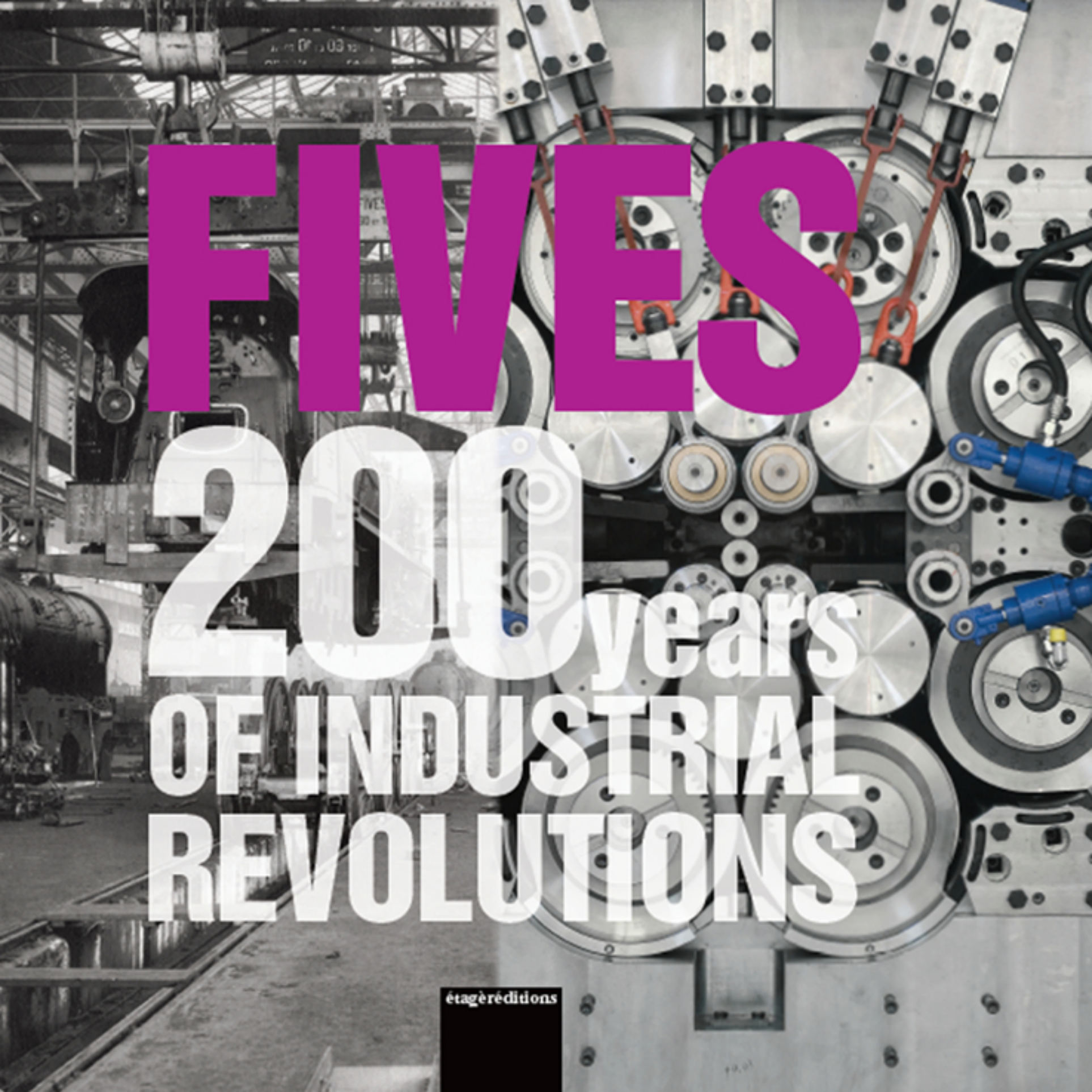

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In 2012, the Fives group celebrates its 200th anniversary. Fives group was established through the union of two companies, Fives-Lille and Cail, which, before merging, had each operated separately for about 100 years. Then, from a series of company acquisitions, several of which had proud traditions, the group adapted to the many technical and organizational changes which mark the three industrial revolutions that have occurred over the last two centuries. As a manufacturer of steam locomotives in the 19th century, Fives has become, today, an international reference in the field of industrial engineering. Fives group's long history is represented by its remarkable achievements, beginning with the construction of the first steam and electric locomotives in France. Many prestigious structures of the 19th century bear the mark of Fives group, including the Alexander-III Bridge, the Orsay Train Station and the Eiffel Tower. The generations preceding the mid-20th century, have participated in the reconstruction of France, taking part in the construction of the Tancarville Bridge, and supplying numerous plants throughout the world, large sugar-processing plants in Brazil and cement plants in Mexico… In the 21st century the group is involved in significant and prestigious projects such as the aluminium plants in the Middle East and the most efficient steel production lines in China. Throughout its existence, the Fives group's journey has been closely linked to the major economic events and industrial world.Originating in France, Fives is an atypical group, led by the ambitions of the women and men and their sense of entrepreneurship. The group has thus been able to innovate throughout its history acquiring the power of a large corporation while retaining the operational flexibility of a small business. The reputation of Fives is a result of an exceptional history that we invite you to recapitulate in this anniversary book.

Frédéric Sanchez
Chairman of the Fives Executive Board

2012 | *Alexander-III Bridge - Paris (France)*

Around 1904 | *construction of the Fades viaduct, Sioule river (France)*

Fives, 200 years of industrial revolutions

Foreword by François Caron, historian, specializing in 19th century French economic history

Fives and the three industrial revolutions

The history of Fives is based on three major periods from the early 19th century, each of which was characterized by the preponderance of a new technological system. Each system was a product of the industrial revolutions, which can be defined as the evolution of a new set of innovative techniques which introduced ground breaking technical and organizational changes. The first system was developed between the early 19th century and the 1870s. It marked the first revolution instigated by individual