**Title**

Far more than just materials – a brief history of Empa

1. Where innovation starts
   1. How can we live and work in a future without fossil fuels?
   2. The future of building and living
   3. How can we reduce our impact on the environment?
   4. How can we improve our health and performance?
   5. Which materials will we need in the future – and who is going to produce them?
2. Where Swiss industrialisation was forged
3. Putting an institution to the test
4. Empa finds a new identity
5. What does the future hold? Some perspectives on challenges and opportunities

**Acknowledgements**

A book such as this can only be produced as a team effort, as is clear from the various authors of the individual chapters and inserts. But these authors received invaluable and active support from at least the same number of people again, who provided the practical assistance needed to make the book a reality – less visible, but no less important.

Urs Meier and Marianne Senn spent hours painstakingly scouring the Empa Archive for useful and presentable information – and came across a whole host of treasures in the process. Anina Steinlin drew up the first basic concept, engaged in an intensive period of research, and held and summarized a series of initial interviews with numerous contemporary witnesses. Katharina Wehrli collated the texts from various different sources into a coherent body of work (and at the same time ensured that the whole thing was written in clear and comprehensible German). Lastly, Urs Bernet brought all of this work together to give the book its final form.

Our thanks go to the numerous interviewees who offered their stories to our authors and researchers, giving up so much of their valuable time in the process. Further thanks go to the authors of the short articles in the areas of philosophy, politics, business and academia, which provide a tentative glimpse of the future.

