, national and international events in 2021, including:

- 2021 Open BIM panel discussion (co-organizer and moderator)
- Swissnex Brazil (on the topics of urban living, climate change, sustainability, and the future of cities)
- Sixth annual construction conference held by the Franco-Swiss chamber of commerce
- 2021 EcoCloud Sustainability conference (co-organizer and moderator)

FUSTIC

www.fustic.org

2021 ENAC Innovation Seed Grants winners

Our Innovation Seed Grants are a unique opportunity for ENAC scientists and engineers to obtain funding (up to CHF 20,000) so they can explore innovative ideas early on in the development process. These grants are intended to support research and technology transfer at our school and encourage researchers to think across boundaries and design holistic, sustainable, inventive solutions to critical societal problems. The grants are open to ENAC PhD students, post-docs and other researchers who are in the initial phase of developing an application, product or service with a real societal impact.

ANTIVIRALPS

Screening for novel antiviral compounds in alpine and polar lakes.

- **PI: Anna Carratalà (LCE - IIE)**
- **Start date: 1 Sept. 2021**
- **Duration: 6 months**

MOCA

MOnitoring traffic Congestion in Africa using a swarm of drones.

- **PI: Manos Barmpounakis (LUTS - IIC)**
- **Start date: 1 Nov. 2021**
- **Duration: 6 months**

RE:CRETE

Proof-of-Concept for the REuse of cast-in-place reinforced conCRETE panels.

- **PI: Maléna Bastien Masse (SXL - IA)**
- **Start date: 1 Sept. 2021**
- **Duration: 4 months**

SWISSVENT

Smart WIndow SystemS for maximizing natural VENTilation in residential buildings.

- **PI: Evangelos Belias (HOBEL - IIC)**
- **Start date: 1 Jan. 2022**
- **Duration: 6 months**

ARKAIYA

Gatekeeping Archaea companion for diagnostic and therapeutic: a unique 'microbiome-management' solution for child colic, asthma and allergies.

- **PI: Horst Pick (GR-LUD - IIE)**
- **Start date: 1 Sept. 2021**
- **Duration: 6 months**

INNOWAL

INNOvation for Water And Legionella: Developing an innovative device to eliminate of Legionella risk at the water end-uses in buildings.

- **PI: Amirreza Heidari (ICE - IIC)**
- **Start date: 15 Jan. 2021**
- **Duration: 6 months**

i-IAQ

Integration of indoor air quality predictions into healthy building designs.

- **PI: Shen Yang (HOBEL - IIC)**
- **Start date: 1 Sept. 2021**
- **Duration: 6 months**

Communication

As consumers, businesses and policymakers become increasingly aware of issues related to climate change, sustainability and urbanization, the teaching and research being done at ENAC will play an essential role in informing the public debate. That's why we place such emphasis on communicating with the public about our research, discoveries, inventions, technology transfer and degree programs.

In response to the growing use of video and images in today's information consumption habits, we enhanced the communication group in 2021 by hiring an interactive media designer. This media designer works alongside our journalist and head of communication.

We rolled out new communications channels during the year to strengthen our impact, including a redesigned website and a new intranet and newsletter.

We also expanded our presence on social media by setting up a LinkedIn account to complement our accounts on Facebook and Twitter, where the number of ENAC followers has continued to grow.

A large part of our communication strategy involves publishing articles and issuing press releases regularly, which are picked up broadly by the press. This gives us wide visibility in regional and national newspapers whose journalists often request interviews with our researchers. We would like to take this opportunity to thank our researchers for taking the time to contribute.

Positioning the ENAC School on the sustainability challenges

Author: Armand Goy

Our communication strategy aims to boost ENAC's visibility by positioning it on three major sustainability challenges: climate change, digitalization and urbanization.

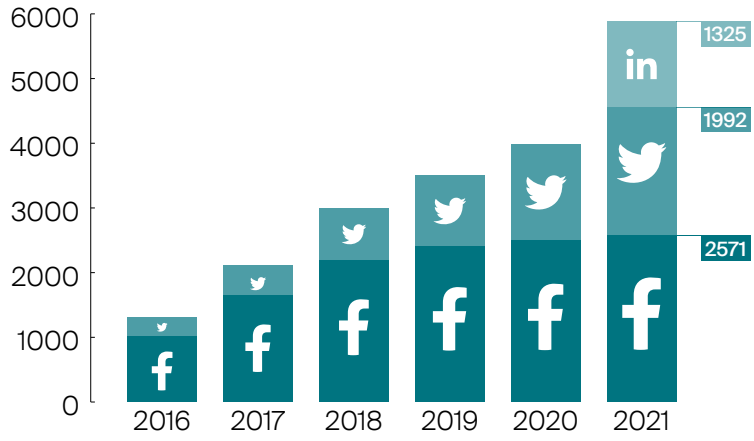
We want to showcase the breakthroughs made at our labs and present them to the general public and potential research partners, while also illustrating the excellence we deliver in education in order to attract high-potential students who will lead the next generation of architects and engineers.

Producing and distributing high-quality content plays a key role in this process. We have a continuously updated website and recently introduced an intranet and a newsletter; we are also very active on social media. Our social media presence has expanded considerably over the years enabling us to reach our various target audiences. We set up a LinkedIn account in 2021, bringing our total number of followers across all our social media accounts to nearly 6,000.