entrepreneurs and resulted in radical changes in energy use and mechanization. The second revolution, which took place between the 1880s and the 1950s, shifted the orientation of the company's systems towards mass production and increased a corporate concentration, although the individual entrepreneurs did continue to play a vital role. The third revolution, from the 1960s to the early 21st century, supported the rise in flexible production developments and business boomed.

The period of entrepreneurs 1830 | 1880

Tracing back to its origins, Fives group was the result of a merger of two companies, Cail and Fives-Lille, that were established in the 19th century, at a time when France was experiencing its First Industrial Revolution. Both companies played a leading role in introducing radical technical changes, through the use of steam power, new materials and mechanization. Their success demonstrates the importance of the initiatives and role played by the individual entrepreneurs, who were personally involved in managing the company, as well as fostering and developing the technologies that were fundamental to the First Industrial Revolution. These techniques have changed the system in two ways; first, by transforming production methods through an energy revolution and second, through the development of new products and technical networks, such as the railways or gas distribution networks.

Jean-François Cail incarnated the ideal of the entrepreneur with a flair for innovation. Initially starting with the company as an apprentice he rose through the ranks, earning the social and professional recognition which, in the 1860s, established him as one of the most powerful industry leaders in France. In his early years, the young apprentice, gained the confidence of Charles Derosne, the son of a scholar described as a chemist and manufacturer, who, in 1812, founded a company specializing in the manufacturing of distillation and sugar-processing equipment. Thereafter, in 1836, Jean-François Cail and Charles Derosne together created the company Derosne and Cail. Upon the death of Charles Derosne in 1846, Jean-François Cail became the successor of the company. From this moment on it diversified its activities, while remaining a leader in sugar production technology. It engaged in the railway market in 1844 and built the first Crampton locomotives after acquiring the exclusive manufacturing rights from its English inventor. In 1847, it had four production sites with a total driving force of 135 hp and 230 forges, with more than 2,000 employees. In 1850, it was the second largest constructor of steam locomotives in France. In 1855, the company branched out into metal fabrication with construction of the Arcola Bridge in Paris, the first bridge to be made of wrought iron rather than cast iron, followed by the *Pont Noir* railway Bridge of Moulins in 1858.