**Image captions**

* 1 Empa researcher Maryna Bodnarchuk and her team are developing new materials for more efficient energy storage.
* 2 Empa researcher Corsin Battaglia and his team are researching solid-state batteries – a new, safe type of battery with a high energy density.
* 3 Heat storage units allow solar thermal energy to be stored well into winter. Empa researcher Benjamin Fumey is working on a heat storage technology based on sodium hydroxide.
* 4 Filling up with hydrogen, methane or a mixture of the two? All options are available at the Empa filling station.
* 5 The mobility demonstrator ‘move’ shows what the climate-friendly mobility of the future could look like.
* 6 Approval granted: hy.move, the world’s first hydrogen-powered road sweeper. The vehicle contains a fuel-cell electric motor specially developed at Empa’s motor laboratory.
* 7 Federal Councillor Guy Parmelin learns about hydrogen-powered mobility from Empa researchers at the Geneva International Motor Show.
* 8 The kite from Empa spin-off TwingTec harnesses the power of the wind at dizzy heights to generate electricity.
* 9 In the NEST SolAce unit, everything revolves around light.
* 10 Energy-efficient sweating: this futuristic-looking wellness installation in the NEST Solar Fitness and Wellness unit uses 80% less energy than a normal installation of this kind – and meets its energy needs using photovoltaics.
* 11 NEST serves as a vertical neighborhood for energy research: energy flows to where it is needed.
* 12 Empa researcher Stephan Bücheler is working on the foundations of solid-state batteries.
* 13 At the Energy Hub, researchers are working to optimize energy management for the neighborhoods of the future.
* 14 + 15 In the wind and water tunnel, it is possible to simulate how summer heat spreads through a city – and ways of providing relief.
* 16 Long-established, but by no means obsolete: wood is a renewable raw material – and can be given entirely new properties thanks to modern wood research.
* 17 Violins made with fungus-treated wood have proved their potential under scientific conditions.
* 18 Empa is researching a formula for carbon-negative cement that is made from magnesium silicates. As a result, this slightly whitish concrete binds more CO2 than is released during its manufacture.
* 19 Microplastics are almost omnipresent on planet Earth. Empa researchers are studying how they enter the environment and, once there, how they spread.
* 20 How do airborne pollutants such as nitrogen oxides (NOx) spread out across Lausanne? Answers are provided by complex computer simulations.
* 21 Cars are set to become cleaner. Empa is researching new types of catalytic converters, more efficient engines and hybrid propulsion systems.
* 22 This geometric ceramic structure of a car’s catalytic converter was developed on a computer.
* 23 Laying tarmac is a hot business and is particularly strenuous for construction workers. At Empa, research is underway into tarmac that requires less intense heating. This is good not only for the environment, but also for human health.
* 24 The concept of a circular economy informs every detail of the NEST Urban Mining and Recycling (UMAR) unit.
* 25 Detailed aviation noise modelling with sonAIR is used to develop quiet flight procedures. Here, we see an Airbus A320 making a northerly approach to Zurich Airport.
* 26 Textiles for hazardous workplaces, extreme sports or treating diseases must attend to the needs of the human body. Manikins are simulation dummies that can be used to study textile performance.
* 27 Textile sensors can be used to measure physiological parameters in real time. In medicine, virtual doppelgangers are intended to help with the treatment of diabetes and pain, for example, and may even allow predictions to be made regarding the course of treatment.
* 28 Polymer optical fibers can be used as health sensors and can even be woven into textiles.
* 29 Empa researchers have developed liquid sensors that warn of poor wound healing. Integrated into a dressing, the substances start to glow as soon as key markers in the wound reach a critical value.
* 30 In a microfluidic flow chamber, researchers can study how biofilms form on implants.
* 31 Nanomedicine uses tiny particles to introduce drugs into the human body or to intercept toxins, for example. Empa researchers are developing new technologies for these applications.
* 32 Empa’s Coating Competence Center closes the gap between laboratory research and industrial applications in production technology.
* 33 Researchers from Empa have succeeded in growing carbon nanotubes – structures with extraordinary mechanical, thermal and electronic properties – from precursor molecules.
* 34 The Empa spin-off Flisom is beginning series production of flexible, thin-film solar panels in 2020.
* 35 Graphene nanoribbons, which are just a few atoms wide, can be electrical conductors, insulators or even semiconductors depending on their geometric structure.
* 36 Creating specific graphene structures requires considerable technical resources. Empa researcher Gabriela Borin Barin evaporates specially prepared molecules in a high-vacuum chamber in order to grow graphene nanoribbons.
* 37 In future, it should be possible to print electronic components such as conductive tracks, transistors or capacitors – just like letters in a newspaper.
* 39 Additive manufacturing builds up structures layer by layer. This allows structures to be created with almost unlimited complexity.
* 40 Every human body is unique. This makes 3D printing an extremely attractive technology for the medical industry, allowing the production of personalized implants, for example.
* 41 A Swiss invention and a cornerstone of Empa: Werder’s universal testing machine for construction materials.
* 42 Ludwig von Tetmajer, founder of Empa and its director from 1880 to 1901, in his study.
* 43 The university district in Zurich with the Empa building (bottom left) on a postcard dating from 1900.
* 44 Inside Empa’s machine room at Leonardstrasse in Zurich.
* 45 Empa’s staff in 1901.
* 46 The collapse of the rail bridge over the Birs at Münchenstein on 14 June 1891 claimed 71 lives – and was the worst railway disaster the world had ever seen.
* 47 + 48 Ludwig von Tetmajer and the structural engineer Willhelm Rittler were tasked with investigating the accident. Their report caused quite a stir, uncovering a cascade of design flaws, construction defects and poor maintenance.
* 49 The Gotthard railway is considered a milestone in the history of engineering prowess.
* 50 The Kaplan turbine paved the way for widespread electrification in Switzerland.
* 51 François Schüle, director of Empa from 1901 to 1924.