Another element of our communications strategy involves issuing press releases and maintaining contact with journalists. Thanks to this effective approach, ENAC gets almost daily press coverage.

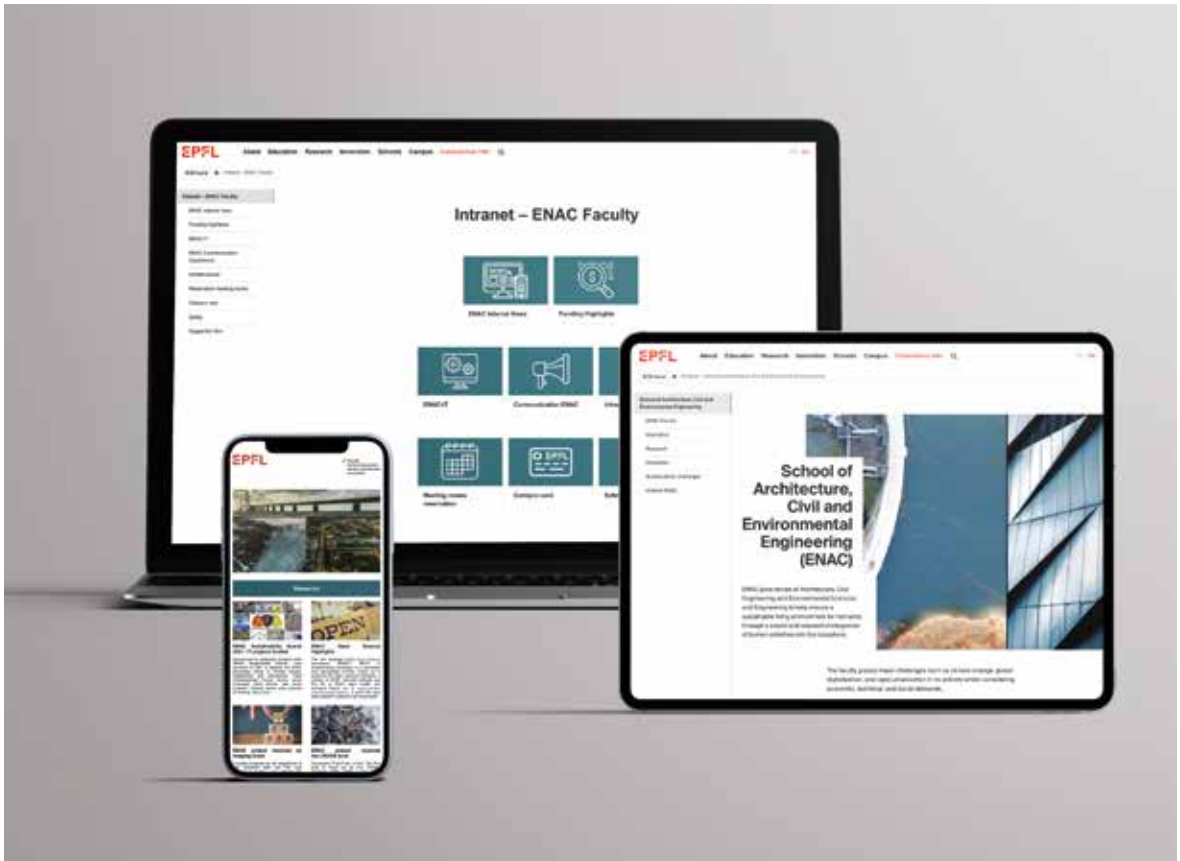
Our scientists and engineers have been contacted for their expert insight hundreds of times by Swiss and international news outlets.

