**1969–2001**

On 1 December 1969, Theodor Erismann took on his new role as director of Empa. At that point, there was no indication of the turbulent decades that Empa was about to face: economic crises, hiring freezes lasting several years, changes in the political environment, several reorganizations and restructurings – and at the same time, incredible technological advances and the setting of a visionary course that have continued to impact Empa to this day.

The first thing Erismann did was a careful reorganization of Empa, together with the new director of Empa St. Gallen, Paul Fink. Large laboratories or those covering too many different areas were split, smaller laboratories were merged, and new laboratories created in order to tackle new projects. The new fields of activity included plastics and construction physics as well as electronic data processing and public relations. The most important development, however, was the creation of the six divisions. This new management level reported directly to the Board of Directors. This new organizational stucture did not meet with universal enthusiasm within Empa: the laboratory heads, in particular, who had become accustomed to fairly hands-off management by the director, suddenly felt their freedom was being restricted.

While everything had been turned on its head in Dübendorf, the St. Gallen site was initially unaffected by the reorganization. However, project responsibilities began to shift: While standard routine testings were increasingly being carried out by industry partners, Empa was, the longer, the more, charged with solving specific problems, which were at times highly complex.

**Empa shifts focus to R&D**

Erismann made it his goal to shift Empa’s focus more towards research and development, wanting to echo the glory days under Mirko Roš. The spirit of the times made this very hard to achieve, but Empa identified key research and development areas. A research committee was established, though only in an advisory role. A first important step was the initiation of the research program MARES (MAterials RESearch), carried out by the construction materials laboratory under Albert Rösli. The project intended to investigate the scientific basis for the time-dependent behavior of non-metal construction materials.

The economy was booming – at least for the time being. This also posed a challenge for Empa. Finding qualified personnel for new roles was no easy matter; the job market had run dry. Areas such as structural engineering and construction, in particular, were buzzing, along with the national economy. One consequence of this boom was that there was little room for research projects, such as looking into lightweight concrete. Innovative projects in the concrete laboratory were overridden by routine checks, for example for the Gotthard tunnel, which was under construction at the time. The same applied in the metals laboratory, which spent the majority of its time inspecting metal fuel tanks for the thriving transport sector.

However, it wasn’t just clients from industry that meant Empa employees had little time left for research projects. The chemistry laboratory, for example – one of the most cutting-edge laboratories in Switzerland – received around 40% of its projects directly from industry, which were the only paying clients. The remaining 60% came from federal bodies, such as ETH Zurich, the Swiss army or the Federal Office for the Environment (FOEN). The problem: These projects didn’t bring in any money; only pro forma invoices were sent to Bern. Empa’s senior management did not do enough to combat this ‘free outsourcing’ by federal bodies, and the result was a host of missed opportunities. In the course of an emission analysis, the chemistry laboratory concluded that diesel soot was probably carcinogenic – but they didn’t have the time to pursue their research any further and publish the results in a leading scientific journal owing to the volume of routine analyses to be carried out. Others later received the credit for their discovery.

**The fuel crisis leads to a hiring freeze**

In 1972, the Club of Rome’s report ‘The Limits to Growth’ was making waves around the world. It criticized unrestricted growth in a finite space. Environmental protection became the new buzzword. Empa was, once again, ahead of its time – it had been researching the harmful effects of air pollution, industrial wastewater and noise pollution long before environmental concerns gained public attention. Interest in the topic increased massively in 1972, and Empa received additional funding, with which to modernize its equipment and establish more air quality monitoring stations. A team from the air pollutants and fuel technology laboratory built a new measuring station on the roof of the high-altitude alpine research station at Jungfraujoch to measure air pollutants that had come from far away, carrying out their research as a partner within a pan-European network. The team had little idea at the time of how important the station would become in future (see page xxx).

The Yom Kippur War in October 1973 marked the end of the post-war economic boom. Empa felt an immediate impact of the resulting fuel crisis. Petrol was rationed for federal bodies, the heating temperature was lowered and air conditioners decommissioned. The long-term consequences were much more severe, however. Switzerland went into recession. Its GDP dropped sharply. The Swiss government suggested a tax reform to increase tax revenues, but in 1974, the electorate voted for spending cuts by the government instead. This led to a hiring freeze for all federal agencies – including Empa.

This was a particularly heavy blow to the newly formed laboratories that were still in the process of being set up. In many areas, the hiring freeze caused significant delays in the completion of projects – for which certain clients from industry showed little understanding. At the same time, federal bodies showed an increased interest in taking advantage of the ‘free outsourcing’ offered by Empa in order to relieve their own budgets. The number of projects from industry clients did not diminish, however. Despite the fact that the construction industry was suffering, it continued to commission Empa with interesting projects, although of a new kind. During the economic boom, industry partners assigned Empa mainly test projects, the results of which were often used for advertising purposes. Internal development projects were few and far between, meaning that corporate development engineers often had to support the production or even sales teams. Now, however, progressive companies, in particular, allowed them to turn their attention to new developments, and collaboration with experts at Empa was increasingly in demand. The workload increased significantly, with the number of employees remaining the same. Declining a project wasn’t easy: According to Empa’s regulations, this decision could only be taken by the senior management – a laborious official channel that was only used in the case of highly obscure requests. The hiring freeze persisted, and even by the late 1970s, there was no end in sight.

But there were positive developments, too. The IT section acquired its first computer in 1974, a PDP-11 from the Digital Equipment Corporation. Empa employees had previously been carrying out calculations using slide rules and electromechanical Madas calculating machines. If you hit ‘Divide by 0’ – intentionally or unintentionally – the Madas would clatter away until the plug was pulled. With the introduction of EDP, IBM's punch card machines made their way into Empa. A courier brought the punched cards full of data to ETH in Zurich, where they were read and processed. The courier then transported the printed output back to Empa. With the advent of its own new computer, Empa now had a medium-speed terminal that was connected to the ETH computer center. Automation and data collection progressed rapidly throughout the 1970s, with quantitative image analyzers and new measuring devices with digital output. These advances helped to relieve the staff shortage, which were becoming parlous in some areas. The 1970s also featured another highlight: In 1977, the European Space Agency (ESA) commissioned Empa to carry out load testing on the payload fairing for the Ariane 1 rocket on a 1:1 scale (see page xxx).