In the 1860s, the company had reached its peak with two factories in Paris, Chaillot and Grenelle, one in Denain and a subsidiary in Brussels, as well as others in the colonies. Turgan, a dictionary of French factories published in 1863, noted that the company overall had a total of 5,000 employees, 2,000 of which were in Paris. The Turgan dictionary wrote that the *Établissements Cail*, is "neither a foundry, nor an ironworks, neither a boilermaker, nor a manufacturer, but is rather a combination of all of these things, and much more." One of the achievements by this group, which remains intact today, is the company's ability to collaboratively deploy a wide range of skills on the same project. While Jean-François Cail's mode of technical success and social betterment was not unique to the mechanical engineering industry, it was exemplary, however, it could be found in the luxury goods, textiles and metallurgy industries. Such individual entrepreneurs were the real "engines of growth", the heroes of the Industrial Revolution in France. Jean-François Cail died in

1871, on the eve of the Second Industrial Revolution, leaving behind the second largest company, after Schneider, in the mechanical engineering industry and metal fabrication plants.

Fives-Lille originates from the company Parent & Shaken. After building the first railway in Belgium, stretching from Brussels to Malines, Parent & Shaken moved into the locomotive construction market and established a business in France, first in Oullins, then in Fives near Lille and later in Givors. The company was founded in 1861, which became Fives-Lille in 1866, specializing in mechanical engineering. In 1854, the firm had already overhauled the first French railway from Lyon to Saint-Étienne, and by 1867 it was employing 1,730 workers. It entered into a 9-year-long agreement with Cail in 1861 for the construction of locomotives and civil engineering infrastructures such as bridges and viaducts. This collaboration was particularly productive, with Fives-Lille developing strongly in the field of metal fabrication, surpassing Cail. Under the Second Empire, Fives-Lille built part of the Exposition Palace for the 1867 Universal Exhibition in Paris, a large number of iron bridges, including the European Bridge, and several railway lines in France, as well as many of their viaducts. Cail pursued its production of sugar-refining equipment. It had achieved a key market position in the sugar industry in France and overseas, building plants in Cuba, Mauritius and Réunion Island which Turgan described as “splendid”.

The core feature of the Cail and Fives-Lille companies was their talent for innovation and for diversifying their activities. They ranked top in the construction of locomotives, but they retained their expertise in general mechanics, capable of providing a variety of products, such as the minting press which Cail himself had designed at the beginning of his career. They successfully seized the opportunity presented by the rise of the railways and urban growth, and expanded their civil engineering and metal fabrication activities accordingly. Market expansion brought radical changes in the knowledge and skills of mechanical engineering companies such as Cail and Fives-Lille. Craft skills were transformed into industrial processes, and engineering specialism rose in tandem with the new developments. Innovation came either from close observation of craft and indus-

trial practices, which were then formalized, or from conceiving new procedures based on the introduction of new tools. The latter were invented by applying the engineering sciences, which at the time were in full swing. Engineering was taught in specially created institutions such as the *École des Arts et Métiers* or the *École Centrale des Arts et Manufactures,* founded in 1829.

While Jean-François Cail was not really himself an inventor, his mechanical expertise enabled him to promote the new ideas of the engineers and inventors around him. He organized a system of technological monitoring, and set up a research department headed by exceptional engineers such as Houel, who had constructed the Crampton locomotive in 1849. Houel devised a new system of work organization adapted to the new techniques being implemented. He set up a method of manufacturing based on drawings that summarized the key concepts of production trades. These drawings were the basis for the way that the work was divided and monitored. Henceforth, it would be the engineers who reigned supreme in the factory and took responsibility for the shape of the whole production process. Initially, the engineers who occupied positions of responsibility in Cail and Fives-Lille came from the *École des Arts et Métiers*, founded in 1780, and later it would be graduates of the *École Centrale*. The role played by the research departments in product development, whether of consumer goods or tools, was also a key feature of these companies' organizations. The design process depended on close cooperation between the various skills areas in the company, and also on dialogue with the clients. The railway companies were involved particularly closely with suppliers like Fives-Lille and Cail. They arranged for their own engineers to contribute to the development of the products to be supplied, and insisted on the manufacturing of interchangeable parts and on improvements in the quality of iron and later steel. Cail developed specialized high-precision machine-tools, large-scale forges and new foundries to meet the requirements of this new generation of clients. Similar client demand prompted several French companies manufacturing machinery for the textile industry to transition into the manufacturing of machine tools.