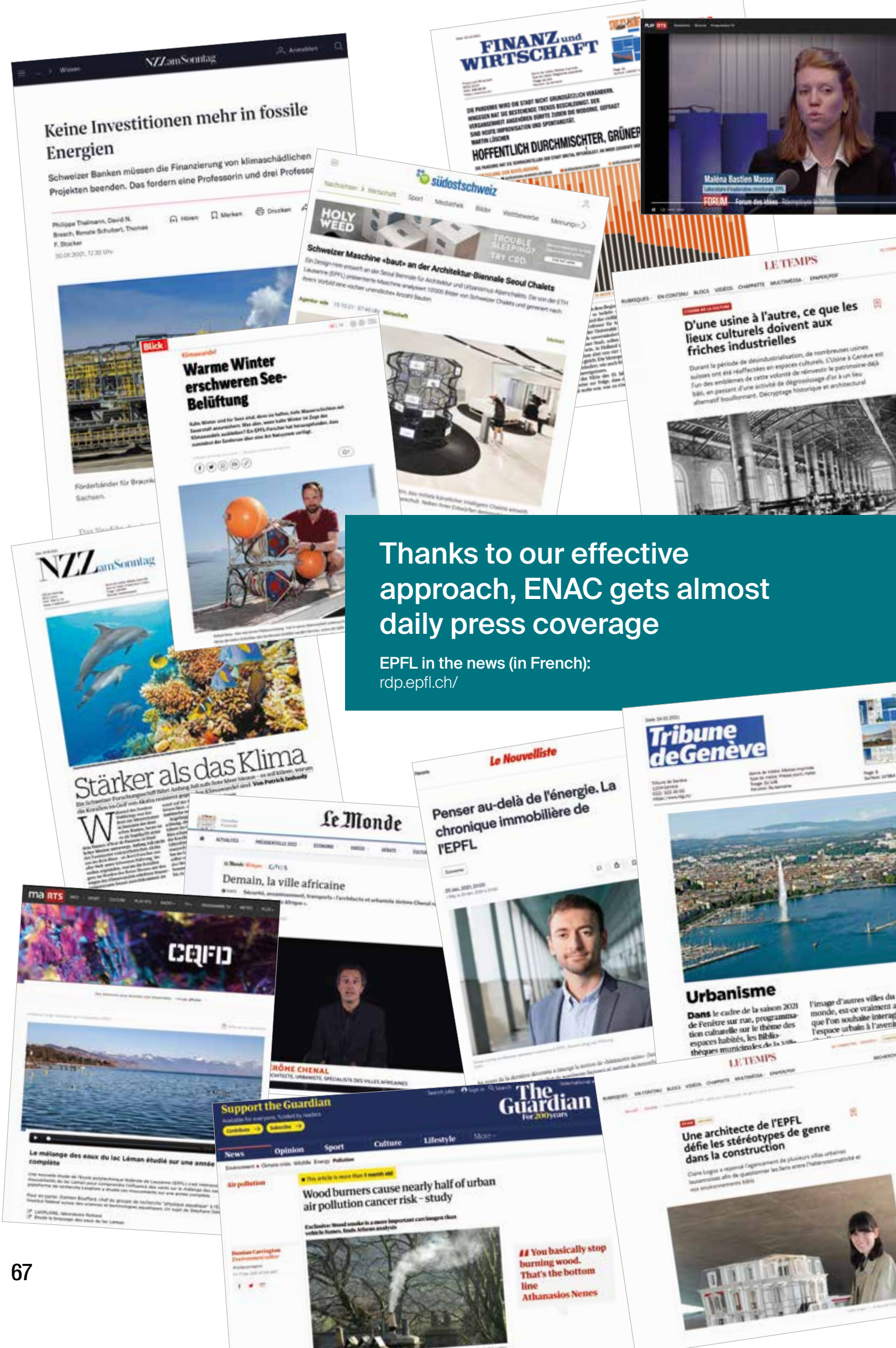
Total ENAC followers on social media



Follow ENAC on:

@epflenac **/epflenac** **@epflenac** **epflenac**





Thanks to our effective approach, ENAC gets almost daily press coverage

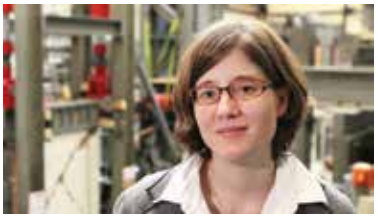
EPFL in the news (in French):
rdp.epfl.ch/

ENAC in 2021

ENAC Board

situation at 31.12.2021

Prof. Claudia R. Binder
Dean of ENAC
claudia.binder@epfl.ch



Prof. Katrin Beyer
Associate Dean for Digitalization & Open Science
katrin.beyer@epfl.ch

Prof. Vincent Kaufmann
Associate Dean for Education & Knowledge Transfer
vincent.kaufmann@epfl.ch

Prof. Rizlan Bernier-Latmani
Head of Diversity Office at ENAC
rizlan.bernier-latmani@epfl.ch

ENAC Council & Commitees

ENAC Dean's Office & General Services

ARCHITECTURE

CIVIL ENGINEERING

ENVIRONMENTAL SCIENCES AND ENGINEERING

Institutes

Prof. Jeffrey Huang
Director of the Institute of Architecture and the City (IA)
jeffrey.huang@epfl.ch

Prof. Dimitrios Lignos
Director of the Civil Engineering Institute (IIC)
dimitrios.lignos@epfl.ch

Prof. D. Andrew Barry
Director of the Environmental Engineering Institute (IIE)
andrew.barry@epfl.ch

Sections

Prof. Dieter Dietz
Director of the Architecture Section (SAR)
dieter.dietz@epfl.ch

Prof. Lyesse Laloui
Director of the Civil Engineering Section (SGC)
lyess.laloui@epfl.ch

Prof. Alexis Berne
Director of the Environmental Sciences & Engineering Section (SSIE)
alexis.berne@epfl.ch