Despite the enduring economic crisis, individual Empa laboratories were able to upgrade their equipment towards the end of the decade. The construction materials laboratory acquired cutting-edge servo-hydraulic systems that were able, for example, to simulate earthquakes for large structural elements. The metals laboratory, in turn, invested in a microprobe/scanning electron microscope, which opened up a whole new world of previously unanticipated possibilities.

**International collaboration takes on new forms**

In its founding statement in 1880, the Swiss government stated that Empa’s main responsibility was to contribute to the resolution of national problems – which in the beginning chiefly concerned the quality of construction materials. It also emphasized that the publication of the investigation reports as well as Empa’s reputation were of primary importance. Domestic and international renown could not be achieved through publications alone, however. It was equally important to maintain an international network by participating in conferences and being a member of professional associations. This was something Mirko Roš knew very well – he was a founding member of RILEM, the International Union of Laboratories and Experts in Construction Materials, Systems and Structures. Erismann, too, who came from the precision machinery industry, recognized the PR power of associations, organizations and conferences. He served as the director of RILEM from 1979 to 1982.

RILEM, though, was limited to the field of construction, so Erismann sought international partners who were active in a range of other areas. In 1977, he succeeded in establishing the Association of European Material Testing Institutes (EM). Its members included the five biggest European materials testing institutes in Germany, Sweden, Finland and Switzerland. The heads of the institutions met twice a year to exchange ideas, and technical symposiums were held. This sharing of experiences was especially valuable for the representatives from Finland, Sweden and Switzerland, who lacked appropriate discussion partners in their home countries.

From the early 1970s, Empa also maintained a close relationship with the Massachusetts Institute of Technology (MIT). In 1979, the first PhD student from MIT carried out the experimental part of his PhD thesis at Empa, and from 1981 onwards, many of Empa’s laboratory heads spent a year at MIT. Its first-class equipment made Empa an attractive partner for the world-renowned institute. Aspiring MIT professors spent their long summer holidays in Empa's labs with their PhD students, carrying out experiments day and night. They then went back home to analyze their results at MIT. In return, they shared their modelling expertise, something which Empa had thus far been lacking. This equitable collaboration enabled engineers and scientists at Empa to gradually amend this omission.

**An anniversary in a challenging environment**

1978 was roughly mid-term in Erismann’s stint at Empa. He was disappointed that his ideas for research and development projects often ground to a halt in the cogs of the federal administration, and that hiring additional personnel, which would have made the individual laboratories much more profitable, was a no-go for political reasons. Erismann was persistent, however, and was determined to make up for lost ground in the second half of his time as Empa director.

Jakob Karl Burckhardt had taken on the presidency of the Swiss School Board (now the ETH Board) in 1966. As the government’s former nuclear delegate, he had an understanding of technical challenges and thus of Empa’s acitivities. Change was in the air in 1979, however, when a new president took the reins. The Swiss government elected Maurice Cosandey – president of the École polytechnique fédérale de Lausanne (EPFL) and professor of metal and wood construction – the new president of the School Board. This did not bode well for Empa, as it was soon to find out.

In the early 1980s, as in the previous decade, the entire federal administration was subject to spending cuts. The universities and their associated institutes were on a short leash: Applications for business trips needed to be submitted to the School Board’s scientific advisor. The same went for approval for TV and radio interviews. In addition, Empa’s budget for IT and printed publications was massively cut.

Despite these difficult circumstances, however, Empa had good reason to celebrate: 1980 marked its 100th anniversary. At the official ceremony in Dübendorf, Federal Councillor Hans Hürlimann conveyed the government’s greetings and congratulations and offered words of praise: Empa had always fulfilled its duty to promote the safety and protection of people and the environment. He also emphasized Empa’s unique position as a federal service provider in a market economy. It was Empa’s duty to demonstrate what was technically possible, safe and economically viable. ‘Empa represents courage and resolute management,’ concluded Hürlimann in his speech. ‘It enjoys a reputation built on reliability and indisputable objectivity.’ Five years later, Empa St. Gallen celebrated its 100th anniversary, too. It opened its doors to the public on 29 June 1985 and met with great interest.

Despite the praise of the federal government, however, Empa’s reputation as part of the ETH Domain was waning at the beginning of the 1980s. Cosandey, the new president of the School Board, repeatedly criticized the activities of Empa’s wood laboratory. He also demanded better coordination between the activities of the materials science departments at the ETH campuses in Zurich and Lausanne, the Federal Institute for Reactor Research and the Swiss Institute for Nuclear Research – which would merge to become the Paul Scherrer Institute in 1988 – as well as Empa.

**Privatizing Empa?**

What had been discussed behind closed doors eventually became official in 1982: the School Board commissioned a working group to discuss the possibility of privatizing Empa. Empa began creating reports labelled ‘Reasons for existence’, in order to have well-founded evidence, with which to defend the institution should worst come to worst. In the summer of 1983, a committee, in which members of Empa’s management also participated, came to the conclusion that a foundation was the best organizational form. This would give Empa more freedom in terms of both finances and personnel.

The hiring freeze introduced in 1974 prevailed, and the number of Empa employees remained around 500. When Erismann first took on the reorganization of Empa at the start of his time as director, he had expected a massive growth within the institution. Circumstances had visibly deteriorated since, however, and Empa’s organizational structure was no longer appropriate to the current situation. After intensive discussion, the Empa senior management reduced the number of divisions from six to five; the "special areas" division was closed and its laboratories distributed among the remaining divisions. In 1984, after a tedious battle with the federal administration, Empa was finally given the opportunity to hire a deputy director. The Swiss government elected the head of the construction materials division, Urs Meier, who took up his new post immediately.

In 1984, the Swiss National Science Foundation (SNSF) launched the research program ‘Materials for Tomorrow’s Needs’ with an overall budget of CHF 19 million. Empa teams submitted a variety of proposals, for instance on materials for the production of components for textile machines. The proposal envisioned the use of carbon fiber-reinforced polymers (CFRP) to develop much faster-moving parts, such as bands for weaving machines. What's more, all Empa projects submitted to the SNSF were discussed beforehand with industry partners and tailored to their needs. However, every single one of them was turned down by the SNSF.