Already in the first half of the century, these French companies, with the help of large investment banks, began exporting their new skills, and winning foreign markets. Fives-Lille and Cail took up the challenge. They joined forces to build railways in Spain, Switzerland and Italy, then in Egypt and Russia. Cail built all the bridges on the Moscow-Novgorod and Moscow-Saratov rail lines. In this period, the two companies grew and established themselves in the international market. This involved exporting locomotives, as well as sugar-refining equipment, and civil engineering installations.
The technologies of the First Industrial Revolution, as developed in the Fives-Lille and J.F. Cail and Co. factories, laid the foundation for a technological culture and company ethos which produced the great industrial successes of the 20th century. Many practices current in the 1860s persisted well into the 20th century because they were integrated into a constantly evolving system of production.

The Second Industrial Revolution: the development period 1880 | 1914

The 1880s witnessed the emergence of a new set of technologies which constituted what can be called the Second Industrial Revolution. It was characterized by the rise of new industries, particularly in the energy field, with the creation of electricity networks, the combustion engine, the steam turbine, and of materials. Many of the innovations provided solutions for the malfunctions which had come to light in the technological system of the First Industrial Revolution. The new forms of energy gradually, but profoundly, transformed the way workshops operated. In a 1892 advertisement, the German electricity company AEG explained how electricity could largely eliminate cumbersome transmission shafts, simplify transmission devices, make machine tools more independent, facilitate assembly, make possible driving force at a distance and considerably improve safety. Electricity paved the way for the automation of processes, replacing purely manual operations or those dependent on steam energy. This in turn facilitated the adoption of continuous production methods, the corner-stone of mass-production, and allowed factory space to be rationalized. However, electric motors were in fact little used at first, because they had to be adapted to the enormous variations in power demand of large industrial plants.

Alongside these developments, advances in material technology and material machining greatly improved industrial processes. This resulted in products that were better adapted to their use. All these new techniques were beginning to be applied in the French industry from the 1880s to the First World War. They became fully integrated between the 1920s and the 1950s.

The emergence of new technologies in the 1880s and 1890s coincided with a severe economic recession, which struck in 1883. Moreover, economic activity slumped in the first years of the 20th century, from 1901 to 1905. In France, the effects of these recessions were magnified by the sudden reduction of investment in the railways, and, from 1883 until the mid-1890s, the whole sector of heavy engineering decreased in size. The response of this sector was to scout for new markets based on use of new technologies.
Both Cail and Fives-Lille saw its orders for locomotives and railway machinery plummet, but the fortunes of the two companies differed significantly. J.-F. Cail and Company had been weakened by the death of Jean-François Cail in 1871. The company went into liquidation in 1882 and became the *Société Anonyme des Anciens Établissements Cail*. It did not find a way out of the crisis, and its capital was reduced by one half in 1889, leading to another liquidation in 1898. It then became known as the S.F.C.M. or *Société Française de Constructions Mécaniques, Anciens Établissements Cail* which was taken over in the 1900s by Louis Le Chatelier, a highly talented engineer and son of the scientist Henry Le Chatelier, who by 1905 had managed to turn the company around. He was one of the principal advocates of the movement to rethink industrial labor, a movement which was gaining momentum at the time.

Fives-Lille, by contrast, reacted energetically to the crisis from the start. Between 1880 and 1890, it supplied more than a quarter of all the orders placed in France for railway equipment. It diversified into lifting apparatuses and electrical equipment, and was very active in metal construction, building the *Galerie des Machines* for the 1889 Universal Exhibition and the metallic roof structure of the Orsay Train Station. It also branched out into building bridges and railway lines abroad. It became a world leader in civil engineering,

specializing in bridges and perfecting the technique of compressed-air caissons. Joining forces with *Schneider et Compagnie* in order to exploit this technique to the fullest, Fives-Lille built the Morand Bridge in Lyon and the Alexander-III Bridge in Paris. At the beginning of the 1890s, Fives-Lille was making record profits, but this strategy was not without its risks and unsuccessful ventures in Spain caused heavy losses for the firm in 1898. The company would later climb back into second place for the manufacturing of locomotives in France.

Another response to the crisis was the expansion of firms, such as those at Fives-Lille. They oriented their research to target techniques vital to well-defined products such as sugar-processing equipment, hydraulic systems (practiced at the Eiffel Tower), lifting and handling equipment, civil engineering installations and turbines for power-stations. Research led to the diversification of activities, thus confirming that new technologies really could create new markets. Fives-Lille's financial results remained disappointing until the mid-1900s. They then increased their profits by four times as much between 1906 and 1910, thanks to an increase in orders for locomotives, linked to an unprecedented rise in railway traffic, a strong economic upturn generally, and the positive effects of diversification, with the development of new supply chains. Moreover, overheads could be substantially reduced due to advances in mechanization and factory production methods using electricity. At this time, the organization of factory work began to change. Fives-Lille and Cail, under the aegis of Louis Le Chatelier, were involved in this newly created movement to rationalize factory work. The first stage of the process, which would continue slowly through the interwar years, was the reorganization of space and of handling systems.