ENAC Dean's Office

situation at 31.12.2021

ADMINISTRATION

Jeroen Jaap van Hunen
Deputy dean
jeroen.vanhunen@epfl.ch

Consuelo Antille
School administrator
consuelo.antille@epfl.ch

Marie-Christine Buluschek
Project manager
marie-christine.buluschek@epfl.ch

Cristina Perez
Administrative assistant
cristina.perez@epfl.ch

Marc Roulet
Administrative assistant
marc.roulet@epfl.ch

Victoria Sanjuan Ruiz
Administrative assistant
victoria.sanjuan@epfl.ch

COMMUNICATION

Armand Goy
Head of communication
armand.goy@epfl.ch

Marie Geiser
Interactive media designer
marie.geiser@epfl.ch

Sandrine Perroud
Journalist
sandrine.perroud@epfl.ch

EDUCATION

Melanie Studer
Coordinator of interdisciplinary education
melanie.studer@epfl.ch

Samuel Cotture
SKIL coordinator
samuel.cotture@epfl.ch

FINANCE

Laurent Gaillard
Head of finance
laurent.gaillard@epfl.ch

HUMAN RESOURCES

Melchior Allet
HR manager
melchior.allet@epfl.ch

INFRASTRUCTURES

Barbara Tirone
Head of infrastructures
barbara.tirone@epfl.ch

INNOVATION & PARTNERSHIPS

Frédéric Dreyer
Innovation and ecosystem manager
frederic.dreyer@epfl.ch

Charlotte Vandenberghe
Project manager
charlotte.vandenberghe@epfl.ch

IT / DATA & OPEN SCIENCE

Laurent Desimone
Head of IT
laurent.desimone@epfl.ch

Charlotte Weil
Data scientist
charlotte.weil@epfl.ch

2021 teaching and research awards

Institut of Architecture and the City (IA)

Dietz, Dieter; Cheung, Teresa; Sze Wing; Zamarbide Elizondo, Daniel (ALICE)
The Most Beautiful Swiss Books 2021.
Swiss Federal Office of Culture, Bern.

Valdez Juarez, Ruben Alberto (ALICE)
Mies Crown Hall Americas Prize.
College of Architecture, Illinois Institute of Technology, Chicago.

Abenia, Tiphaine Laure Elodie (ALICE)
Prix de la thèse en cotutelle France-Canada 2021.
Consulat général de France, Canada.

Trazic, Laura (LAPIS)
EDAR PhD Thesis Dinstinction Award 2021.
EPFL.

Wasilewski, Stephen William (LIPID)
2021 Best Paper Award.
Symposium on Simulation for Architecture and Urban Design (SimAUD).

Hamzeian, Boris (LTH3)
Prix neuvième édition Italian Council .
Ministère de la culture italien.

Brütting, Jan (SXL)
EDCE PhD Thesis Distinction Award 2021.
EPFL

Montagne, Nicolas Robin (SXL)
IASS Hangai Prize.
Surrey International Conference on Spatial Structures.

Graf, Franz; Marino, Giulia (TSAM)
Docomomo Rehabilitation Award.
Docomomo International.

Galbiati, Giuseppe (TSAM)
New European Bauhaus Prize.
European Union.

Civil Engineering Institut (IIC)

Keller, Thomas (CCLAB); Khovalyg, Dolaana (ICE); Mudry, Alexandre Patrick; Pugin, Madeline
Best paper award.
International Building Physics Conference, DTU Denmark.

Beyer, Katrin; Tomic, Igor (EESD)
Best paper-abstract award.
International Conference on Recent Advances in Civil and Earthquake Engineering, Peshawar, Pakistan.

Cornelio, Chiara (LEMR)
EDME PhD Thesis Distinction Award 2021.
EPFL.

Passelègue, François Xavier Thibault (LEMR)
ERC starting grant.
European Union.

Javanroodi, Kavan; Nik, Vahid (LESO-PB)
Best paper prize.
Beyond 2020 conference, Gothenburg.

Ancey, Christophe (LHE)
Harold Jan Schoemaker Award - 2021 IAHR Awards.
International Association for Hydro-Environment Engineering and Research (IAHR).

Frérot, Lucas (LSMS)
Best PhD Award.
Swiss Community for Computational Methods in Applied Sciences (Swiccomas).

Schleiss, Anton (PL-LCH)
Honorary Membership Award.
International Association for Hydro-Environment Engineering and Research (IAHR).

Lignos, Dimitrios (RESSLAB)
2021 Best Teaching Award, Civil engineering section.

Skiadopoulos, Andronikos; Inamasu, Hiroyuki (RESSLAB)
Best Paper & Early Career Award.
International Association for Earthquake Engineering (IAEE), Japan.

Hartloper, Alexander Riley (RESSLAB)
SNSF Postdoc mobility.
Swiss National Science Foundation (SNSF).

Ataç, Selin (TRANSP-OR)
PhD mobility award 2021.
EPFL EDCE.

Environmental Engineering Institut (IIE)

Tollenaar, Veronica (ECEO)
SEP Young Scientist Award.
Swiss Snow Ice and Permafrost Society.

Rinaldo, Andrea (ECHO)
Distinguished Alumnus Award.
Inaugural Neil Armstrong Distinguished Visiting Fellow.
Purdue University.

Rinaldo, Andrea (ECHO)
Hagler Fellow.
Hagler Institute of Advanced Studies at Texas A&M University.

Rinaldo, Andrea (ECHO)
PROSE award for the Environmental Science category .
Association of American Publishers.

Benettin, Paolo (ECHO)
Outstanding paper of the year.
MG Anderson Editor's choice.

Fritz, Livia; Meinherz, Franziska (HERUS)
Best Paper Award.
GAIA – Ecological Perspectives for Science and Society.

Fritz, Livia (HERUS)
2021 Science Award.
Austrian State of Vorarlberg.

Nenes, Athanasios (LAPI)
American Assosiation for Aerosol Research Fellow.
American Association for Aerosol Research, (AAAR).

Nenes, Athanasios (LAPI)
Academia Europaea Member.
Academia Europaea.

Nenes, Athanasios (LAPI)
Web of Science Highly Cited Researcher.
Clarivate Analytics.

Dudani, Nikunj (LAPI)
Innosuisse Business Concept - Spring 2021.
Innosuisse.