**The world’s strongest cable tensile testing machine**

Despite troubled times, Empa was engaged in a number of exciting projects. The senior management of Eternit AG wanted to replace asbestos in its fiber cement products with a non-hazardous fiber as quickly as possible, in particular in its roof slabs. This resulted in a large-scale project that involved various Empa laboratories from all divisions. Initial experiments quickly revealed that it was very difficult to replace asbestos fibers that caused lung cancer. Asbestos is very easy to process, with fantastic mechanical properties, and is incredibly durable – which is also the reason why the fibers cannot be broken down in the lungs. Almost the entire spectrum of polymer fibers was evaluated, including carbon and aramid fibers. The latter was discounted for mass-produced construction products for cost reasons, however. Polyvinyl alcohol (PVA) fibers were finally proposed as a compromise, and Eternit AG was able to successfully replace asbestos fibers years before an official ban was issued.

Urs Meier kicked off the first projects using carbon fiber-reinforced polymers (CFRP) for cables in bridge construction in 1980. The idea of using a super-material for construction – one which thus far had only been used for space travel and military aviation because of high costs – seemed so crazy that he carried out his first experiments in secret. The idea of permanently strengthening concrete constructions by attaching thin CFRP plates was developed in 1982. The results of the preliminary studies were so promising that two official research projects were launched. In Anglo-American countries, this ‘crazy idea’ gained huge traction, while the German-speaking world almost unanimously responded with an uncomprehending shake of the head. It was the start of a huge success story, however. CFRP is now a well-established element in construction, and Urs Meier is one of the most internationally renowned pioneers and experts in the field. Only last year, in 2019, the prestigious Society for the Advancement of Material and Process Engineering presented him with the Fellow Award for his lifetime achievements.

Another project came to successful (and loud) completion in 1984 after many years of development. Since 1969, clients from around the world had been coming to Empa to have their stay cables for large bridges tested for fatigue loading. Once the experiments had been carried out, the cables’ remaining load-bearing capacity needed to be determined, which was usually between 18 and 20 meganewtons. For the longest time, Empa did not own a machine that could apply such a force. Clients had to travel to Stuttgart – which was an unsatisfactory situation. In 1970, Erismann began developing an innovative concept for a machine that would allow Empa to apply an enormous force of up to 30 meganewtons (3,000 tons). ‘Floating’ seal rings, multiple cylinders, column-free force transmission and ‘breathing’ cylinder barrels were used for the first time. Erismann’s visionary concept needed to be implemented, however – a Herculean task that would take several years. On 16 August 1984, the strongest cable tensile testing machine in the world was inaugurated. The practical implementation of the large-scale testing machine was impressively demonstrated on a large-caliber cable, and astounded the 100 or so guests invited to witness it. The sound of the individual wires breaking was said to have sounded like military target practice.

**The ETH Domain under evaluation**

By now, the Swiss economy had been struggling for a decade. In the final months of 1984, however, the situation worsened dramatically. Politicians argued about an efficiency enhancement program, which would have a massive impact on the School Board – numerous jobs would be cut. At a meeting in October 1984, the president of the School Board Cosandey called for a 25% reduction in staff at Empa. Empa received help from an unexpected quarter, however: The president of ETH Zurich, Heinrich Ursprung, asserted that they could not take drastic action of that sort without good reason. He suggested subjecting Empa to an overhead cost analysis by the renowned company Hayek. The suggestion met with widespread approval. Another surprise move was also made, namely, to extend the evaluation to the entire ETH Domain.

What followed was a nerve-racking time for Empa, whose very existence was at stake. Questionnaires were filled out and presentations prepared. The division heads discussed for days on end. On 15 January 1985, Empa St. Gallen was to present itself to Hayek’s team of experts; the next day, it would be Dübendorf's turn. Everyone was on edge. The two presentation days were not the end of the process, however. The Hayek team spent several weeks investigating individual topics such as ‘Materials of the future’, ‘Optimal use of materials’, ‘New industrial and testing technology’, ‘Testing under extreme conditions’ and ‘Waste disposal, ecology, health’.

On 11 July 1985, it was finally over. The institutions received the long-awaited report . The Hayek study suggested two models for the future of Empa St. Gallen: It should either be integrated into the Dübendorf branch, or reorganized. In addition, it recommended streamlining the administration and, ideally, centralizing it in one location, which would cut around 10 jobs in Dübendorf and five to eight in St. Gallen. The Hayek study also explicitly noted that, unlike other research institutions, Empa had a strong external focus and aimed at meeting the demands of Swiss industry. This meant it was important to allow Empa sufficient freedom and flexibility in order for it to carry out its activities as effectively as possible. The report also suggested spinning out Empa’s services business into an independent entity. Cosandey was not particularly pleased with the report's findings, but Empa's senior management heaved a sigh of relief. The School Board would no longer be able to impose a 25% staff cut.

When it came to the ETH Domain, the Hayek report concluded that both ETHs and their ‘annex institutions’ presented opportunities for reduction and rationalization, but also had a lot of additional requirements and ground to make up. As a consequence, instead of ordering a huge staff cut, the School Board vowed to create an additional 700 jobs. Empa's senior management was required to commission a detailed analysis, with the aim of outsourcing the purely service-oriented functions while keeping the research activities in close collaboration with ETHs. The support sections were also to be concentrated in Dübendorf. The suggestion of moving Empa St. Gallen to Dübendorf was not pursued any further, as the political and economic importance of such a highly qualified institution for Eastern Switzerland was too great.

The results of the analysis were released in September 1986. It outlined which areas were to be expanded, maintained or cut back. As a result, the Empa management immediately decided to strengthen research activities. At the time, only 6% of Empa’s overall budget was earned through its own research. The aim was to double this figure by 1993. High targets were set for contract research, too. Guidelines for Empa’s strategic planning were drawn up in 1987: Research, development and knowledge transfer were to be promoted, as well as consulting in all its forms. Its testing activities were to be considerably reduced, however, in particular routine testing. The key principle of the strategy was that Empa should serve important Swiss interests, first and foremost the safety of its people and the environment. It should support the Swiss economy and enhance its competitive edge on international markets.

