EmpaQuarterly

Research & Innovation #53 | May 16

NEST – building the future together

Lightweight concrete shell design

Wooden building materials for the 21st century

Working in the office of the future

Empa
Materials Science and Technology

"With our commitment to NEST, we provide the concrete foundation that paves the way for innovative building solutions of the future."

Gerd Aufdenblatten, CEO Holcim (Switzerland) AG

"NEST gets our vote! There's nothing else like it in Switzerland, where research and development can be tested in practice on site."

Kurt Frei, Managing Director, Flumroc AG

"Belimo interprets NEST with originality, uniqueness, meaningfulness and transparency. These four characteristics guarantee the success of a company. NEST enables us to test the impact of these characteristics."

Alfred Freitag, Sales Director, Belimo Automation AG

"In collaboration with EMPA and ETH Zurich, NEST provides us with new results from timber research, which encourage innovations and enable new, marketable timber technology to be developed and realized."

Max Renggli, CEO Renggli AG

"NEST opens the right door for sustainable living and work space in Switzerland. Consequently, this platform fits in with Swisscom's sustainability commitment."

Roger Wüthrich-Hasenböhler, Director Digital Business, Swisscom AG

"As one of the largest real estate investors and building owners in Switzerland, we're extremely interested in the development of sustainable technology and systems. We're proud to be a NEST sponsor."

Stefan Mächler, Group Chief Investment Officer, Swiss Life-Gruppe

"Thanks to the knowledge transfer between research and practice, and testing new technologies and materials under practical conditions, Geberit hopes to be able to tailor innovative products and systems more specifically to our customers' needs and launch them on the market sooner."

Hanspeter Tinner, Managing Director, Geberit Vertriebs AG

EmpaQuarterly

Special Edition – NEST

Cover
NEST as it might look in future. Computer graphics: Marco Kohler, www.3d3w.ch

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Installation of the prefabricated modules for the unit Vision Wood on April 26, 2016.

"The path from the kernel of an idea to the market resembles a trek through the wilderness."

Peter Richner, dept. Director Empa

NEST – building the future together

We all want to live and work in an environment where we feel at home and that satisfies our career and leisure needs. In reality, however, it is often a very different story: Overly hot in the summer, dry air in the winter, artificial lighting instead of daylight, atrocious room acoustics – and above all an unacceptably high energy requirement for heating, cooling and hot water. Within the scope of the Energy Strategy 2050, this is to be reduced by a total of 40 percent by 2035 and the amount of fossil energy even slashed to one third. This is contingent upon a fundamental transformation of Switzerland's building stock, especially the roughly 1.4 million older buildings that come up short in terms of energy efficiency.

Ingredients for a success

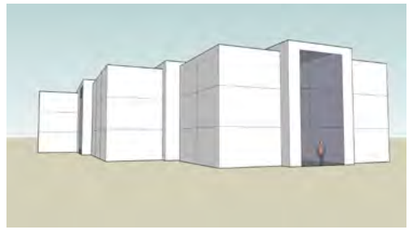
At face value, Switzerland, the world innovation champions, boasts all the ingredients to continue its success story: tremendous economic potential, an SME-oriented economy and a research community that ranks among the best worldwide. Experience, however, teaches us that, in the building sector, the path from the kernel of an idea to its successful implementation on the market is a long and perilous trek through an unknown wilderness, where all too often promising concepts fall by the wayside. High building costs and demands on the lifespan of 20 years for the various trades and more dampens the courage to seek new solutions that have not yet proven their capability sufficiently in practice.

NEST as accelerator

NEST offers an open and dynamic platform that can plug this gap between research and the market. Using new building processes, units where people live and work are made from new materials, systems and individual components. Instead of under laboratory conditions, the individual solutions have to prove themselves within the overall building system. A constant interaction with the users enables a holistic assessment under realistic conditions, and the close collaboration between research and industry guarantees that scientifically founded and marketable insights are generated – an ideal prerequisite for successful innovations. In this sense, NEST is an oasis in the aforementioned wilderness, where travelers from research and industry can meet, bounce ideas of each other and gear themselves up for the next stage.

Multinational corporations become committed

Almost seven years after the first ideas blossomed into NEST, the platform is now going into operation. In an exemplary consorted effort, the public sector, the private sector and science provided the necessary financial resources to make this globally unique research and technology transfer platform possible. The holistic approach, which ranges from energy and comfort to handling water and the inclusion of humans, was pivotal. And we are happy to note that NEST is already being recognized as a unique opportunity by researchers from Switzerland and abroad, and that both SMEs and multinational groups are signing up for the various projects. Moreover, we managed to arouse the interest of real estate owners, who will ultimately be the end customers for the new solutions. There are already concrete collaborations with individual companies, which have large real estate portfolios. NEST is still a small oasis, granted. But it already has great appeal and I am convinced that it will continue to grow in years to come and show us how we can build the future together. //






A platform for ideas emerges

From the project sketch to the official opening in just under seven years.

NEST's predecessor project, the living cell "self", was premièred at Swissbau trade fair in Basel in January 2010. It is designed as a place where two people can live and work, is the size of a ship container and is self sufficient in terms of energy and water. As a research and demonstration project, "self" aims to prove that it is possible to live in comfort (at least temporarily) even if you can only use natural energy sources.

Images above
The first sketches were created in 2009, while the last ones were done during the construction phase.

Images below
After the ground-breaking ceremony in August 2014, a visitor car park on the Empa campus in Dübendorf was transformed into an excavation site, and then into the first floor. The scaffolding in front of the building disappeared in early May 2016.

… August 2009
While "self" is still under construction, Empa's General Management is already thinking about a larger follow-up project. General Management member Peter Richner contacts partners from the research sector.

… September 2009
Eawag Director Janet Hering presents the project, in addition to a first sketch, to the ETH Board in the Executive Committee.

… In 2010
Initial ideas for units are developed together with research groups from the ETH Domain, universities of applied sciences and potential partners from industry.

… September 2010
A preliminary study is prepared for the backbone.

… January 2011
The NEST preliminary study is complete. The search for financing options begins.

… August 2011
The NEST project receives 2.5 million Swiss francs from the 'Frankenstärke' measures by the Swiss government to curtail the strength of the Swiss franc.

… December 2011
General planning contract is awarded.

… September 2012
Planning application is submitted to Dübendorf municipal council.

… January 2013
Bids for preliminary studies for the units HiLo (ETH Zurich), City Lifting (EPFL), meet2create (HSLU), Natural Living (Empa). Natural Living later becomes Vision Wood.

… March 2013
Planning permission is granted.

… April 2013
Objection by a private individual.

… By the end of 2013,
various partners have committed to financing NEST: including the Göhner Foundation, the ETH Board, the Swiss Federal Office of Energy, the Canton of Zurich and the Town of Dübendorf.

… December 2013
The objection to the planning permission is denied. The Swiss National and State Councils approve the construction program in 2014. NEST is part of the program and can therefore be built.

… 26. August 2014
NEST ground-breaking ceremony, with the joint participation of Walter Steinmann, Director of the Swiss Federal Office of Energy; Markus Kägi, Canton Zurich government official; Lothar Ziörjen, Mayor of Dübendorf, architect Fabio Gramazio Janet Hering, Director of Eawag and Gian-Luca Bona, Director of Empa.

… 11. September 2015
NEST is erected with joint sponsorship from research, industry and the public sector and all project partners.

… 12. January 2016
Construction begins on the first NEST unit: meet2create.

… 26. April 2016
Installation of the prefabricated wooden modules of Vision Wood.

… 23. May 2016
Official opening of NEST by the President of the Swiss Confederation, Johann Schneider-Ammann.






"NEST is like a small town."

NEST's exterior will often change – the interior will remain steady and clear. Architects Fabio Gramazio and Matthias Kohler explain the principle of the "upside down lab".

"Maximum freedom opens up maximum possibilities"

NEST provides a solid structure, into which new housing and research modules can keep being slotted. How did you come up with this idea?
Fabio Gramazio: It was important to us to leave the builders and users of the units as much freedom as possible. So we designed a fixed bearing structure. This makes the construction of the units easier as they don't need any supports, for instance. Secondly, we abandoned the notion that all the units needed to be exactly the same. Instead, we consider NEST like a small town. There are north and south-facing "plots" – or units – larger ones and smaller ones. You then have to deal with this given situation and certain limitations in a convincing manner.

Do these limitations at NEST to a certain extent force the researchers to be flexible and find new solutions?
Matthias Kohler: Yes, it brings research close to reality. When you build in the city, you never have an ideal situation. Some plots are just the ticket for photovoltaics, for instance; others not at all. You also need to find answers to this in NEST. And the impact of this research can be experienced directly; after all, the modules are lived in, which is a first. In the past, there was often this chasm in research: The experiment works under ideal lab conditions, but doesn't in everyday life with all its interferences. It's a different story at NEST. The research questions are tested directly here.