Torii, Shotaro (LCE)
Young Reserachers Exchange Fellowhsip.
State Secretariat for Education, Research, and Innovation (SERI).

Kohn, Tamar (LCE)
Excellence in review.
Environmental Science and Technology Letters.

Schaub, Aline Laetitia (LCE)
HMZ Award - PhD challenge.
Hochschulmedizin Zurich - UZH.

Gehring, Josué (LTE).
EDCE PhD thesis distinction award 2021.
EPFL

von Gunten, Urs (LTQE)
Best Paper Award Environmental Science and Technology.
Royal Society of Chemistry.

von Gunten, Urs (LTQE)
First and Second Runner-up
Royal Society of Chemistry.

von Gunten, Urs (LTQE)
Best Paper, Environmental Science: Water Research and Technology.
Royal Society of Chemistry.

Grossiord, Charlotte (PERL)
Mercator Fellowship.
German Research Foundation.

Mas, Eugénie (PERL)
Mobility Award.
EDCE EPFL.

Schirmer, Kristin (TOX)
AGEPoly Polysphère Award 2021, ENAC.
EPFL.

2021 Students awards

Architecture Section (SAR)

Juliette Armanet et Morgane Voirol
Prix de la Ville d'Ecublens

Marion Aubert
Prix Wekbund Suisse SWB

Riccardo Acquistpace
Prix des meilleurs énoncés théoriques

Lucas Bastos et Yamina Sam
Prix SIA Vaud

Romain Barth
Prix des meilleurs énoncés théoriques

Pietro Berta et Simone Izzo
Prix des meilleurs énoncés théoriques

Maud Abbé-Decarroux et Aloys Mützenberg
Prix de la Fédération Suisse des Architectes (FAS) Romandie

Camille Ehrensperger
Prix Mita Krafft Gloria

Marion Fonjallaz et Morgane Hofstetter
Prix des meilleurs énoncés théoriques

Candice Franzetti
Prix SIA Vaud

Harry Waknine Freire
Prix de la Fondation Arditi

Harry Waknine Freire
Prix Mita Krafft Gloria

Marina Garlatti
Prix des meilleurs énoncés théoriques

Maxence Grangeot
Prix Bonnard et Gardel (BG), construction et développement durable

Maxence Grangeot
Prix Mita Krafft Gloria

Claire Heuschkel
Prix des meilleurs énoncés théoriques

Claire Logoz
Prix Orlando Lauti

Claire Logoz
Prix Mita Krafft Gloria

Bastien Marzoli
Prix SIA Vaud

Aloïs Mützenberg
Prix Mita Krafft Gloria

Coline Pernet
Prix SIA Vaud

Zhao Ruojun
Prix des meilleurs énoncés théoriques

Paul Trellu
Prix des meilleurs énoncés théoriques

Lisa Virgillito
Prix des meilleurs énoncés théoriques

Paul Wang
Prix des meilleurs énoncés théoriques

Civil Engineering Section (SGC)

Jasso Espadaler Clapes
Prix CITEC

Jasso Espadaler Clapes
Prix UPIAV

Davide Lamberti
Prix IM

Audrey Letertre
Acier Student Award, Centre suisse de la construction métalique

Riccardo Maestrani
Prix SGEB

Alexandre Mudry
Prix IIC

Selimcan Ozden
Prix SGEB

Nicolas Tireford
Prix Pegurri

Xavier Vingerhoets
Prix Sarada Vinnakota

Sarah Voirin
Prix SIA

Romain Van Mol
Prix STUCKY

Environmental Science and Engineering Section (SSIE)

Alexis Barrou, Edouard Cattin, Quentin Chiche, Blanche Dalimier, Marine Manche et Julie Reznicek
Prix Durabilis

Aurélien Brun
Prix IGSO (Association des Ingénieurs géomètres de Suisse occidentale)

Joaquìn Gajardo, Benjamin Rey
Prix CSD Ingénieurs

Michael Perna
Prix swisstopoEDU

Joëlle Perretten
Prix Géosuisse (Société suisse de géomatique et de gestion du territoire)

Joëlle Perretten
Prix SIA Vaud

Valérie Zermatten
Prix SIA Vaud

Valérie Zermatten
Prix swisstopoEDU

Appointments

Professor Beate Jessel, former President of the German Federal Agency for Nature Conservation, Bonn, Germany, appointed full professor of landscape development in the Department of Environmental Systems Science at ETH Zurich and in the School of Architecture, Civil and Environmental Engineering at EPFL (ENAC)

Beate Jessel was appointed full professor at ETH Zurich as well as at ENAC. She took up her post as director of the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) at the start of September 2021. Beate Jessel's research interests encompass concepts and strategies for nature conservation, landscape development and land use management, environmentally oriented planning, river basin management and landscape aesthetics.

Took office on: 1 September 2021

Professor Olga Fink, currently assistant professor at ETH Zurich and research Affiliate at Massachusetts Institute of Technology (MIT), USA, appointed tenure-track assistant professor of civil engineering

Olga Fink's research focuses on the development of intelligent algorithms for complex infrastructure and industrial systems. She is a recognized expert in the fields of deep learning and hybrid algorithms for intelligent maintenance systems. Fink sits on a number of committees, serves as an expert for Innosuisse, and participates in various working groups at ETH Zurich. Her expertise and research interests will significantly strengthen civil engineering at EPFL in the area of predictive maintenance of infrastructure systems.