* 52 Mirko Roš, director of Empa from 1924 to 1949.
* 53 The electrification of the railways in the interwar years increased demand for safe and reliable materials – an ideal task for Empa.
* 54 Kloten Airport was opened in 1948, with Empa engineers playing a significant role in its construction.
* 55–60 Empa staff in their laboratories in St. Gallen in the early 1960s.
* 61 Laboratory of the Swiss Testing Institute in St. Gallen, c.1930.
* 62 Bunkers in the Swiss mountains: by analyzing hundreds of samples, Empa was able to prove that the concrete used in many bunkers was of poor quality – and would have offered barely any protection in an emergency. A scandal of the postwar period.
* 63 Eduard Amstutz, director of Empa from 1949 to 1969.
* 64 Empa’s engineers setting up the test.
* 65 Successful loading tests: the bridge shortly after its collapse.
* 66 Administrative building in Dübendorf.
* 67 Construction of the new Empa building.
* 68 The Empa vehicle fleet in the 1960s.
* 69 The new Empa site from the air.
* 70 Empa experts study the wreckage of the Caravelle.
* 71 Finally, space for large research apparatus: Empa staff conduct impact tests on crash barrier posts in the new premises.
* 72 Plans for the new research station for air pollutants at Jungfraujoch.
* 73 The Sphinx Observatory with the measuring room in the foreground.
* 74 Since 1972, the Jungfraujoch research station has been used for the measurement of harmful emissions, among other things.
* 75 Fracture testing on a reinforced concrete beam in Empa’s Building Hall.
* 76 Alfred Rösli, head of the reinforced Concrete and Concrete Structures department and professor at ETH Zurich, gives a lecture in Empa’s Building Hall.
* 77 Modern measuring equipment such as microprobes paves the way for new analytical capabilities.
* 78 Theodor H. Erismann, director of Empa from 1969 to 1988.
* 79 From 1978 onwards, Empa analyzed materials for the payload fairing on space rockets.
* 80 An elaborate load introduction system simulates the forces acting during the rocket’s launch.
* 81 Empa’s workshop in St. Gallen in the late 1970s.
* 82 The hailstorm simulator, developed in-house at Empa.
* 83 Urs Meier, director of Empa in Dübendorf, is a pioneer of carbon fiber reinforced polymers in construction.
* 84 A CFRP world premiere at Empa: the first 30-metre-long CFRP-reinforced concrete mast, developed at Empa for Nordostschweizerische Kraftwerke.
* 85 + 87 Three CFRP plates and three nights of work were enough to reinforce the bridge successfully – marking the start of a boom that would spread around the globe.
* 86 The Ibach bridge in Lucerne – the first CFRP-reinforced bridge in the world.
* 88 Developed in-house at Empa, the tensile testing machine for cables exposes stay cables for bridges to tremendous forces.
* 89 The Empa battleground in the 1980s: the General Conference of the Swiss School Board. Shown here: Heinrich Ursprung, president of ETH Zurich (third from left), Urs Meier, director of Empa in Dübendorf (seventh from left).
* 90 A contribution to the safety of mountain travelers: a loading test on a cable car.
* 91 Empa’s analyses revealed corrosion in the hangers holding up the swimming pool’s roof.
* 92 + 93 On 9 May 1985, the roof of Uster’s indoor swimming pool collapsed. Twelve people lost their lives.
* 94 Anselm Lauber during noise measurements in the ‘sound house’.
* 95 Fritz Eggimann, director of Empa from 1988 to 2001.
* 96 A sure footing: the BST 2000 flooring and footwear tester from the Textile and Clothing department simulates the human gait and determines the slip resistance of shoe soles and floor coverings.
* 97 Empa investigated the supposed Hitler diaries to ascertain their authenticity in 1983 – and exposed them as fakes.
* 98 Since 1996, the World Cup and European Championships have only used footballs that have undergone Empa’s rigorous testing program.
* 99 In 1992, the High-Performance Ceramics department began operations: here, Empa researcher Roland Bächtold is performing a strength test.
* 100 In 1994, Empa gained a third location with its Thun site.
* 101 Empa in St. Gallen moved into its new building in 1996.
* 102 Federal Councilor Ruth Dreifuss on a visit to Empa.
* 104 Louis Schlapbach, director of Empa from 2001 to 2009.
* 105 A focus on science: from 2001 onwards, five new research programs have enhanced Empa’s profile.
* 106 Empa chemist Matthias Nagel researches functional polymers for use in OLED displays.
* 108 Federal Councilor Pascal Couchepin opens the second Swiss NanoConvention in Bern in 2007, which was organized by Empa.
* 109 The cover of *Nature* on 10 November 2011, with probably the ‘smallest electric car in the world’, for which the Nobel Prize in Physics was awarded in 2016.
* 110 The annual PhD Symposium provides Empa’s doctoral students with an opportunity to network and discuss ideas.
* 111 EmpaNews (now EmpaQuarterly) has been reporting from Empa’s research laboratories four times a year since 2003 – at which point it still took the form of a newspaper.
* 112 Applied research: since 2001, it has been possible to examine bridge suspension cables for damage non-destructively by using magnetic fields thanks to technology from Empa.
* 113 Opened in 2004, the Empa-Akademie organizes a program of scientific meetings, conferences, seminars, and training and further training events.
* 114 The travelling exhibition Nanopubli gives the wider public an understanding of the subject of nanotechnology.
* 115 New processes for vaccine production are scaled up in the bioreactor in St. Gallen.
* 116 Gian-Luca Bona, director of Empa since 2009.
* 118 The Coating Competence Center forms a bridge between research and industry.
* 119 An example of successful technology transfer to industry: the construction materials manufacturer Fixit worked with Empa to develop a highly insulating, aerogel-based plaster.
* 120 The Empa spin-off TwingTec uses kites to harvest wind energy at great heights.
* 121 In 2011, the new laser center in Thun was officially opened, featuring a unique UV laser system that allows researchers to develop novel surfaces. Industry partners can also use the system to texture large films with micrometer to nanometer precision.
* 122 Research and demonstration platforms such as move and NEST (in the background) show off the innovations that emerge at Empa in collaboration with its industry partners.
* 123 Additive manufacturing allows complex structures to be created from metallic alloys.
* 124 The Empa future fund paves the way for research projects that will make a key contribution to the sustainable world of tomorrow.
* 125 Mirko Kovac conducts research on autonomous drones that could be used to maintain infrastructure.