NEST is a research lab and inhabited building all rolled into one. How does this affect the architecture?
Fabio Gramazio: The building's façade will keep changing throughout the project. That's fully intentional – a town thrives on change. The atrium and thus also the interior façades, on the other hand, are constant and very clearly designed. This inner zone also contains communal spaces, which can be used by residents and visitors. NEST is effectively a lab that's been turned inside out. The experiments take place on the periphery, i.e. outside, and the façade, which gives the structure its identity, is at the core, i.e. inside.

The finished building looks convincing and coherent. How long did it take you to reach this level of clarity?
Matthias Kohler: You'd be forgiven for thinking that it's a very stripped-down building at first glance – it only consists of an atrium and the floor slabs. But it isn't that straightforward. We invested a lot of time and energy in designing this building. Although it will keep changing shape, there are things that simply have to be spot-on. The emergency escape routes, for instance, always need to work, regardless of which units are placed where. And the position of the doors or connections for the technology should really be optimized so that virtually any conceivable kind of unit can be planned and installed. All this development work is embedded in the skeleton, but it's practically invisible.

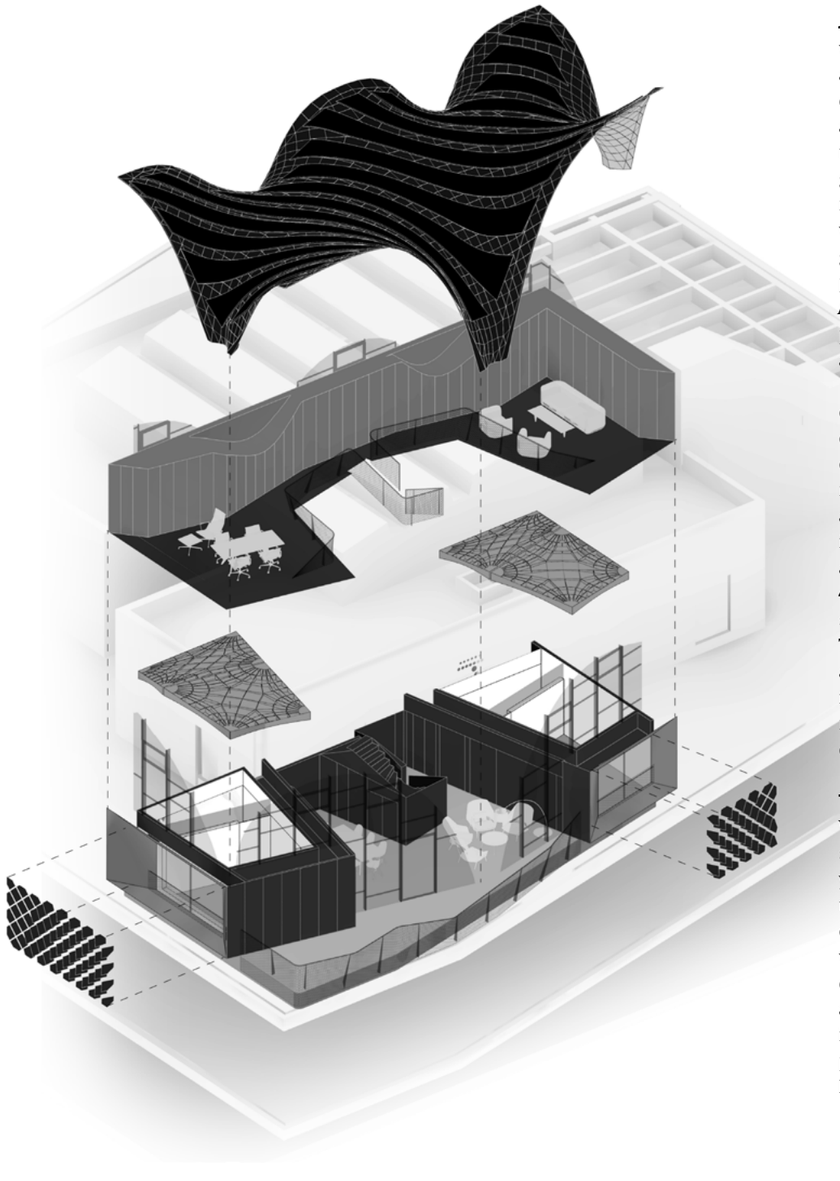
While buildings are made to last for decades, their technology usually needs to be upgraded within 15 years. Can NEST counteract this?
Fabio Gramazio: It's true that building technology has a shorter lifecycle than the physical structure. At present, you adapt the building to this short lifespan. We hope there's an alternative, though. If you offer the necessary flexibility, if you embrace the unknown instead of defining everything, perhaps there will also be possibilities to construct buildings that are made to last longer again. //

INTERVIEW: Michael Staub

HiLo – futuristic building construction turns real

The HiLo unit of ETH Zurich is to take shape in NEST in 2017. The project extends far into the future: a self-supporting lightweight concrete roof will form the visual 'crown' of NEST. The south and west-facing walls will incorporate an adaptive façade with moving solar modules that regulate light and shading as well as the temperature and energy balance of the unit.

TEXT: Rainer Klose / PICTURES: ETH Zürich



From 2017, the architectural crown of the research building will reign from the uppermost platform in the southwest corner of NEST: the HiLo unit. This ambitious project is focusing on further developments in lightweight construction and energy management of buildings. At the same time the partners – two research groups at ETH Zurich – also want to lend new impetus to design. They are endeavoring to bring about a renaissance of filigree concrete shell architecture that is compatible with today's energy standards. Arno Schlüter and Philippe Block, both professors of architecture at ETH Zurich, are managing the project together.

Schlüter is responsible for the energy concept and management of the unit. The concept is centered around efficient on-site energy generation and self-learning, automatic control approaches for energy supply and space conditioning. One core element is the adaptive solar façade on the south and west-facing sides: square modules of 40 x 40 cm in size are coated with thin-film solar cells from Flisom, an Empa spinoff. The modules are controlled pneumatically and can rotate around two axis to either follow the sun to collect energy, provide a maximum of shading for the interior or or open up the view to the outside.

The indoor climate follows the person
When the room is unoccupied, the unit is supposed to maximize the solar energy yield. Either electricity is generated actively using the thin-film solar cells on the envelope or the incident sunlight to passively heat up the interior of the unit to the desired temperature. The decision on what action to take is also supposed to be taken in interplay with other NEST units, which pass on their needs to HiLo via the Energy Hub (see page 21).

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As soon as an occupant enters HiLo, his/her requirements take priority. The aim is to save the occupant from having to use dozens of buttons on a control panel in order to obtain the right room temperature of pleasant lighting conditions. Instead, HiLo is familiar with certain preferences of its occupants and can use these discreetly in the background to optimize energy consumption and maximize comfort. Take for example an occupant who likes a bright, cool room during the day in order to work or concentrate on reading. The solar modules open up the view to the outside, the LED light is adjusted to the brightness and the heating and cooling system creates the desired temperature using the most opportune energy source available at the time. Towards the evening, the occupant wants privacy and slightly warmer conditions. And so, the modules shade the interior and at the same time the temperature increases slightly. The occupant only has to intervene if he/she wants to change the lighting or temperature in the room from his/her probable preferences. The system learns from these interventions to even better adapt in the future.

"Occupant-Centered Control" is the name given to this principle by Schlüter and his team, which they have been testing in their own offices at ETH Zurich for 18 months now. Schlüter's team fitted a first version of the adaptive façade to the "House of Natural Resources" of ETH Zurich (www.honr.ethz.ch) in August 2015 and has since been researching and further developing the façade, the effect and the control technology. For HiLo, the technology is taken to a next dimension, with two façades influencing the climate of the indoor space, which due to its spatial sophistication, is more complex to control.

"The research on comfort in buildings has created a vast body of knowledge over the past 30 years", says Schlüter. "Nowadays we pretty much know at which conditions most people feel comfortable, but we don't consider the context enough, like cultural and psychological aspects. In HiLo, we want to revisit and validate these findings, which also mostly stem from laboratory situations, in a real-life environment." The research project is to run several years, as the intention is for guest scientists from different cultural regions to spend time living in HiLo and have their preferences and impressions collected. What, for example, does a Norwegian, a Somalian, a Chinese person and a Colombian need to all feel comfortable, and how is this different? HiLo will help to gather these data and to refine the automation and control of the systems accordingly. At the same time the effectiveness and efficiency of the technology will be tested in real-life conditions.

Designed by two ETH-Zurich workgroups and under construction on NEST's southwestern face, the unit HiLo is set to enchant visitors to Empa with its extravagant appearance.

Lukewarm water for heating

The whole endeavor is even more ambitious due to the fact that HiLo is not only a building with a large percentage of glass on the façade, but also has different, controllable heating system components. One of the design innovations, an activated lightweight concrete floor, will be used for the ceiling of the private en suites of HiLo. The floor system incorporates water piping that heats or cools the room facing surface as required, thus functioning as a radiant heating or cooling element. "Using large surfaces for radiation exchange is a very efficient way of achieving a pleasant interior climate", says Schlüter. And there is another advantage of the integrated design: "We can use water with a low temperature for the heating – for example from free waste heat supplied from the NEST backbone that cannot be used for any other purpose." And so the designer apartment also recycles 'leftovers'.