Entry into office: 1 March 2022, in Lausanne

Professor Sarah Nichols, currently Assistant Professor at Rice University, USA, appointed tenure-track assistant professor of architecture

Sarah Nichols carries out research on the history of construction materials, how the materials are produced, and what construction practices are used in Switzerland, particularly in light of political and environmental concerns. Her current focus is on the role of concrete – an area in which she is making an important contribution to efforts to design a circular economy and fuel demand for sustainable construction materials. With the appointment of this up-and-coming architectural historian and theoretician, our Institute of Architecture is strengthening its teaching and scientific influence in a research area of great societal importance.

Entry into office: 1 March 2022, in Lausanne

Professor Stefana Parascho, currently assistant professor at Princeton University, USA, appointed tenure-track assistant professor of architecture

Stefana Parascho is a researcher, architect and lecturer who works at the interface between architecture and digitalization; her main interests are computational design and integrative models of architecture, and she has won multiple awards for her research. Her aim is to promote an interdisciplinary approach to architecture through the development of digital production methods and robot-assisted manufacturing processes. Stefana Parascho has all the academic and personal qualities of a first-class researcher and lecturer; she will be an asset to EPFL in this socially relevant field.

Entry into office: 1 March 2022, in Lausanne

Professor Charlotte Malterre-Barthes, currently assistant professor at Harvard University, USA, appointed as tenure-track assistant professor of urban and architectural design

Charlotte Malterre-Barthes works on urgent aspects of contemporary urbanization, conducting research on how design and planning can engage with questions of fair access to resources, the mainstream economy, better governance, and ecological/social justice. She investigates interrelated topics such as climate emergency, materials, food systems, migration, self-initiated urbanism, and real-estate, with the help of various technologies, from satellite images to field work. Charlotte Malterre-Barthes spent six years as director of the Master's degree in Urban Design program at ETH Zurich, and is a co-founder of the the Parity Group and of the Parity Front, associations dedicated to improving equity in architecture. She is also a member of several committees and co-director of her own urban design practice.

Entry into office: 1 August 2022, in Lausanne

Dr Meret Aeppli, currently postdoctoral fellow at Stanford University, USA, appointed tenure-track assistant professor of environmental engineering

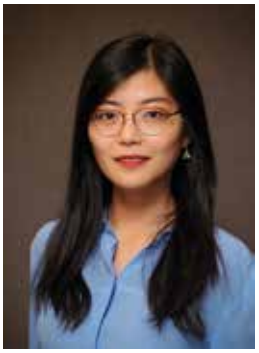
Meret Aeppli investigates redox reactivity and the role of soil in the global carbon cycle. The aim of her research is to find sustainable ways of protecting soil carbon and reducing the negative effects of climate change. At ENAC she will set up a research program to explore the carbon cycle in watershed areas, with particular emphasis on the study of carbon stabilization in soils at contrasting locations commonly found in Switzerland, such as high altitudes and floodplains.

Entry into office: 1 September 2022, in Sion

Dr Andrew Sonta, currently postdoctoral fellow at the University of Columbia, USA, appointed tenure-track assistant professor of civil engineering

Andrew Sonta's research focuses on data-driven modeling, analysis and design techniques for the enhancement of social and environmental objectives in the built environment. He aims to address urban sustainability challenges through a multidisciplinary perspective. Andrew Sonta also studies the physical connections between energy consumption and the efficient operation of buildings. In addition to developing a new research program, he will contribute to new clusters involving EPFL, the Smart Living Lab in Fribourg and the recently founded Center for Climate Impact and Action (CLIMACT).

Entry into office: 1 September 2022, in Fribourg



Dr Kenan Zhang, currently research assistant at Northwestern University, Illinois, USA, appointed tenure-track assistant professor of civil engineering

Kenan Zhang's research looks at transport management, with particular reference to newly emerging transportation services, autonomous vehicles and machine learning in transport. In her work, she combines her specialist knowledge of engineering and transport with her statistical skills. Her research interests are a match with our interdisciplinary approach at ENAC and our emphasis on the digitalization of urban infrastructures. This up-and-coming researcher is also helping to quantify the potential of technological innovation to improve the efficiency and sustainability of urban transportation systems.

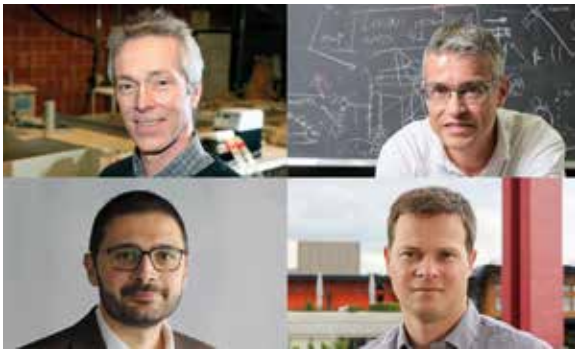
Entry into office: 1 September 2023, in Lausanne

Appointments

Paolo Perona took over as academic director of ENAC's Platform of Hydraulic Constructions, working alongside its operational director, Giovanni De Cesare.