Lastly, the economic slump was a catalyst to the company's presence, and financial investment, abroad, as part of a movement of internationalization of the world economy, prefiguring globalization. It was sustained by the intensification of capital movements made possible by a multi-lateral system of balance of payments, and thanks to the large investment banks. As a result, from the 1880s onwards, major French public works and engineering companies were tremendously successful abroad. In 1914, France was the

second exporter of capital in the world after Great Britain, with 20% of world exports. In 1881, the main client countries were the Mediterranean countries and Central Europe (57%), in 1914 Eastern Europe (28%), North and South America (16%), the Ottoman Empire and Egypt (6%). Fives-Lille knew how to take full advantage of this expansion. It operated particularly in Hungary, Eastern Europe and South America. It built the railway line from Pest to Semlin, which also involved the construction of two huge bridges, as well as the line from Linares to Almeira in Spain, which involved similar works. One of its flagship achievements was building, from 1891 to 1895, a 750 meter long bridge over the Danube in Cernavoda, Romania, in particularly difficult conditions. This project marked a milestone in the history of bridge construction techniques. Such major successes also opened up markets for locomotives for the two companies. The company's international development, which started in the 1860s, had thus entered a new phase, and its international outlook is still today a prime feature of the company's culture.

The Second Industrial Revolution: the maturity period 1914 | 1958

A strong continuity unites the experience between the years of the two world wars, and post-World War reconstruction to the 1950s, which were linked by the elaboration of a new production model generally identified with Fordism. It aimed at achieving mass production and vertical integration of companies. The success of this model was in dissociable from the technologies of the Second Industrial Revolution, which were introduced in the interwar period, in a highly unstable climate, becoming widespread between 1945 and 1960, at a time of strong and sustained growth.

In the 1920s, the capital goods industries were the principle drivers of growth, and suffered less than other sectors in the 1930s economic depression. Fives-Lille and Cail were particularly well positioned at the time, thanks to their traditional markets in sugar-refining equipment, railways and public works. These sectors remained very buoyant, even in the 1930s. The two companies were much in demand in the 1920s and 1930s for major public works projects such as building the electricity networks, electrifying the

railways or supplying oil and gas installations.
New production and product development methods transformed industrial production, as did rationalization of both its technical and organizational systems. Production was henceforth based on increasingly efficient electro-mechanical processes. New energy technologies were introduced and French business leaders adapted Taylorism to the particularities of their industrial culture and extended automation. During this period, Fives-Lille and Cail put their energies into diversification, especially in the 1930s, branching out into gas engines, automobile vehicles and materials for the cement industry, which would become one of the group's major specialties. Cail was one of the companies which promoted new work organization methods, affecting everything from the circulation of parts to the regulation of the supply chain, the specialization of workers, the monitoring of results and the institution of bonuses, which was adopted by Cail in 1932. The companies also applied management methods derived from different theories of organization, including budget control, standardization, efforts to reduce waste, time organization, motion studies, and product and process developments. These practices provided the basis for a modernization which continued during the Second World War and was completed in the 1950s.

The three watchwords of the 1950s were productivity, diversification and industrial concentration. In the immediate post-war period, orders flowed in, first from reconstruction projects and then as a consequence of increased industrial investment in metallurgy, cement and large civil engineering projects. From 1950 to 1960, the capital goods sector expanded at a rate of 7% per year in France. This growth was due to increased productivity in the sector, which ranked third in Europe. Mass production continued to be the dominant system, and its general characteristics were reinforced by the adoption of American methods just after the war, delegations of French company heads and engineers visited the United States. Welding engineers from Fives-Lille took part, and probably other categories of engineers as well. The high growth rates of the 1950s and 1960s can thus be analyzed in terms of catching up on productivity, by adapting American procedures. Companies in the capital goods sector have implemented diversification strategies based

on the close relationships they have established with public enterprises and large firms in the primary sector. Cail concentrated on developing rolling mills and steel manufacturing equipment, while Fives-Lille expanded its activities in heavy electro-mechanical materials and civil engineering works.