Shell roof as a sandwich design

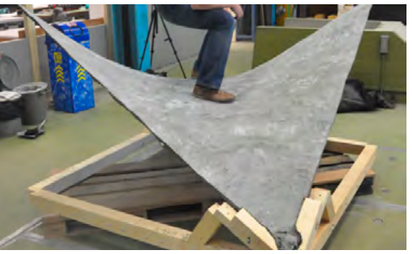
With the elegant concrete shell designs of architect Heinz Isler (1926-2009), Switzerland has a strong tradition of interesting, modern shell architecture. These structures include the highway service area at Deitingen Süd, the indoor swimming pool in Brugg and the Flieger-Flab-Museum in Dübendorf. Together with the Block Research Group at ETH Zurich, Philippe Block is continuing his legacy with research into thin and expressive lightweight construction using concrete. Unlike Isler, however, the conditions he is working in are different, as single-layer concrete shell roofs don't even come close to meeting today's energy standards. That also applies to the multi-curved shell designed by the team as the roof of HiLo.

Schlüter sees this obstacle as a sporting challenge. "Unlike in cold buildings, such as service stations, our roof covers a heated residential space. This means it has to be well insulated and cannot have any thermal bridges." According to Block, this is very doable. "We have already created several shells on different continents." Nevertheless, the HiLo roof is an ambitious individual piece. "To address the building physical requirements, we are building it in four layers," explains Block. "The inside layer is exposed architectural concrete with an embedded heating and cooling pipe system. Then, an insulation layer follows onto which the second layer of concrete is applied. Finally, there is another layer of insulation with thin-film solar cells on top."

Ultra-thin concrete interior cladding

Particularly the roof's construction process is innovative, with its individual layers applied one by one on a carefully engineered cable-net and fabric formwork. The shell is 30 centimetres thick at its five point supports. However, its optimised form allows an average structural thickness of just 8 centimetres and as little as 3 centimetres thick at the shell's outer edges. Remarkably, because of the innovative flexible formwork, there is no need for any scaffolding under the roof. While the roof is being concreted, other trades can carry on in the interior of the HiLo.

1



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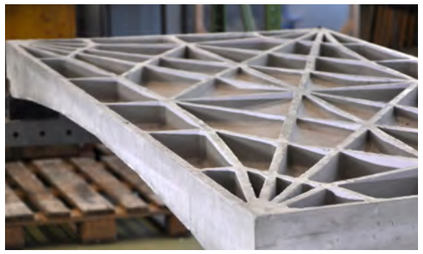

Lightweight floors for skyscrapers

A further innovation being made a reality by the Block Research Group in HiLo is the design of the novel, self-supporting, concrete floors. They do not need the usual steel reinforcement that has been used to build concrete slabs for more than 100 years. “Concrete cannot really withstand any tensile forces, but it is very happy to carry loads in compression as an arch”, explains Block, “so we designed a stiffened vaulted floor that carries all applied loads in compression.“

As a result, the ribbed floor is around 70% lighter than traditional concrete floor slabs, so it could help to save considerably on materials and thus on costs in skyscrapers in the future. In NEST, the floor will be used in a real-life environment for the first time. It separates the lower level of the duplex apartment from the open space under the curvaceous shell roof.

Prototype will confirm the concept

Because not only the construction method but also the layered structure of the HiLo roof are so unique, the team is currently planning a full-scale prototype of the roof design. Together, scientists and practitioners are entering into a venture that could represent a huge step forward for construction technology in Switzerland. //

1
An early prototype of the HiLo roof construction in an improvised stress test.

2
These lightweight ceilings separate the upper floor from the lower floor. They are around 70 percent lighter than conventional concrete ceilings.

3
HiLo’s interior will be characterized by a lot of light and a futuristic loft atmosphere.

“Arming ourselves for the unexpected. Can we manage that?”

Ludwig Hasler,
publicist, philosopher and physicist

Pilot or passenger?

The future is a lot like luck. Some want to force it – and are bound to miss it; others sit back and wait for luck to come to them – and end up waiting in vain. But the worldly wise know what it’s all about: We have to make ourselves seem so attractive that fortune doesn’t overlook us when it happens to whizz by, but rather takes notice and thinks: Look over there; I can do all sorts of things with this Empa lot.

And the future? Can we plan it? As we – unlike the Gods – don’t know what it holds, this would be planning the unplannable. So sit back and wait then? This would reinforce the already rampant fearmongers, who see nothing but climate change, wars and disasters looming on the horizon and are obsessed with safety: Prevent worse from happening, conserve what we’ve got, no experiments. This heightens the risk of the future catching us on the wrong foot.

Anyone who wants the future needs to work with it. First, we have to look attractive – for variations of futuristic eventualities. We have to motivate, transform, invent and rejuvenate ourselves – to arm ourselves for the unexpected. Can we manage that? At NEST? The name is deceptive: You don’t settle in all nice and cozily here; you join to re-emerge completely different, no sitting on your laurels; you live a makeshift existence – to discover how to build, reside and live more sophisticatedly and intelligently. You function virtually like nature here, which, instead of taking the cushy route, muddles its way through by checking all the options, including those that seem futile. Evolutionary drive doesn’t get any better than that.

At present, the future tends to be primed in a more one-tracked manner. Digitization is the magic word here. Cars that drive by themselves, houses that keep tabs on themselves, apps that control us. It all comes across as quite pretentious and just seems like one ginormous infantalization program. Evidently, our future is supposed to consist of having sensors at the bar tell us that one whisky really was enough; after all, we want to perform well on our morning jog, and the health insurance company agrees.

What do we want? Fifty years ago, we dreamed of flying cars. Flying, beating gravity, conquering space. And now? We are supposed to be carted around like infants. The old visions regarded the future as an anthem of change, an explosion of human possibilities. Most digital designs increase comfort, nothing more, in favor of external control. They serve a society of unimaginative consumer zombies, who are always told what they are supposed to want next.

Mobility may well run like clockwork at first if we remove accident-prone humans from the traffic equation. And if it manages itself, energy efficiency may well work at first, too. Then digital versus analog behaves like reason versus freedom; machine versus man. Machines don’t make mistakes; they don’t even know how. They are never drunk, in love, tired, distracted, sad or high. Humans make 1,001 mistakes because they are always elsewhere in whatever they do. But only thanks to this are imagination, melancholy, dreams, brainwaves, collapses and innovations born…

To whom does the future belong? The machine? Freedom? Us? Will we still be pilots in future – or just passengers? Will we use what others program – or will we program our future? We are already deciding this today. At Empa’s NEST. In ETH-Zurich nests. Soon in the Innovation Park. One day throughout the entire Swiss nest? Do we want to be the pinnacle of technology, i.e. pioneers and not merely users? Do we want to think as well as amass knowledge: linguistically, artistically, philosophically? The future has the Swiss nest as a laboratory that pairs off contrasts instead of separating them: research & industry, technology & art, society & genius. The future thrives on provocations of chance. //

The fascination of wood

Many people dream of living in a wooden house, but after a few short years the exterior is already weathered and faded. Even when used inside, the material is very sensitive, fading in direct sunlight and warping under potted plants if your neighbor overwaters it while you are away on holidays. It takes a lot of effort to maintain a house like this. Regular sanding and varnishing is needed, unless you want to tear down your patio and rebuild it every five years. Wood is nevertheless the preferred material of many people because it is attractive to look at and strong and simple to work with, making it ideal as a material for construction.

At the end of April, a construction crane pushed the first residential units into NEST just like they were a set of drawers. The new unit, called “Vision Wood”, is true to its name, as it contains a great deal of that age-old material. Except with completely unexpected properties that suddenly make possible what has been impossible in the past.

TEXT: Amanda Arroyo / PICTURES: Empa, Renggli AG, Rossi-Binna AG

Most of the unit Vision Wood consists of seven prefabricated modules, which had been delivered by flatbed truck and mounted by crane on April 26th.

New inventions put to the test in real life

In order to make wood easier to care for and thus (even) more attractive as a material for building, Tanja Zimmermann, Head of the Empa department “Applied Wood Materials”, and Ingo Burgert, Professor of “Wood Materials Science” at ETH Zurich and Empa researcher, have worked together with their teams to incorporate new functions into the tried-and-tested material. Now the two want to test these material developments in the new unit “Vision Wood”, which was recently inserted into the NEST building. “This will be the proof of how the materials behave in real-life conditions”, says Zimmermann.

The unit contains three turn-key residential units that will initially house two doctoral students. One of them will have an interest in wood and the other one will not. The third residential unit is to remain empty for the time being and will be used for guided tours. “I would love to move in there myself”, jokes Zimmermann. “But I wouldn’t be prepared to do another doctorate for the privilege”. The two students will use the unit together as one residential space and cause wear and tear through daily use. This is the ultimate practical test for the new material developments.