Perona studied mechanical engineering at Politecnico di Torino and obtained a PhD in hydraulic engineering from Politecnico di Milano in 2001. He is a professionally registered engineer and qualified professor of hydraulic engineering. Perona joined ETH Zurich as research fellow in 2003 and then EPFL as an SNSF assistant professor in 2010. In 2015, Perona became full professor and Chair of Environmental Engineering at the University of Edinburgh, UK, where he also served as Head of the Research Institute for Infrastructure and Environment until 2020. He currently holds three positions: visiting senior scientist at EPFL; visiting professor at the University of Edinburgh; and project manager at Holinger AG. Perona's research is experimental and analytical, focusing on the mathematical modeling of the ecohydraulics and morphodynamics of water systems and the related importance for sustainable hydropower planning. He has extensive teaching experience and has supervised or co-supervised 16 PhD theses and authored or co-authored over 100 peer-reviewed publications. Since 2018, he has also been serving as chief editor for *Water and Wastewater Management*, a specialty publication of Frontiers in Environmental Sciences.

Entry into office: 1 January 2022



Management renewals and appointments, effective 1 September 2021

Civil Engineering Institute (IIC):

Professor Dimitrios Lignos took over as head of the Institute of Civil Engineering, for a four-year term. He succeeded Professor Michel Bierlaire, who was very active in his role as institute director since 2017.

Director of the Environmental Sciences & Engineering Section (SSIE):

Professor Alexis Berne took over as head of the Environmental Science and Environmental Engineering section, for a two-year term. He succeeded Professor François Golay, who led SSIE since 2013. Prof. Berne will be followed by Prof. Alcherio Martinoli, who will serve as section head from 1 September 2023 to 31 August 2025.

Environmental Engineering Institute (IIE):

Prof. D. Andrew Barry agreed to a further two-year term (until end-Aug. 2023) as head of the Institute of Environmental Engineering.

Promotions

Professor Brice Lecampion promoted to associate professor of geo-energy

Brice Lecampion's work focuses on fundamental and applied research topics connected with subsurface geo-energy projects (deep geothermics, CO_2 storage, gas extraction and storage) with the aim of improving practice within the industry and making expert knowledge available to policy-makers, regulators and the general public.

With his solid industry experience and experimental work, he is making a substantial contribution to his field, in which he is regarded as one of the world's leading researchers.

Took office on: 1 October 2021

Dr Anastasios Vassilopoulos promoted to adjunct professor

Anastasios Vassilopoulos investigates advanced materials for sustainable structures. At ENAC, he has furthered a research area that looks at fatigue damage in building components made of composite materials. His work is making a key contribution to a new generation of advanced materials, and he is regarded as a leading researcher in his field.

Took office on: 1 October 2021

Professor Nikolas Geroliminis promoted to full professor of transport engineering

Nikolas Geroliminis is consistently working to address complex problems with strong theoretical underpinnings, advancing his field through theoretical and methodological contributions that reflect developments in technology and the societal context in which transportation systems operate. He has an extensive record of innovative, trend-setting and outstanding research that is marked by a particular combination of breadth and depth, spanning topics such as traffic modeling, traffic control, network systems, optimization and on-demand transportation.

His research puts forth an all-in-one solution for monitoring and analyzing transportation systems at a large-scale in a fast, reliable, accurate and high-quality way, identifying the sources of congestion and offering advanced traffic management and transportation solutions. Among his recent initiatives is the creation of an open-science large-scale dataset of naturalistic urban trajectories of half a million vehicles, using data collected in a one-of-a-kind experiment involving a swarm of drones. Among other editorial roles, he is currently the editor-in-chief of Transportation Research Part C: Emerging Technologies, one of the leading journals in the field of transportation.

Entry into office: 1 January 2022

Departures

Professor Harry Gugger retired on 1 February 2021

Harry Gugger was a key member of our faculty for nearly two decades and has marked architecture at ENAC as much as he has the Swiss and international scene in architecture and culture.

The Schaulager, the Laban Dance Center, and the Tate Modern are buildings that have introduced new concepts of cohabitation of the arts with the public. As key partner at Herzog De Meuron, he was at the core of such inventions. Gugger is a winner of the Meret Oppenheim Prize and contributes to the field of architecture through his own firm, Harry Gugger Studio, established in 2010. At ENAC, he left his mark on a generation of highly skilled and motivated architects and urbanists, equipping them with an unparalleled skillset backed by the outstanding methods he developed at his laboratory, LABA. Gugger's research made a significant contribution to new ways of thinking about the way architects interact with the environment. His publications from Havanna Lessons to Manor Lessons constitute the legacy of his research and teaching. We thank Professor Gugger warmly for his commitment to our School and for his contribution to our international reputation through his achievements.

Professor Alfred Johny Wüest retired on 31 August 2021

Alfred Johny Wüest, who worked at EPFL since 2012, has been a true leader in the observation, prediction and engineering of inland water systems. Through his activities at the Swiss Federal Institute of Aquatic Science and Technology (eawag), he also helped forge close ties between EPFL and eawag. We thank Professor Wüest warmly for his commitment to our School, his internationally recognized research, his contribution to the education of engineers in water resources management, and his influence on students learning about scientific approaches to limnology.