The Swiss government paid little heed to the external analyses, however. In 1988 it decreed a funding cut of CHF 8 million for the ETH Domain – instead of an increase of at least CHF 47 million demanded by the Hayek report. Empa’s existence was no longer under threat, however, and the repositioning as a research institute was the long-term goal.

**The new strategy is put into action**

1986 saw the first indications that Empa’s trajectory within the ETH Domain was finally on the up. To everyone’s great surprise, the Swiss government appointed Empa director Erismann to the Swiss School Board, as a representative of the Domain's research institutions. Empa also created a research committee to evaluate internal research proposals. Up until that point, these had been evaluated by a superior or by Erismann himself. The new assessment process was a major step forward, particularly when it came to interdisciplinary research projects.

That same year, the long-awaited X-ray building opened its doors. Thanks to the new radiation-protected building, Empa was able to put a highly radioactive cobalt radiation source into operation. Two X-ray rooms enabled entire tank trucks to be X-rayed. It even became possible to screen 100 mm-thick pieces of iron.

Erismann’s era was coming to an end. The director announced his resignation on 1 October 1988. The governement appointed Fritz Eggimann the new director, making him a full professor of IT at ETH Zurich at the same time. Urs Meier took over the management of Empa Dübendorf. Eggimann was not particularly involved in the operational activities at Dübendorf and St. Gallen; he focused on his activities at ETH Zurich, his role as treasurer of RILEM, Empa's research committee, quality assurance, and on maintaining a good relationship with the School Board and the Association of European Material Testing Institutes.

The School Board also underwent a change: President Maurice Cosandey retired on 28 February 1987. Heinrich Ursprung, who had shown Empa considerable support with the Hayek initiative, took over the role the very same day.

The government issued new legislation regarding Empa. Among other things, these gave Empa its current name: the Swiss Federal Laboratories for Materials Science and Technology. Empa’s tasks were also further expanded upon: Greater emphasis was to be put on research and technology transfer to industry. According to the new legislation, Empa was a neutral, independent national service and research institute for the scientific investigation of raw materials, products, facilities and processes for industry and the federal administration. Research and development for more a economic and environmentally friendly use of materials and new testing methods and devices were also among its activities. The new legislation also stressed that Empa was to give priority to activities that improved the safety of people and the environment and promoted the competitiveness of the Swiss economy. And: Empa was granted the option of passing on routine tests to third parties.

The new strategy was not necessarily easy to implement, however. Requests from industry to participate in research and development projects were still accompanied by urgent testing assignments, which, while going against the strategy, could not simply be turned down overnight. Empa had no wish to affront these companies, particularly as they often ended up being partners in research projects. Major steps towards a repositioning were nevertheless taken at both the Dübendorf and St. Gallen sites. A new vision entitled ‘1999’ provided for the Dübendorf site to focus considerably more on construction and raw materials over the next decade. In particular, it aimed to take advantage of synergies between the various laboratories. Laboratories that had previously been self-contained were to be integrated into Empa’s interdisciplinary network and focus on the key areas of construction and raw materials. The idea behind this concept can be illustrated by looking at the air pollutants laboratory. The laboratory had spent the previous 30 years doing pioneering work in developing analytical technology for harmful atmospheric emissions and was responsible for the national NABEL network. Up to this point, its activities had not required much in the way of interdisciplinary collaboration with other Empa laboratories, however. The laboratory now began taking on projects concerning emissions relating to construction and raw materials, working closely with other Empa laboratories.

Appropriate measures were also initiated at Empa St. Gallen, and a new organizational structure with three divisions was introduced in April 1989: textiles/clothing, chemistry/biology and communications technology/packaging. Research was to be promoted and routine work reduced in St. Gallen, too. Industry was understandably concerned; they feared a reduction in important services. Empa thus offered its help in trying to find a solution for obtaining the necessary quality certifications for the companies.

**A range of new research topics**

In keeping with the tradition, the 1990s were also a turbulent time for Empa. Important decisions were taken to secure its future as a research institute, both on a political and a scientific level. Empa continued to have to assert itself within the ETH Domain.

New scientific areas were emerging. The President of the School Board, Heinrich Ursprung, asked both ETHs, the Paul Scherrer Institute and Empa to see whether they were able to enter the field of nanoscience. Urs Meier suggested a virtual center within Empa for material compounds to promote interdisciplinary collaboration across all divisions, in particular between natural scientists and engineers. Compound materials exhibit properties that cannot be achieved by a single group of materials. In the case of fiber-reinforced polymers, for example, the fibers direct force through the material and increase the stiffness of the polymer, while the polymer matrix fixes the fibers in position and supports them.

Environmental impact was also becoming an increasingly important factor for construction materials. Empa was now evaluating manufacturing, usage and disposal with the aim of creating comprehensive criteria for a sustainable use of construction materials. The aim was to quantify benefits – such as heat and sound insulation – and costs – such as the impact on soil, water and air, and energy consumption – in order to provide helpful information when it came to choosing materials.

1990 saw more staff changes within the ETH Domain. Jakob Nüesch became the new president of ETH Zurich. Roland Crottaz, former vice president of EPFL, took over from Heinrich Ursprung as president of the School Board. Not a bad choice for Empa: Before moving to EPFL, Crottaz had owned an engineering firm for road construction and had positive encounters with Empa. His good relations with Empa had continued during his time as a professor at EPFL, meaning that his election as president did not pose a threat to Empa’s positive relationship with the School Board.

Empa itself was also under a new leadership. Paul Fink retired in May 1991, and the Swiss government appointed Xaver Edelmann director of Empa St. Gallen. Edelmann had earned his PhD under Theodor Erismann and was department head at Sulzer Innotec at the time. Walter Muster became deputy director of Empa Dübendorf.

Empa started giving up the first of its testing activities. From January 1992, the Swiss Association for Pressure Tank monitoring (SVDB), now the Swiss Association for Technical Inspections (SVTI), took on all testing and inspection projects in the area of transportation of dangerous goods. This meant that around 20 of Empa's staff were now open for new projects in line with the institution's new strategy. Urs Meier allocated the new positions to the high-performance ceramics laboratory, which was being set up.