Otherwise beech wood is used as firewood

One unusual aspect is that the unit is largely made from beech wood. “The woods in Switzerland are full of these deciduous trees”, says Zimmermann, “but up to now we didn’t know what to do with them.” That’s because this type of wood is very sensitive to moisture. It warps dramatically when it gets wet. Left unprotected, a wooden façade made from this material will become completely warped and covered in fungus after just a short time. This is why nice beech stem wood is only used for interiors, for example for furniture, or as firewood. But in fact it would be excellently suited to load-bearing structures on account of its strength. Hence the unit’s load-bearing structure is made from cross laminated beech timber.

“But even the surfaces in the interior use lots of beech”, says Zimmermann. For example, the sensitive beech wood was rendered water repellent with a special surface treatment. The result is a washbasin and shower panels that repel water.

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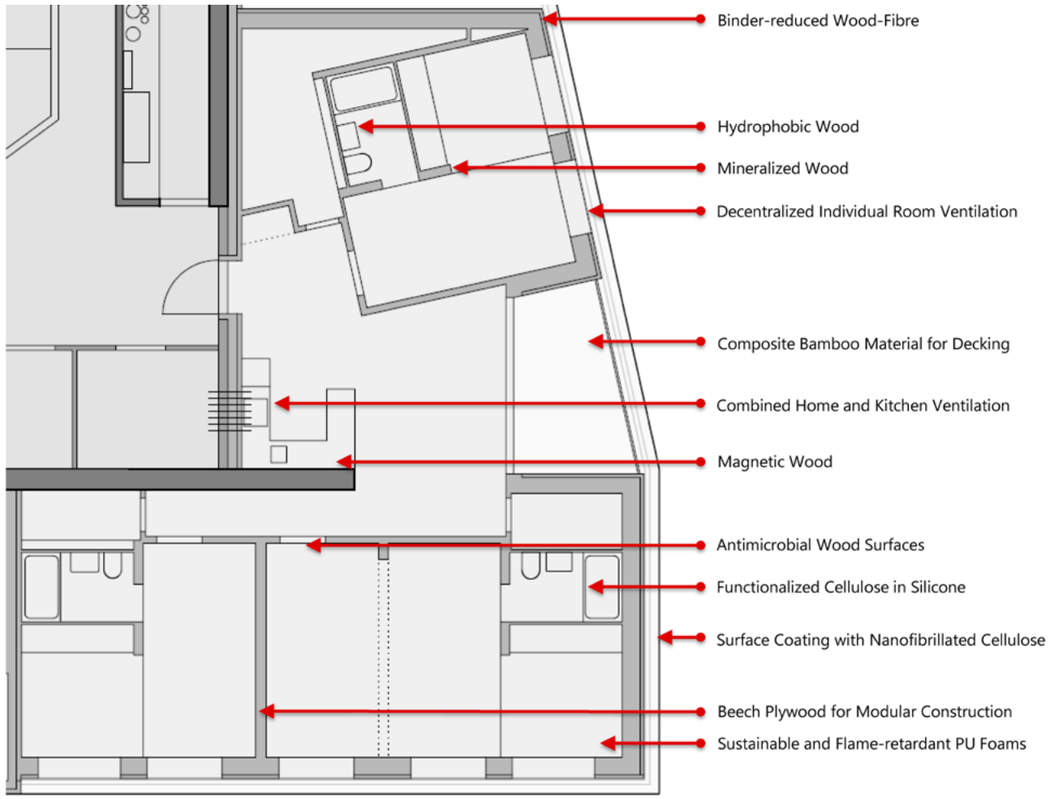
Prefabrication of the modules at Renggli AG.

Right
Furniture made from bamboo composite for the roof terrace of Vision Wood.

Vision Wood at a glance:



Wood in completely new places
The doors and door handles, too, have entirely new properties. Thanks to lime stored in the wood, the doors are more fire resistant, while the wooden door handles kill germs from unwashed hands thanks to antibacterial iodine integrated in the structure of the wood. Another highlight is the magnetic wooden notice board that magnets stick to because of iron oxide particles on the inside. Even the unit's silicone seals include the wood component cellulose as a thickening agent.

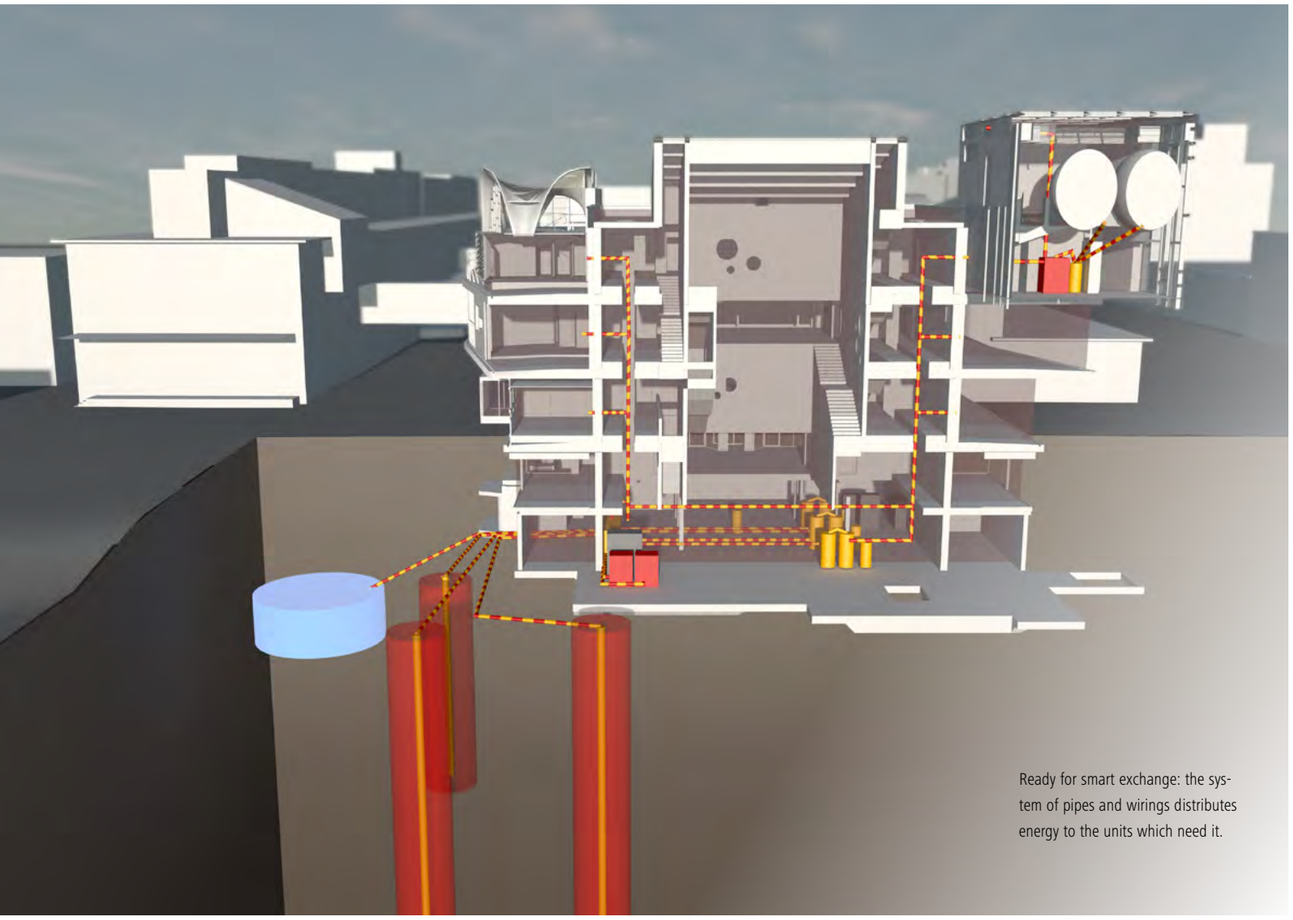
Further innovations are being tested on the exterior. Firstly, the wooden façade will be more weather and UV resistant thanks to coatings using microfibrillated cellulose as reinforcing and carrier material for active substances. This means that fewer cracks will form and the façade will be protected from microorganisms. Secondly, a new and highly resistant bamboo composite material will be used for the patio. Thanks to an eco-friendly resin, the bamboo will also be watertight and weathertight. The patio furniture is also made from the same material. Because it has especially good tensile strength, it is possible to create particularly filigree structures. The "Vision Wood" unit is proof that wood can be used to marry attractive design, comfort and sustainability in perfect harmony with each other.

Modular construction – a glimpse into the future
One remarkable aspect of the Vision Wood unit is the particularly high number of prefabricated individual components. This is not by chance, but part of the research project. The seven modules that make up the three housing units are manufactured by the project partner Renggli AG and delivered by flatbed truck. A mobile crane was used to slot the modules into NEST's middle platform on April 26.

The company's CEO, Max Renggli, has steadily been gearing his firm towards this kind of production. "Modular construction has a future," says Renggli. "It ties in with the modern production means we have at our disposal today. Using a 3D technique, we can plan the modules way in advance before assembling them in our production halls and delivering them to the building site just in time. This enables us to achieve a clean process operation and minimize the construction phases that take place outside our control." For Renggli, the installation of the modules is a kind of test run, on the back of which he wants to optimize synergies with other sectors. "NEST could be a springboard for a new building culture with more precise planning, more networked thinking and more diligence on the path towards the end product." //

GRAPHICS: www.3D3W.ch

Energy research in a vertical neighborhood



Ready for smart exchange: the system of pipes and wirings distributes energy to the units which need it.