Professor Luca Ortelli retired on 31 July 2021

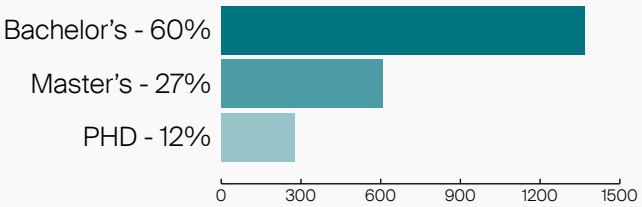
As Director of the architecture section and the Institute of Architecture, Luca Ortelli left a lasting mark on the intellectual aspect of the discipline of architecture. Through his teaching commitment, rigor and passion, he worked to integrate the critical culture of architectural design into engineering fields. At ENAC, Ortelli strove to promote research and teaching that include an ethically responsible and socially sustainable perspective. After 25 years of at EPFL, Ortelli retired at the end of the 2021–2022 school year. We thank Professor Ortelli warmly for his exceptional commitment to our School.

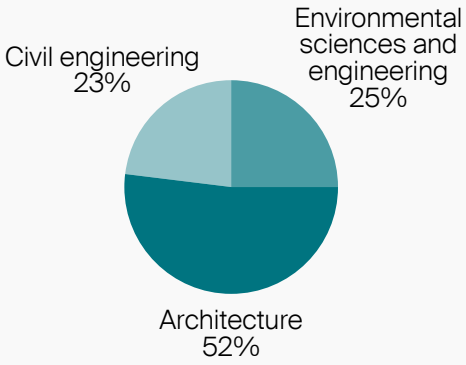
2021 key figures

Education

2,258
Students

44% Women
56% Men





503
Degrees

Source: EPFL

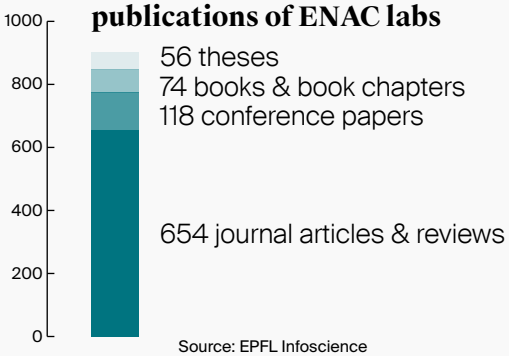
Research

578
Researchers

37% Women
63% Men

70
Research units

902
publications of ENAC labs



Source: EPFL Infoscience

Main national and international research grants

SNSF: 15
Innosuisse: 8
Swiss Federal Offices: 15
EU programs: 15

Source: EPFL GrantsDB & grants/lab. Grants signed in 2021

Innovation

6 Six ENAC linked start-ups created

25 Research and technology transfer agreements

Source: EPFL

Staff

760 (632 FTEs) employees

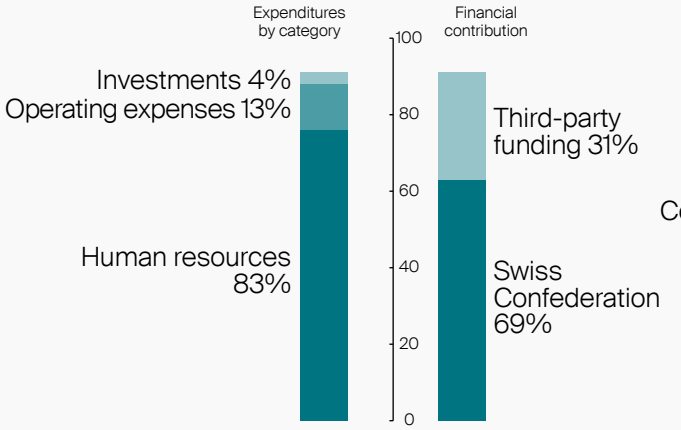
39% Women
61% Men

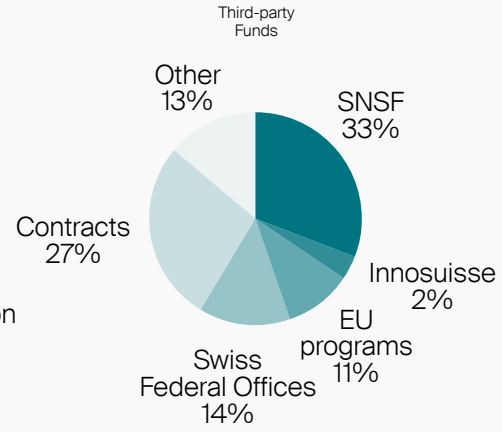
57 Nationalities

Source: EPFL

Budget

91 MCHF total budget





Source: EPFL

Impressum

Editorial

Simone Amorosi; Rizlan Bernier-Latmani; Aïcha Besser; Claudia R. Binder; Valentin Bourdon; Anne-Muriel Brouet; Olivier Burdet; Rémi Carlier; Cécilia Carron; Samuel Cotture; Frédéric Dreyer; Armand Goy; Emmanuelle Marendaz Colle; Sandrine Perroud; Melanie Studer; Nicolas Tetreault; Charlotte Vandenberghe; Charlotte Weil.

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Follow us
@epflENAC

www.enac.epfl.ch

DEAN
Prof. Claudia R. Binder
dean.enac@epfl.ch

EPFL ENAC-DO
Station 18
CH-1015 Lausanne