**The new strategy bears its first fruit**

For a technology competition in 1991, the metallurgy/interface technology laboratory collaborated with the company Berna in Olten to submit the research project ‘Amorphous diamond-like carbon layers’. It received an award and won the opportunity to be presented at the internationally renowned Hannover trade fair. Also in 1991, the award-winning project ‘Ultra-light reinforcement of structures’ was put into practice for the first time. Together with partner companies, an Empa team restored the Ibach bridge near Lucerne, which had been damaged during construction work. It used carbon fiber-reinforced epoxy resin plates to do so – a world first and an example of a research project carried out by Empa from its scientific basis all the way to practical implementation.

At the same time, Empa enjoyed only limited success in the first round of the national priority program ‘Materials’, however: Only a quarter of the proposals it submitted made it through to the second round. The program was promoting radical innovations in the development and implementation of materials – a topic that precisely reflected the new Empa strategy. Empa’s modest success rate was proof that decades of expertise in testing and characterizing materials was no guarantee for unconventional ideas. The assessment panels were also inclined against Empa. On the one hand, the institution was considererd an additional competitor; on the other, many were skeptical about its transition from testing to research. The sceptics did not take into account that many of the longstanding testers that had worked at Empa had since moved to industry and been replaced by talented young researchers from around the world. This transformation was also reflected in the number of employees: After years of stagnation, Empa’s staff had grown to 648 by the end of 1991.

On 1 January 1992, the new high-performance ceramics laboratory was inaugurated. The laboratory was due to be fully operational by the end of the summer. EPFL and ETH Zurich were already active in the field of high-performance ceramics, however. To make sure Empa didn’t miss the boat, Walter Muster commissioned a number of research projects. One project, supported by the Federal Office for Energy, aimed at characterizing and optimizing the structure and mechanical behavior of ceramic fuel cell elements, for example.

The idea of privatizing Empa popped up once more. FDP National Councilor for Bern, Jean-Pierre Bonny, put forward a motion to have the Swiss government create a report by the end of 1993 on the possibility of privatizing federal agencies, which was signed by 72 members of parliament. He listed a number of examples, including Empa. Empa's senior management began to dig out their old ‘Reasons for existence’ files – but it heaved a temporary sigh of relief when the government sought to reject the proposal, and parliament did not pursue it.

**A third Empa location in Thun**

In 1992, the Swiss people voted on whether or not to join the European Economic Area (EEA), which would have made Switzerland part of a huge domestic market with 380 million inhabitants stretching from the North Cape to Iberia. Federal authorities – including Empa – and industry invested a great deal of effort preparing for Switzerland’s potentially entering the EEA. The initial predictions foresaw an approval, but the electorate rejected membership by a very tight margin. This had immediate consequences for Switzerland’s research landscape: Swiss institutions no longer had an equal right to participate in the European Community's research programs. Only self-funded, project-based participation was permitted. Swiss partners were not allowed to lead projects – a situation that would be revisited in 2014 following the acceptance of the initiative against mass immigration.

Changes were also taking place in Swiss politics. The new ETH Act came into force on 1 February 1993, and the Empa legislation needed to be adapted accordingly. The law brought certain important changes for Empa: It made it a legal entity with the same status as the two ETHs and established its focus on high-level scientific projects. Empa also adopted new labor laws and took on more financial responsibilities.

The early 1990s saw the first national women’s strike and the election of Ruth Dreifuss as Federal Councillor. The promotion of women became a prominent topic, also at Empa. An internal working group concluded that measures needed to be taken to promote equal opportunities. Women were encouraged to take on leadership roles, and men were encouraged to be less wary of professionally successful women. Short- and medium-term measures included shorter core working hours, part-time positions in management roles and the option of working from home. On 1 December 1993, the first woman joined the management team at Empa: Helene Felber became the head of the wastewater/waste materials/environmental technology laboratory in St. Gallen. Shortly afterwards, Empa and Eawag opened a joint nursery.

Another political development also altered Empa’s fate: The fall of the Berlin Wall in 1989, the collapse of the Soviet Union and the dissolution of the Warsaw Pact heralded the end of the Cold War. This meant disarmament for most of the armies in the West, including the Swiss army. The reduction in defense contracts meant the specialist section for materials and testing technology belonging to the Federal Department of Defence (FDoD) was no longer working at full capacity. The Chief of Armament, Toni Wicki, suggested transferring employees from this area of the FDoD to the Federal Department of Home Affairs and, more specifically, to Empa. This transfer took place on 1 January 1994, when 31 employees formed the new Empa laboratory for materials technology in Thun. The first major research project carried out by the new laboratory concerned the high requirements for the properties and lifespan of surface coatings applied by thermal spraying. This project was the very first step in establishing an expert center for modern coatings that would later emerge.

**The longstanding recession shapes Empa**

Empa's repositioning as a research institute continued to progress in the early 1990s. Filing patents with the Federal Office for Intellectual Property was nothing new for Empa, but 1992 was the first year, in which it registered a number of patents – and more were soon to follow. What was also novel was the fact that the patents did not concern testing machines but developments such as building renovation processes using high-performance fiber composites, energy storage materials, digital controls for electronic publishing and semi-transparent heat insulation with latent heat storage.

1993 was a difficult year for the Swiss economy. The recession was keenly felt by the cyclical branches of machinery, metal and textiles, which were suffering from declining revenues exceeded only by those of the construction industry. At Empa, the number of external projects took a dive in various divisions, and existing projects were cancelled or failed to materialize. In consultation with the president of the ETH Board, Empa’s Board of Directors made two decisions: to use employees that were not fully utilized to support and accelerate internal research projects, and to drive the acquisition of new research projects with industry.

Empa suffered an unexpected blow at the end of 1994, when the president of the ETH Board, Roland Crottaz, announced he would be stepping down early from his post. Crottaz had always been a fair and understanding supervisor for Empa. He was succeeded by Francis Waldvogel as president and Stephan Bieri as vice president and delegate for the Domain's research institutes.

Switzerland joined the World Trade Organization (WTO) in 1995, which gave rise to hopes of a change in the economic climate. But Switzerland’s economic outlook was not bright at all at the start of 1996; the country’s economy had hardly grown for the last three years, and remained untouched by the economic boom experienced by the surrounding countries. Switzerland was an outsider in Europe.