In the district of the future, favors amongst neighbors will go much further than lending a lawnmower or giving some sugar for baking. They will help each other out with energy – with electricity, heat and gas. With the help of the demonstrators NEST and move, the "ehub" – short for Energy Hub – combines energy flows between buildings and mobility within a 'vertical' district. The aim of the project is to optimize energy management.

TEXT: Stephan Kälin / PICTURES: Empa, 3D3W

Buildings as energy producers, seasonal storages in the district, bi-directional energy networks: Energy supply is becoming more and more decentralized, and at the same time is raising a range of new issues. What level of local energy autonomy makes sense? What is the importance of new technologies and what combinations make sense? How can the energy demand in mobility be integrated in building-systems? What are the effects on the electrical distribution grid or heating networks? "ehub is an energy research platform that makes it possible to answer these and other questions, test new energy concepts and determine the potential for increased efficiency", says Urs Elber, Managing Director of Empa's Research Focus Area and Project Manager of ehub.

Many components, one central platform

ehub comprises a large number of components that convert, store and release energy. They are connected with each other via intelligent controls and can be extended to incorporate further technologies. "Depending on the research question, the components can be operated separately or in concert. That's why there is not just one operating scenario, but lots of different ones, some of which run parallel to each other", explains Philipp Heer, ehub Technology Manager. As a test environment, ehub uses the two demonstrators NEST and move. "From an energy perspective, the individual units in NEST represent independent residential or office buildings", according to Philipp Heer. For energy research, NEST is thus a "vertical district" where new energy concepts can be examined for a single component up to a group of buildings.

The units are connected to different electricity, heat and gas networks, which allow energy to flow in both directions. "For example, heat can be transferred from one unit where it is too hot and to a unit where heat is needed", Heer explains. If more heat is generated in summertime than is needed within the neighborhood, seasonal storage systems are used. ehub has an ice storage and various geothermal probes for this purpose. The stored heat can then be redistributed back into the district, i.e. to NEST, in winter.

Shift to mobility

Thanks to efficient photovoltaic units, in future more electricity will be produced in summer than is consumed locally. In a building, batteries can store this energy in the short term, but in order to store electricity for longer periods, it can be converted to hydrogen. For this purpose, ehub uses components of the mobility demonstrator move. In this demonstrator Empa collaborates with partners from industry and the public sector to show several ways in which the mobility of the future can be transitioned from fossil fuels to pure renewables. There excess electricity is used to create hydrogen with Electrolysis to store it in special tanks. The hydrogen serves as a fuel for fuel-cell vehicles on the one hand and it can be re-routed back into the building on the other hand, where it is converted back into electricity using fuel-cells.

'Signposts' for future investments

ehub is open to receiving specific questions from research and industry. "Our results on suitability and the combination of individual technologies in a system should lay the foundations for future investment decisions by planners, architects, energy suppliers and the authorities and give them meaningful and integrated alternatives for action." That's how Urs Elber sums up the goals of ehub. To make sure this is a success, it is also necessary to think beyond the district and understand how the changed local networks can impact on the overall energy system, he says.

This is why the next step is for ehub is to be expanded beyond the boundaries of the Empa campus and linked up to the "Energy System Integration" (ESI) platform of the Paul Scherrer Institute (PSI). This broad collaboration raises energy research to a new level and allows research to be conducted on energy networks that are geographically distributed. Moreover, pooling the various skills and technologies enables a holistic view of the energy systems of the future.. // **ehub.empa.ch**

move – mobility of the future

ehub combines two demonstrators on the Empa campus: NEST and move. In both, energy is converted, stored, used and sometimes even generated.

Opened in November 2015, the demonstration and technology transfer platform "move" enables Empa researchers to investigate the production of new fuels based on renewable excess electricity with significantly lower CO2 emissions in a real environment. Renewable electricity serves as the energy source, especially during periods with low electricity demand – or is generated in one of NEST's units.

This renewable electricity can be turned into mobility in different ways: Firstly, it can be stored temporarily in a grid-battery for a few hours and then used to charge electric vehicle batteries. Secondly, it can be converted into hydrogen for fuel cell vehicles by way of electrolysis. Hydrogen is easier to store than battery power.

Ultimately, the aim is to expand the project and produce as a third way synthetic methane from hydrogen and CO2 at "move", which will enable the renweable electricity to be used in gas vehicles.

Besides the optimization of energy conversion and storage technologies, "move" should also reveal which kind of vehicle drive is best suited to which "mobility application".

move.empa.ch

"We could axe various power stations if our electricity and gas grids were used correctly. "

Switzerland's buildings need to become smarter and more energy-efficient. Walter Steinmann, Director of the Swiss Federal Office of Energy (SFOE), believes that they can learn this from NEST.

"NEST should be a beacon that lights our path."

Mr. Steinmann, what challenges does Switzerland's building stock face?
Swiss buildings need to become more energy-efficient and intelligent. And both at the same time, too. Buildings need to form an active element in a larger overall energy system. This especially goes for the heat and power grid. Instead of merely being consumers here, buildings should become part of these networks and, if possible, feed electricity or energy into them.

And why do our buildings need a higher IQ?
Thanks to the mounting intelligence in buildings, we are able to control systems in an increasingly user-oriented way. This improves efficiency and interaction. As residents, we still provide important input, but the buildings will perform the lion's share of the regulation work thanks to their intelligence, without any help from us.

Where does NEST come in?
NEST enables researchers to test new solutions experimentally and check whether they can survive on the market. The backbone provided is crucial; you can test the individual modules and technologies on it, which will be exciting. This is something that doesn't exist anywhere else.

The SFOE supports NEST as a lighthouse project. What do these projects mean for the Swiss federal government?
The term lighthouse projects was coined by Doris Leuthard. She wanted – and still does – to show the population at large that it's already possible to head in the direction of the Energy Strategy 2050 today. A lighthouse project like NEST should therefore cast its light across the region and make it clear that this is presumably where the energy world is heading. Not only is this interesting for private individuals or building owners, but also the entire industry. At NEST, you can practically see the new things on the horizon and then ponder whether we need new professions to realize themen.

For a long time, the focus for the realization of the energy strategy was on the building shell. Now building services are increasingly to be promoted. What is the SFOE's strategy?
Firstly, building technology is increasingly to become part of the cantons' building program, which means it can be co-funded. Secondly, we want to reach a stage where good examples like NEST also get noticed outside the industry. After all, a great many people are unaware of the opportunities that building services offer. And finally, we also need competent people to realize all these good ideas. That's why we're involved in education and training in conjunction with the electrical installation association VSEI, for instance.

In Switzerland, power stations are currently a hot topic. How can the discussion be brought from production to consumption or energy efficiency?
That's an important process which has only just begun. A current study reveals that we could axe various power stations in Switzerland if the electricity and gas grids were used correctly. In other words, they wouldn't just serve transport, but also the storage and just-in-time production of energy. There are still great efficiency and savings opportunities here. A second key point is the residents. We have to focus more on them and especially their conduct. They should see themselves and their buildings as a key piece in the bigger picture. //

INTERVIEW: Michael Staub

Bastian Etter checks that the urine recycling system is working. The system extracts nutrients from urine and is part of the research activities in the WaterHub.

The toilet of the future

Wastewater treatment consumes a huge amount of energy. A great deal of effort is needed to remove substances like nitrogen or medicine residues from the wastewater, while on the other hand we use large amounts of energy to collect nitrogen from the air for fertilizers. Is there another way to do this, or is it perhaps possible to connect the two? In the "WaterHub", Eawag's research project in NEST, researchers are looking for answers.

TEXT: Mirella Wepf / PICTURE: Eawag

The toilets in NEST are unique. They contain sensors that can detect whether water or urine is flowing into the bowl. As soon as urine is detected, a small channel opens that allows the urine to pass through separately. When the toilet is flushed, this channel closes and the fecal matter is flushed into a second pipe together with the toilet paper. The 'number 1' and 'number 2' land in a room in the basement of the building that is around 100 m2 in size, where they are processed and examined by Eawag researchers in pilot facilities.

The German company Duravit developed the toilets in collaboration with Eawag and other companies. These toilets carry out a key function in the "WaterHub" – the official name given to NEST's water research activities. "Without separating out the urine, a huge part of our research projects would not be possible", explains Eawag researcher Bastian Etter, who coordinates the WaterHub. In the ini-

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tial phase, the WaterHub comprises three main projects: the treatment and recovery of urine ('yellow-water' is the technical term), the treatment and recycling of water used for bathing and washing food, clothes and dishware (referred to as 'greywater') and the treatment of fecal sludge comprising toilet paper, feces and flushwater ('blackwater'). Further projects will be added over time, for example research in the field of rainwater recycling, innovations to counter the development of odor in wastewater and various platforms for industry cooperation.

Saving energy and money

"When you think about it, the way we handle wastewater is absurd", says Etter. "We mix feces, urine, greywater and rainwater together, flush it with valuable drinking water, and in the wastewater treatment plant it all has to be separated again using huge amounts of energy." He does the math: "Between 50 and 90 percent of the nutrients that have to be removed from our wastewater come from urine." These are chiefly nitrogen and phosphorus, high concentrations of which have an adverse effect on bodies of water. Two thirds of the medicine residues in the wastewater also come from urine, but urine only makes up one percent of the total volume of wastewater. To sum up, if we were to separate out the urine from the outset, it would be possible to run wastewater treatment plants with much less energy.

Theoretically, feces and urine could also be put to better use – either as fertilizers or as fuel. However, there are some problems with this that have not yet been fully resolved. At the core, these include the efficient and safe removal of pathogens and the fact that there are no market-ready processes for separating feces from urine and recovering the nutrients. Etter says: "In the case of nitrogen for example, which is needed in agriculture as fertilizer, we are currently taking the long way round. We use enormous industrial plants to collect nitrogen from the air. At the same time we put a great deal of effort into removing it from our wastewater. It would make sense if we could make this a closed cycle."

Six wastewater channels

These examples explain why NEST has six separate pipes instead of one single wastewater channel: one each for feces, urine, rain water, the lighter (i.e. less polluted) greywater from the shower, the heavier water from the kitchen (containing grease) and, just to be sure, one channel that leads into the sewage system. The separate wastewater flows make it possible to examine certain issues in a targeted way and to come up with solutions to reduce water consumption, to reuse service water several times and to use the nutrients in the wastewater.

According to Bastian Etter, it is definitely realistic for larger buildings in Switzerland to have their own wastewater treatment facilities in future and to no longer be dependent on the sewage system. "We're not there yet, but the trend will and should go in this direction." He tells us that the first pilot projects are already in planning but are not yet a reality.

However, the Eawag researchers are not just aiming to optimize wastewater management here at home – they are also looking to countries with other requirements, in particular to developing countries and to regions that suffer from drought. More than two billion people worldwide do not have access to hygienically safe toilets. This burdens the environment and poses a health risk to society.

Large treasure trove of experience in relation to water

When carrying out their research work at NEST, the Eawag researchers can fall back on the experience gained from numerous predecessor projects. These include the development of the Blue Diversion toilet, which won an Innovation Award in 2014 from the International Water Association (IWA) for the best applied research (www.bluediversiontoilet.com).

The separation of urine has already been taking place for the past eleven years in the Eawag main building, which is situated 200 meters from NEST. The resulting fertilizer manufactured by Eawag using a newly developed process has recently gone on sale. NEST will offer Eawag and its partners considerably more scope for innovation. //

"Several generations of researchers will work at NEST."

Janet Hering is Director of the aquatic research institute Eawag. At NEST, she is looking to initiate research that aids the careful handling of water and sewage.

"Water and energy are closely linked"

Ms. Hering, Eawag has a research scope that extends beyond Switzerland. What will be the major global challenges for water and sewage in the next decade?

The two biggest problems worldwide are safe drinking water and inadequate sanitary infrastructure for large sections of the population. This affects numerous developing countries. Drinking water often contains germs, and there is often a lack of sewer systems or sewage treatment.

How can we approach these problems and where do your NEST projects come in?

We want to conduct research that can be used in developing and industrialized countries alike. At NEST, we're studying a technique we co-developed to treat urine, for instance. This enables valuable nutrients to be obtained and used as fertilizer. Another research focus area we're pursuing at NEST is the preparation and use of graywater. The global demand for this technology is huge.

How would you describe this kind of graywater usage?

Graywater is water that's only slightly polluted. It can be cleaned and reused a second time. NEST offers us the opportunity to study graywater under real conditions, without actually exposing the residents to the water. To date, relatively little research has been conducted on how such systems work – one reason for the extremely extensive pipe system in the backbone.

NEST has a planned service life of at least 30 years. What's the timeframe for the Eawag projects?

In its first year of operation, we'll focus on installing the entire infrastructure. We then want to get started on the first research projects as soon as possible. Usually, they will be doctoral projects that last for four years. So several generations of researchers will be able to work at NEST. We're aiming for increased collaboration with industry so we can either prepare products for the market or incorporate them into the Innovation Park in Dübendorf.

Do we need to think more about saving water again?

Pure water consumption isn't really such a problem. But it's important to realize that water and energy are closely linked. In other words, water consumption automatically leads to an energy demand – primarily due to the hot water supply and wastewater treatment. And the energy required needs to be produced first. It's less about the cost of this energy production than the repercussions. I'm talking about climate change, for instance.

Those are relatively complicated relationships. Can this issue be solved technically or will it take a change in behavior instead?

There's no such thing as a perfect solution that works across the board. You always need to look at the context, then weigh up the pros and cons. But some things are presumably just common sense. The utility room springs to mind: After all, do we really need to do all our laundry at 95 degrees these days? (Laughs). With today's machines and detergents, your laundry will still get clean at lower temperatures. So while the result is still the same, it uses a lot less energy. //

INTERVIEW: Michael Staub

Offices that adapt like a chameleon

What will the office of the future look like? With "Meet-2Create" researchers from Lucerne University of Applied Sciences and Arts are looking to solve questions like this.

TEXT: Reto Zanettin / PICTURES: HSLU

A quarter of Switzerland's employees regularly work remotely. Many have days where they work from home; some work at another branch, the customer's premises or on the go, as the study SwissFlexWork 2014 conducted by the University of Applied Sciences and Arts Northwestern Switzerland reveals. One of the challenges of mobile and flexible work is to find the right environment for each task. Writing reports and concepts or compiling presentations requires quiet zones. Brainstorming and discussion sessions, on the other hand, need rooms that encourage creativity and teamwork. This is precisely where the Competence Center Typology & Planning in Architecture (CCTP) at Lucerne University of Applied Sciences and Arts – Engineering & Architecture (HSLU) comes in: At NEST, its researchers have now realized a "human office", where the impact of novel office spaces can be tested in practice.

From innovation process to interior design

"The office of the future will be centered on the topics variety, appropriation, comfort, diversity, exchange and encounter," says project head Sybilla Amstutz. "It will be capable of adapting to the needs and activities of the users." For the conception, the developers of Meet2Create began with a typical innovation process. In order to allow an idea to mature, evolutionary mechanisms are required – just like in nature: "variation", "selection" and "stabilization". The scientists assigned these three mechanisms typical tasks that need to be performed in an office. Brainstorming and exchange for example, belong to "variation", presentations and discussions take place in "selection" and individual work ranks among "stabilization". In the Meet2Create unit, three work zones called "Hybrid", "In-Out" and "Cocoon" correspond to these mechanisms.

In "Hybrid", people are supposed to express themselves creatively and develop projects; in other words: perform "variation" tasks, such as brainstorming, discussions or finding solutions. Consequently, the facility is designed for a high degree of flexibility: tables, chairs and presentation areas can be organized and moved around as and when needed. Through "Hybrid", the researchers are looking to gain insights into how spaces can be redesigned and used purpose specific. Additionally the project aims to continually develop furniture for the office of the future.

Naturally created indoor climate

The "In-Out" section based on the evolutionary mechanism "selection" is also geared towards collaboration. Project members meet to present, adapt and prioritize concepts – or have an informal chat. In this zone, no heating, ventilation or air conditioning was installed. Only the room structure, the façade construction, a latent heat storage unit, materials such as wood and textiles, and plants regulate the indoor climate. This design is to demonstrate how temperature, air humidity or even the oxygen balance can be maintained at a performance-enhancing level with passive building technology.

In the "Cocoon" zone, considerations on the evolutionary mechanism "stabilization" are expressed. Individual work and a high degree of privacy are just as possible as focused collaboration. Every user can personalize their own work space, such as by setting the light and temperature according to their individual preferences. And anyone who wants to retreat can sit down in the bay embedded between "Cocoon's" individual and teamwork stations. The experts expect "Cocoon" to yield insights into how the need for privacy while performing tasks can also be fulfilled in open-plan offices. //

Left
In the "Cocoon" zone, the room layout and individually customizable work stations allow both team and individual work. The experiences with this concept will be channeled into the architecture of open-plan offices.

Right
A model of Meet2Create's interior architecture.

"I've come to realize that the coffee machine is the most important place in research."

Government councillor Markus Kägi is Head of the Building Department in the Canton of Zurich, which supports NEST with substantial start-up funding.

"We're absolutely convinced by NEST."

Compact building and energy efficiency are key topics all over Switzerland. What strategy is the Canton of Zurich pursuing here?
As regards energy efficiency, we primarily rely on technical progress, the further education of experts and keeping the public informed. Evidently, our strategy is a success as the renovation rate is above the national average. And we're also on target for the reduction of CO_2 emissions.