The ETH Board periodically commissioned evaluations of the research departments at both ETHs by international expert committees, so-called ‘peer evaluations’ – which posed a threat to the existence of the departments in question. Empa’s Board of Directors had been awaiting a similar evaluation for some time, and the moment finally came on 27 November 1996. Materials sciences at ETH Zurich and Empa were up for assessment, and Urs Meier would be responsible for the evaluation. He sent out a detailed plan to the affected laboratories for optimal preparation. Presentations and brochures were drafted, checked and arranged. Tensions were high when the experts arrived. The day did not go as planned – the experts didn’t want to listen to all of the numerous presentations. Instead, they spent the entire day conducting hearings that were hard but fair.

The debriefing took place two days later, and Empa's Board of Directors breathed a sigh of relief: Oral Buyukozturk from MIT presented an extremely positive assessment. The expert group concluded that Empa’s laboratories were world-class, its services were outstanding, it had global networks, made an important contribution to education, played a groundbreaking role as a pioneer in the field of composite materials and was a successful independent institution.

**A new expert center for technology transfer in St. Gallen**

In 1996, after around 20 years of waiting, Empa St. Gallen was finally able to move into a new building in the west of the city, designed by Zurich-based architect Theo Hotz. Solar panels were installed on the south- and west-facing façades, which were so successful that they earned Hotz both the Swiss and European Solar Prize in 1996. The panels covered 337 m2 and produced around 30,000 kilowatt hours of energy per year.

The new building allowed Empa to dedicate two floors to the Technology Center for the Lake Constance Region (tebo). The aim was to promote St. Gallen/Lake Constance as a technological hub, thereby attracting new companies and creating new jobs. The tebo association was founded a year later, which was made up of representatives from business, science, public authorities and start-up companies. Empa was in charge of the association's administrative office. The association considered itself a center of excellence for the transfer of technology and innovation.

**New cost cuts and staff reductions**

A significant decrease in budget – mainly resulting from a last-minute overall 2% budget cut by parliament – forced Empa to make drastic cuts in 1997. This had a direct impact on the number of employees. Many fixed-term contracts could not be extended, although most of the employees affected were able to find good jobs in industry – Empa has always been an excellent stepping stone for a transition to industry.

The ETH Board’s plans for 2000 to 2003 reduced Empa’s budget by around CHF 4 million annually. In order to continue to be able to invest in modern infrastructure in future, the number of staff at Dübendorf needed to be reduced by around 40 to 50 people by 2001 – if possible, without resorting to drastic measures. The Board of Directors drew up a plan for reducing staff. Instructions were issued to all laboratories stating how many jobs needed to be cut by given deadlines. Some laboratories needed to investigate options for a merger.

Third-party funding was extremely important for Empa. ‘Creating value through knowledge’ was part of the new Empa strategy – and potentially a new source of income. Expertise in construction damage alone was not going to make a lot of money, for example, and so the construction damage team decided to publish a book on the topic instead. 6'000 copies were printed and, thanks to effective marketing, almost all of them sold within a year.

**Facing the new millennium with increased autonomy**

By 1998, plans for a new event space in Dübendorf were fairly advanced. But instructions from the ETH Board's delegate Stephan Bieri stated that the building must not cost a penny more than CHF 2 million. For this reason, toilets were not part of the plan – the argument being that the adjacent employee restaurant already provided toilet facilities. Urs Meier took up arms in defense of toilets in the new building – and they were finally included. The name of the room had also been a topic of discussion since the start of planning. There were initial misgivings about the term ‘Empa-Akademie’, as the name might potentially rub colleagues at ETH Zurich up the wrong way. The discussion of the name lasted for months. Empa eventually decided to be bold and opted for ‘Empa-Akademie’. The groundbreaking ceremony took place on 9 April 1999 and activities began at on 17 January 2000, despite the fact that the building was not quite finished. The Empa-Akademie opened with a bang, with Peter Richner’s controversial lecture ‘Swimming pool roofs 15 years after Uster – have we not learned anyhing?’, which attracted a full house and a lot of media attention.

At the same time, Empa was intensifying the collaboration between the ETH Domain and Swiss universities in the areas of energy research and environmentally friendly construction. Under Empa’s lead, the Center for Energy and Sustainability in Construction (ZEN) was founded, which united the existing expertise in joint projects. ZEN promoted efficient, intelligent energy usage and sustainable development in the field of construction. Resources were to be used responsibly and the environment protected. The focus was on applied research and development and knowledge transfer at various levels. ZEN’s first project intended to demonstrate the significance of the ETH Domain's concept of a 2,000-watt society for construction.

1 January 2000 was a landmark date in the history of the ETH Domain: Each institution received its own objectives and its own budget – a major step towards autonomy and individual responsibility. Empa was granted the right to use third-party funding for its own purposes. It would also become possible to build up modest reserves in future. However, the budget – now referred to as ‘federal financial contribution – was, in turn, reduced. All the funding that was previously centrally managed across the entire ETH Domain for a specific purpose was now integrated into the Empa budget. This gave Empa more freedom – and with it, more responsibility.

2001 marked the end of another era at Empa: Fritz Eggimann stepped down as director. The government appointed Louis Schlapbach, professor of experimental physics at the University of Fribourg, as head of Empa on 1 April 2001. Schlapbach entered office with a clear goal: to make Empa – more decidedly than ever – an internationally renowned top-notch research institute.

((Einschub 1))

**Simulating a hailstorm in the lab**

In the summer of 1973, Switzerland was hit by a heavy storm that caused a huge amount of hail damage. The hailstones reached the size of golf balls and destroyed many roofs. Analyses by building insurers soon showed that synthetic roofing accounted for the majority of the huge damage payments. The insurance companies reacted quickly and wanted to ban synthetic roofing altogether. This would have been fatal for many companies, many of them SMEs. The Swiss plastics industry approached the head of the Empa plastics laboratory and urged him to do something. Soon thereafter he happened to overhear Heinrich Schoenenberger, head of the Technical Commission of Insurance Providers, saying to a colleague at an event: ‘Of course insurance companies would cover the costs for damage to synthetic roofing, if a tiled roof next door was also destroyed at the same time.’ This was the catalyst for a successful Empa project that would last for decades.

Within a year, the plastics team had developed a device that could simulate a hailstorm in the laboratory. First of all, the ‘hail cannon’ was used to shower a truckload of classic roofing tiles. This provided reference results. Then all parties involved began to bargain about reduction coefficients for plastics that took its ageing behavior into account. Empa scientists contributed their expertise and acted as neutral intermediaries between industry and the insurance providers. The final result was the SIA 280 standard for synthetic sealing membranes.

The hail cannon was one of a kind, and became a long-term reliable source of income for Empa. The device and the process were developed further and were increasingly used for foreign object damage (FOD) experiments on high-performance fiber composites. The Empa spin-off Flüeler Polymer Consulting GmbH successfully took over the activities relating to the hail cannon in 2005 – with a pool of customers across Europe.

((Einschub 2))

**Hitler diaries revealed as fake**

A cunning forger, a well-known German news magazine and 11 handwritten books were the main protagonists in one of the greatest scandals in media history. The fake Hitler diaries cost the German news magazine *Stern* around CHF 8 million in 1983. A number of editors-in-chief lost their jobs, and the forger Konrad Kujau and a journalist both ended up behind bars. Empa was among those who uncovered the forgery, after multiple voices called for an in-depth scientific analysis of the books. The 11 volumes eventually ended up in St. Gallen and came into the hands of Kurt Schläpfer, who was head of the printing technology laboratory at the time.

It was ‘a matter for senior management’, recalls Schläpfer, and the Hitler diaries had to be locked away in a safe every evening. It quickly became clear to the Empa experts that the diaries were fake. UV light showed that most of the books used paper treated with optical brighteners, which wasn’t available until 1948. The books’ bindings did not withstand much scrutiny either: They were made of polyamide and some even of polyester, which only became available in 1946. The red seal ties even contained a reactive dye that did not become available until as late as 1956. The Empa detectives concluded that the books could only have been written after the war, meaning they were most definitely fakes.

What followed was a first-class scandal that almost cost *Stern* its reputation, and sent the forger and a journalist to prison. It also gave German cinema one of its most successful films of all time, *Schtonk!*, in 1992. After the scandal blew open, the Hitler diaries were stored in the basement of the *Stern* publishers Gruner + Jahr. The publishing house officially handed the collected volumes over to the German Federal Archives in Koblenz in 2013.

[photo]

*Empa investigates the Hitler diaries to ascertain their authenticity in 1983 – and exposes them as fakes. Image: Empa*

((Einschub 3))

**Radiation alarm at Empa**

On 26 August 1992, two people entered the Empa reception in Dübendorf with two samples of osmium-187 – a rare and valuable isotope of the platinum metal –, which they wanted to have analyzed. This required an inorganic mass spectrometer, of which there were only 11 in Switzerland at the time – one belonging to Empa. Peter Richner, a chemist and head of the trace analysis group (and now its Deputy CEO), was the only person at Empa specialized in this kind of work. He took the project on.

Richner was surprised to find that the samples were sealed in metal rather than being stored in glass vials, as was standard. He shook the metal cylinders in which the material was held. The Geiger counter began to beep alarmingly before he even entered the laboratory containing the X-ray equipment. Richner initially thought there was a problem with the Geiger counter and called his laboratory head Heinz Vonmont. From that moment, it all happened in a flash: The on-call service at the Paul Scherrer Institute (PSI) was called, as were the radiation protection specialists from Swiss National Accident Insurance Fund Suva, the police and the judiciary authorities, and the metal cylinders were safely isolated. PSI analyzed the samples. It transpired that the cylinders contained not osmium-187 but highly radioactive cesium-137. Mirek Barczyk, the 25-year-old Pole who had brought the samples, was arrested along with three colleagues. It turned out Barczyk had no idea what was actually in the sample containers. Two days earlier, he had spent his life savings – around USD 10,000 – to buy the stolen samples from a Ukrainian in Latvia. He had planned to obtain a certificate in Switzerland and go on to sell the sought-after osmium to interested buyers in Germany. To keep the valuable metal safe, he had stored it in a matchbox in his chest pocket during the two-day trip from Vilnius to Switzerland. This turned out to have been a fatal decision. He was told he only had four months to live. There was no possibility of treatment. Barczyk was released and allowed to travel back to Poland.

Richner was also concerned – he had held the sample in his hands for several minutes. But both were lucky: Barczyk’s blood count normalized, and he survived. The results of Richner’s examination were reassuring, and he was able to keep all his fingers.

The incident has had an impact on Empa to this day: Its central freight delivery section now has a Geiger counter that is used to monitor unknown deliveries.

((Einschub 4))

**Damage to buildings**

Switzerland is home to thousands of sports halls, swimming pools, commercial spaces and exhibition sites. Occasionally, mistakes are made when planning or constructing these buildings. These need to be analyzed closely, so from the errors are uncovered and avoided in future. Experts at Empa play a crucial role in this.

**9 May 1985, 8:30 pm:** The suspended concrete ceiling of the Uster indoor swimming pool collapsed into the pool. 12 people died and 19 were injured, some of them seriously. Empa’s investigations revealed that the roof, built in 1972, was not only around 30% heavier than originally planned, but was also supported by stainless chrome-nickel steel brackets, which had developed cracks as a result of the high mechanical strain and the chlorine-filled air. This process is known as stress corrosion. At the time of the building’s construction, the material properties of this kind of steel were unknown to most construction specialists; they were not part of their university education. Following the incident, Empa began holding further training courses for construction experts and published the results of the investigation, alongside appropriate measures for avoiding similar occurrences in future.

**24 February 2009, 6:00 am:** The roof of the GBS gymnasium in the Riethüsli district of St. Gallen – which was just three years old – was covered in 40 cm of wet snow. Although the roof should have been able to withstand this burden, the hall ceiling collapsed 90 minutes before a sports lesson was due to begin. Empa researchers discovered that the hall ceiling was constructed using non-reinforced steel girders, even though the plans had stipulated reinforced girders. The non-reinforced girders collapsed under the weight of the heavy snow.

**12 April 2011, 6:45 pm:** Witnesses at the Bernaqua water park heard a sound like tearing cardboard, and a piece of the suspended ceiling fell from a height of 15 meters. One person was injured. Empa’s investigations revealed that the ceiling, which had been installed three years earlier, was a widely utilized standard construction. Many of the suspensions had not been installed correctly, however. On one side, the roof was only being held in place by a drywall ventilation shaft. When the drywall began to show the first signs of ageing, it tore and the ceiling caved in.