NEST offers efficient housing units with a low space requirement. How does the project help you to achieve your strategic targets?
NEST is a great opportunity for research. As you know, you can't tell research what goals it should achieve. But you can support it financially, which we do and are confident it yields good products that in turn will accommodate our goals. Therefore, we promote NEST out of conviction, and it also fits in with our spatial development strategy, which sends out strong signals as regards densification. What's more, the project is a true lighthouse. It isn't just about theory; the modules are also inhabited. For me, this means that anyone who wants to research something new in this building also has to live with it. That's very direct, immediate access.

Has research been too far removed from practice until now?
No, not at all. But with NEST, you follow a different path. Anyone who wants to try out something experiences it first-hand. Research doesn't get much more empirical than that.

What other insights do you personally expect from NEST?
The project should provide stimuli for technical progress – both for energy efficiency and spatial densification. But I'd like to stress that, as a canton, we provide start-up funding. We don't want to intervene directly in the market, but rather take on more of a mentor role. This enables us to boost the economy's innovative strength and help prepare new technologies for the market.

The City of Zurich and its agglomeration rank among the most urban areas of Switzerland. How rapidly will we see innovations here that hark back to NEST?
NEST should reduce the development time for innovations. I invite entrepreneurs and industries to seize these opportunities, too. This will enable new technologies to reach the practical application stage sooner. If industry continues to be so involved, I'm confident that the first innovations based on NEST will already be on the market in a few years' time.

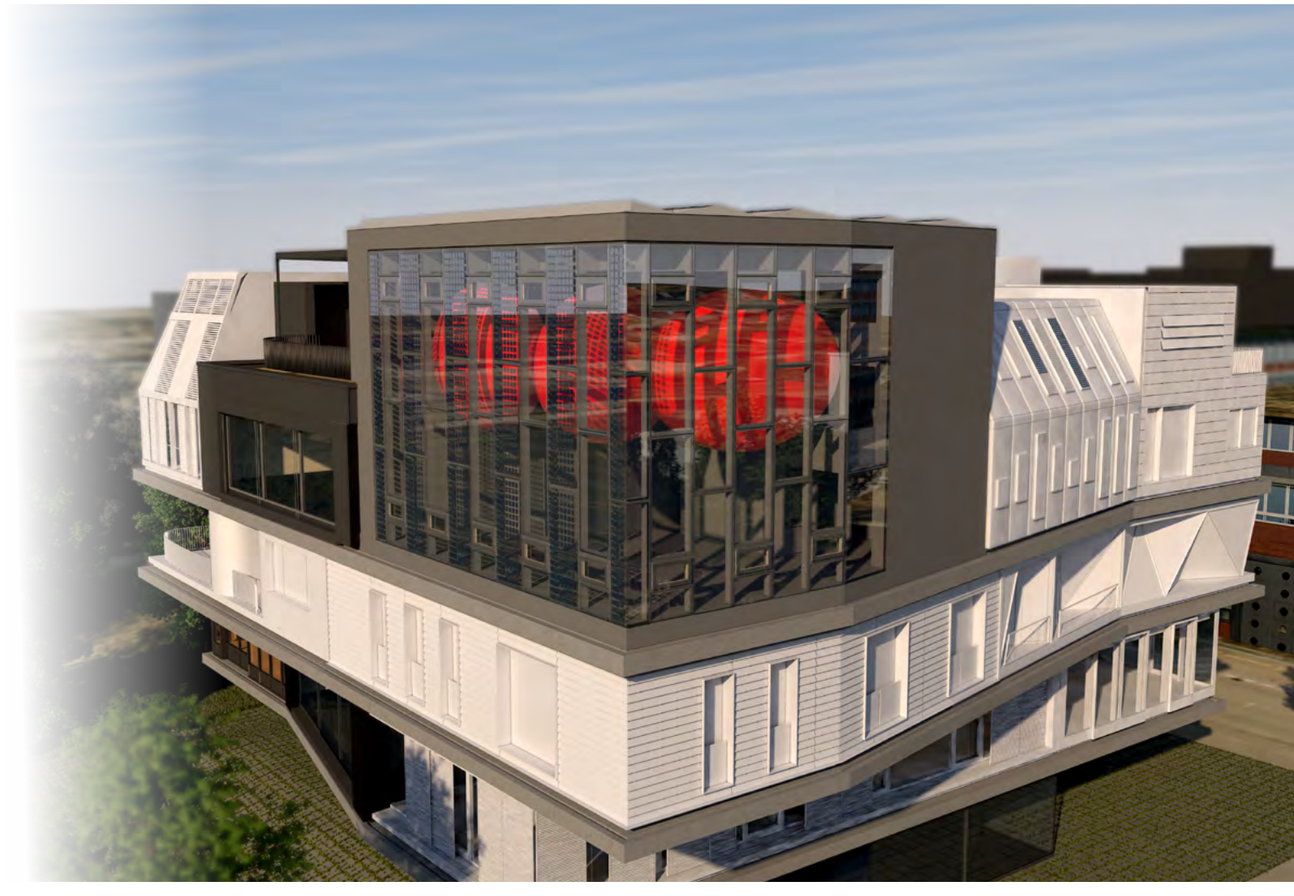
The Canton of Zurich boasts a unique concentration of universities and research facilities. How important is NEST as an ambassador for this expertise?
NEST is another brick for Zurich as a research and development hub. Like the numerous institutions of higher education in our canton, it too should serve the entire population. NEST is in a prime location if you think of the forthcoming Innovation Park in Dübendorf. This provides good stability as the closer together people from research are, the better the results will be. I've learnt that the most important place in a research institution is the coffee machine. People meet there and bounce ideas off each other. We're absolutely convinced by NEST; otherwise, we wouldn't have invested a single franc. And I'm personally behind it 100 percent.

INTERVIEW: Michael Staub

Solar quality of life

A fitness and wellness center is currently being constructed at NEST. Not only is it particularly energy-efficient compared to conventional facilities, it also supplies its own power.

TEXT: Amanda Arroyo / PICTURES: Empa



The unit Solar Fitness and Wellness will be ready on the northeastern side of NEST at the end of 2016.

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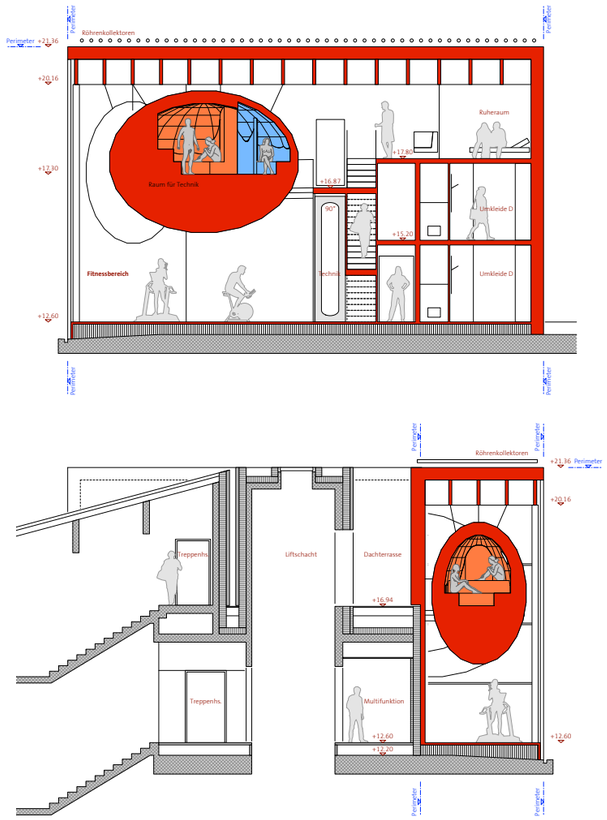
A short bike ride through the streets of Hong Kong with a colleague during lunchbreak. This might sound like a business trip, but it isn't. Instead, it is a vision for the staff at Empa and Eawag: slap-bang in the middle of the Dübendorf campus, a unique fitness center is currently under construction with support from the building services association suissetec and designed by well-known solar architect Peter Dransfeld. It is well worth pedaling away on the high-tech machines. Apart from a special motivation program, which enables you for example to explore various cities virtually or work off a special reward and the health benefit, you actually generate power, too – energy that can be put to good use in the wellness oasis.

"When cycling, I produce roughly the same amount of electricity as one square meter of solar cells," says Mark Zimmermann, Innovation Manager at Empa's fitness and wellness unit. His goal is to satisfy society's needs in a sustainable way. Sauna landscapes are particularly monumental power guzzlers. A conventional fitness center with two saunas and a steam bath consumes about 120,000 kWh electricity per year. "That's a lot," says Zimmermann. "There's plenty of energy-saving potential here." The energy-optimized wellness center at NEST, however, requires only 17 percent of that, which are produced by the building itself thanks to photovoltaics, solar thermal collectors – and the sweat and tears of the fitness-center goers.



First the toil, then the reward: the fitness equipment on the lower floor. The reward hangs in plain view on the ceiling in the form of the sauna landscape.

A heat pump at the heart

Zimmermann gladly reveals how he can save so much energy: Firstly, the steam room and saunas are only heated up when they are actually used. Thanks to a booking system, employees can reserve the Finnish sauna, the bio-sauna or the steam room, which will then be ready for their slot. Secondly, the unit boasts an ingenious system to prevent heat and moisture losses. The showers have a heat recovery system that uses the the warm waste water for warming up the cold water. The same goes for the saunas and the steam room, where heat and moisture is recovered from the used air.

However, the largest energy savings are achieved with the central, so-called high-temperature CO2 heat pump. This centerpiece provides the heat of the entire unit. Using solar power, it can heat up carbon dioxide to 130 degrees. The hot CO2 flows to various water tanks and heats them to different temperatures. "This allows to use the temperature stepwise," says Zimmermann. It is used to heat the storage tank of the Finnish sauna to 120 degrees, of the steam room and bio sauna to 90 degrees. In addition, it warms upthe shower water to 50 degrees and the heating water to 30 degrees. This concept allows an optimum use of the heat, without any unnecessary losses whatsoever.

Air-conditioning for free

Even though the fitness and wellness unit doesn't need any fossil energy sources and is brimming with technical features, the fitness-center-goers don't have to forfeit any creature comforts, either. The efficient heat pump systems allows in summer also for free cooling of the fitness area. Also a very special spatial concept was designed to make the guest feel at home. Although the fitness and wellness sections are housed in the same room, the three elliptical wellness units "float" way above the heads of the people working out.

As a result, the unit will not only boost the physical and mental wellbeing of the staff, it will also move research a step further. Consequently, all will be revealed as to whether the latest developments from the lab will also prove successful in practice. //

"In the past, everyone did their own thing. You can't afford this anymore."

Daniel Huser, the Central President of the building services association Suissetec, regards NEST as an innovation engine.

"Researchers and workmen collaborate more closely than ever before."

Switzerland's building stock still consumes too much energy. What can building services do to help?
State-of-the-art technology is used in new buildings, which usually brings extremely high efficiency gains. Intelligent control systems and operating optimizations can also make major savings – using this method, I can reach both old and new buildings. Another point is the production of sustainable energy. Photovoltaic or solar thermal systems come into consideration for virtually any building.

Your industry already enjoys a sound reputation today and the technical level is very high. What additional innovations will NEST bring for building services?
It demands solutions that have never been asked for before. The backbone, into which the individual modules can be slotted, was very challenging from a building services perspective. Water and sewage pipes, for instance, are usually supposed to be as solid and permanent as possible. It's a completely new mindset to effectively be able to plug this kind of piping in and out. And normally we install piping once and the building is finished. At NEST, this all needs to be far more flexible.

Building technicians aren't just involved in the backbone. Your association supports the NEST module "Solar Fitness and Wellness". How did that come about?
Suissetec will be 125 years old this year. Rather than just mark it with a celebration and a commemorative publication, we also wanted do something for the entire industry. In the wellness module, we use a special, newly developed CO2 heat pump, for instance. It isn't even on the market yet, it's so new. And we can also test how effectively the wellness module's technology can be combined with the layout. The sauna wouldn't be heated in advance, for instance, but only when users actually come.

The innovation cycles in the building industry are around eight to ten years. How can NEST help reduce these periods?
As the initiator, Empa is very strong in research and development. It's very close to new technologies. For our part, we building technicians are strong in realization. At NEST, people now sit around the table who would otherwise have very little contact with each other. It's a congregation of research, industry and skilled crafts and trades, and there's a direct exchange. This will automatically shorten the cycles because nobody is doing anything purely for themselves. As an association, we see ourselves a bit like bridge-builders here.

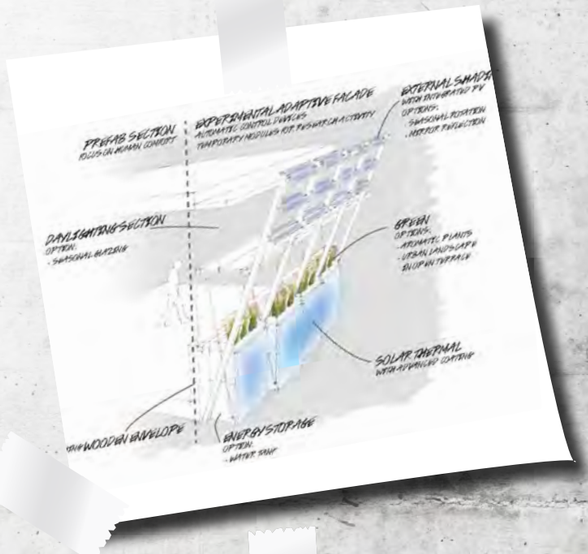
So is NEST an "enabler" for the building services industry because the communication is becoming more intensive?
I originally qualified as a sanitary planner and tinsmith. Back then, you drew your plans, but never really spoke to the heating engineer or electrician. Everyone did his or her thing, on both the drawing board and the building site. You can't afford this blinkered thinking these days. Today, you have to plan together from the outset because the projects are far more complex. Apart from heating, air conditioning and sanitation, there is also the entire building automation now, including electrical planning. At NEST, you can test how this collaboration works under ideal conditions. And one key aspect is the permanent access to the project. Normally, we fire up the systems in a building, then the doors are closed. With NEST, we can ask the users questions and record the latest findings. We're on board throughout the entire project. //

INTERVIEW: Michael Staub

New projects queuing up

TEXT: Reto Zanettin / PICTURES: Empa, iStockphoto

NEST's modular structure based on the "plug-and-play" principle allows for the installation of additional units in the next months and years. Several projects are already in the pipeline. A glimpse into the future.



SolAce: façades in a new light

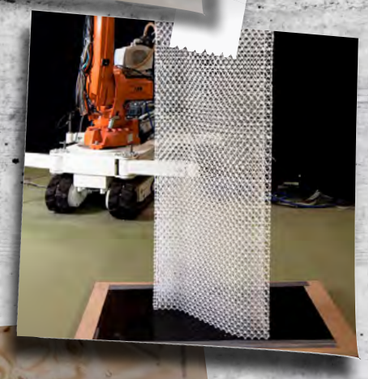
Temperature and air regulation technology is not new to the market. With the NEST unit SolAce, however, scientists from EPF Lausanne are looking to explore another field of climate technology: how to handle light. The unit's façade is to be fitted with technology that has an impact on energy efficiency and increases comfort. The research on energy-efficient light usage revolves around photovoltaics and photothermics. As regards comfort, the scientists are working on channeling daylight into the building's interior. How can light be scattered or concentrated in the room and conducted to one place or another so as to maximize the residents' comfort? A system comprising high-performance sensors, micro-mirrors and other active façade elements should provide the answers. The researchers expect the project to yield strategies for controlling complex façades.

Urban Mining: using building resources in cycles

Cities shouldn't just be regarded as living and working space, but also as a mine of raw materials. Billions of tons of concrete, steel, copper, wood, glass and other resources are embedded in transport routes and buildings. At the same time, these raw materials are becoming increasingly scarce. Therefore, they ought to be recycled and channeled back into the urban raw material cycle once a building has been torn down. In the NEST unit "Urban Mining", experts from ETH Zurich and Werner Sobek Group will be testing the suitability of recycled materials such as natural fibers, paper or even PET for the building industry. At the same time, the researchers will try out construction principles and connection technologies. These should permit as straight-forward a demolition as possible and thus make it easier to recycle.

Active Assisted Living: still at home in old age

In caregiving, the principle of "outpatient before inpatient" applies. Elderly or impaired people want to – and should – remain in their own homes for as long as possible. This is the goal of "Active Assisted Living". Apartments are equipped with intelligent, digital systems, which help people in everyday life. For instance, a digital butler reminds them to take their medication. Or a communication device designed especially for the elderly connects senior citizens with their relatives and caregivers. Scientists of FHS St. Gallen are looking to explore the possibilities and limitations of such assistance systems at NEST. The important thing here is the architectural design and technical flexibility of the building. After all, only thus will multi-generational living be possible. The project is currently in its launch phase. Whether it will be realized in its own separate unit or incorporated into another will be decided in the next few months.



Digital Fabrication: humans plan, robots build

ETH Zurich runs a National Research Focus Area (NRFA) called "Digital Fabrication". Researchers from the disciplines architecture, engineering, materials science, IT and robotics are looking to develop digital technologies for the building industry. The project is based on a digital building process that controls the prefabrication of components and their production on site. From digital fabrication, the researchers expect material savings, insights into joining technology, but also a kind of construction that was previously out of reach. With the NEST unit Digital Fabrication, for the first time the experts will construct a building under real conditions using a fully digital process. Robots will manufacture the façade elements, concrete supports, and floor and roof constructions either at a supplier or on site.

A big thank you

We were only able to design and create something as special as NEST thanks to the active support of our numerous partners. Even though the initial ideas and concepts were developed here at Empa, such a unique project as our "living lab" would not have been possible without them. This "sponsor's board" is a testament to this.

I would like to take this opportunity to offer all our partners my express and heart-felt thanks – for their support (especially financially, but also in the form of input for planning projects, units etc.), not to mention their courage, foresight, advice and so much more. It was (and remains) an exciting journey and I'm convinced that NEST will yield numerous innovations in the building and energy sectors for years to come.

Gian-Luca Bona
Director Empa

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