**April 2018:** While cleaning, the caretaker at Niederuster school discovered corrosion damage to the mounting elements on the ceiling lights in the gymnasium. The school reacted straight away, blocking off the hall and informing the architects – and Empa. The ceiling was removed. Empa researchers discovered serious corrosion damage to the galvanized steel suspensions, caused by corrosive substances in the phenolic resin insulation plates. If these plates become damp, they develop strong acids that can attack the metal suspensions. In response, Empa informed all cantonal building authorities and the architects’ association SIA. It also published notices on how to detect damage of this kind. Fortunately, no one was hurt.

((Einschub 5))

**Empa technology in orbit**

Space rockets require a phenomenal amount of energy to take off. When it comes to launching satellites into space, the payload fairing plays an important role. It needs to be able to withstand strong aerodynamic forces while also being able to detach easily at a later point in the vacuum of space. The payload fairing on the Ariane 5 rocket was manufactured by the Swiss company RUAG Space. In 1994, Empa was called in to carry out impact tests on the casing element. Empa had already helped to develop and optimize the payload fairings for the previous models Ariane 1 (1978) and Ariane 4 (1984), as well as for the US rocket Titan 3 (1988).

The 13-meter casing on the nose of the Ariane 5 made up about a quarter of the total length of the rocket. The payload fairing protects the satellite as it ascends through the atmosphere. The two halves of the casing are shed from the rocket at a height of 110 km, just three minutes after take-off. They are made of a 25–30 mm sandwich construction: The outer layers are made of carbon fiber-reinforced polymers around a honeycomb aluminum core.

In order to simulate the force exerted on the nose of the rocket during take-off and ascension as accurately as possible, Empa researchers developed a complex load induction system. The curved top part of the payload fairing is particularly important. In order to simulate the forces acting on the payload fairing, Empa researchers attached a plastic belt. In Empa’s construction hall in Dübendorf, the nose of the rocket was fixed to a clamping frame and subjected to 600 kilonewtons (60 tons) of lateral force and over 600 kilonewtons of axial force.

The effort paid off; the Ariane 5 took its first successful flight in October 1997. Ariane 5 rockets have been launching satellites for communication, Earth observation and research into orbit since 1999.

((Einschub 6))

**A ‘torture chamber’ for footballs**

It all began with a ball. To begin with, it would have been made of rags or patched together from leather scraps. With the birth of modern football, the first rules were established, enabling the mother of all national matches to take place: England vs Scotland in 1872. Until that point, misshapen fields, different sized goals and different numbers of players meant that games resembled wild brawls more than sporting competitions. The footballs used at the time would not have met the current quality requirements, however. In order for today’s tournaments to be fair, all the footballs need to have reliable properties. And this is where Empa comes in. In 1996, engineers in St. Gallen developed a ‘torture chamber’ for footballs. Only balls that survive all seven test are awarded the FIFA seal of approval.

These tests – which all official World Cup and European Championship balls still have to pass today – include compressing the leather ball into a water bath 250 times to ensure that, if it rains, it won’t absorb water and become too heavy. Its weight, circumference and spherical shape are measured at 4,000 different points, and tested by being fired at a steel plate 2,000 times at 50 km/hour. The ball also needs to stay inflated for 72 hours and bounce back to exactly the right point when dropped from a height of two meters.

Together with FIFA, the experts at Empa have developed fanciful tests and techniques for ensuring that a football does what it needs to do. Emotions can often run high when a new tournament ball is presented – they are often accused of being too hard, too fast, too volatile. Empa expert Martin Camenzind made sure that all the devices used for analysis delivered unequivocal results, however, emphasizing that when it comes to the Empa seal of approval, objective parameters apply, meaning that each and every tournament ball has the same characteristics. Despite all of this, there are always those special players who know how to use the laws of physics to their advantage and shoot the ball past their opponents into the goal. Even clear rules and replicable balls can’t stand in the way of the magic of football.

((Einschub 7))

**A legacy of CHF 1 million**

During Theodor Erismann’s time in office, when a member of the senior management retired, it was customary to take a half-day off to attend a cultural event and then share a festive dinner among colleagues. One such farewell took place at Hotel Schwert in Näfels on 18 September 1985. René Steiner had retired at the end of August.

Steiner had been the head of Empa’s metals laboratory since 1951 and had been responsible for expanding this key area. As part of Empa’s move to Dübendorf, he succeeded in establishing a center of excellence for metal materials testing in 1962. In 1972, in the course of Empa’s grand reorganization, he took on the management of the metals divisions, which by then encompassed five laboratories. He also became a professor at ETH Zurich in 1975.

The food and wine at Hotel Schwert were delicious, and everyone enjoyed a wonderful evening. Farewell gifts were exchanged, and Steiner promised to come back and visit his colleagues at Empa. But in 1991, Steiner suddenly broke off contact with his erstwhile colleagues, in particular with Urs Meier. His reason was the closure of the container/safety technology laboratory. Steiner had worked extremely hard to acquire technical equipment for the laboratory and could not understand why Empa was now giving up its ‘cash cow’. Nothing was heard from Steiner for 9 years. Meier was aggrieved; the two of them had worked together for so many years. He regularly invited Steiner to Empa, but to no avail.

Until 6 July 2005. On that day, Steiner heard a report on his favorite radio station, DRS 2, about Empa’s 125th anniversary. Steiner was delighted to hear about the development of ‘his’ Empa – and got back in touch after 14 years. Steiner was now a widower without children, and wanted to talk to Meier about a research legacy fund. Over lunch, Meier told Steiner about failed negotiations between the founders of the Empa spin-off Carbo-Link and the major Swiss bank UBS regarding a loan of CHF 80,000 for the purchase of a coating system. Steiner immediately expressed his willingness to provide the funding himself, if necessary.

In December 2005, Steiner became ill and was hospitalized. His condition was critical. In his will, he left a bequest to Empa. During a visit by Meier in January 2006, Steiner informed the astounded Empa director that he had left Empa CHF 1 million. This money was intended to fund spin-offs. René Steiner died in Zollikerberg hospital on 23 January 2006. Many Empa employees attended his funeral.