The move towards industrial concentration implied by the merger between Fives-Lille and Cail in 1958 was in fact part of a general tendency in the capital goods sector, and particularly in the mechanical and electrical engineering industries. Such a move had three objectives: first, as was the case with Cail, to integrate a company in difficulty, but which had valuable specialized skills; secondly, to pool very costly activities and equipment; and lastly, to ensure a stronger position with respect to the threat posed by European competition.

The Third Industrial Revolution and establishment of the group 1958 | 1983

The 1958 merger occurred at the beginning of a rapid growth period for the French economy and industrial sector, which continued from the 1950s until 1973. From 1963 to 1973, industrial production was growing at a rate of 6.8% per year. Investment increased at an even greater rate than production, since the highest uptake of new technologies occurred in the capital goods sector. The latter thus had excellent development opportunities. All in all, its share of total added value increased from 11.4% to 16.1% in constant price (price of 1959), but only from 12.5% to 13.8% in current price. This differential accounts for the size of its contribution to global growth, through the transfer of surplus. But this upturn followed after the first oil crisis of 1973, by an economic slowdown and instability until the mid-1980s.

At the beginning of the 1960s, Fives-Lille Cail encountered difficulties which forced it not to benefit during the period of growth. In order to put this difficult period behind it, the company vigorously pursued a strategy of diversification, notably acquiring a major handling company in 1963, which opened up valuable markets for it in France

and abroad, and also the company *Bréguet*, which gave it further potential in sectors in which Cail was already present, such as the sugar and cement industries. Fives-Lille Cail also continued to apply scientific management methods, which were still dominant at the time. It introduced factory-level specialization and concentration of activities on certain areas such as the sugar, cement, paper-making and power station markets, to the detriment of metal fabrication activities. This rationalization also involved establishing devolved systems. Fives-Lille Cail won important contracts abroad, for example with the USSR for the construction of the largest cement-works in the world, in Siberia, followed by similar contracts in Turkey, Iraq and Brazil.

Fives-Lille Cail and other companies in the sector seized the opportunities offered by the technologies of the Third Industrial Revolution to automate their systems and revolutionize their data processing techniques. The Third Industrial Revolution began to have an impact in the booming years of the 1960s. But industrial processes based on electromechanical automation encountered tremendous problems of regulation and control, resulting in constant breakdowns and accidents. Electronic devices and computerized systems came to the rescue. The 1970s witnessed an important step forward, with the invention of micro-chips in 1971. This provided a vital impetus to the technology of complex system regulations. Advances in science and technology paved the way for truly revolutionary advances. New production methods flourished, drawing on the widespread use of electronics, the invention of entirely new materials and manufacturing processes, the development of flexible production systems working around the clock, and the new centrality of information technologies. Flexible production had replaced mass-production. Entirely new information systems, as well as modes of transmission and data processing were devised, facilitated particularly by networked computers. These developments accounted for a radical transformation in management models and methods, aiming at greater flexibility.

Such innovations coincided with a nation-wide movement of mergers, which gained pace in the late 1960s. Later, it was large industrial groups which were favored rather than merged companies. A study carried out in 1972 by the *Centrale de bilans de la Banque de France* listed eighteen large groups in France. Six of them, including Fives-Cail Babcock

(FCB), were in the capital goods sector. FCB resulted from the merger of Fives-Lille-Cail and Babcock Atlantique in 1973, and was the largest French company in heavy mechanical engineering at the time. The same study showed that 73% of its workforce was in the capital goods sector and only 13% in intermediary goods. Its policy of mergers in the years 1958-1972 aimed at promoting decentralized structures, while remaining in sectors linked by true industrial logic. FCB went a step further, in transforming the company into an industrial group. It took over a series of mechanical engineering companies. These acquisitions opened up new possibilities in areas such as ore-processing, boiler making, industrial equipment for the agribusiness, compressors and handling. Several of the companies would be lasting members of the group. *Nordon et Cie.*, for example, specializing in high-end industrial piping, became Fives Nordon in 2007. The transformation of FCB into a large industrial group had really gained momentum, and was formalized through the establishment of the holding company Fives-Lille in 1983.

Fives-Lille, located in the center of globalization from 1983 to present

The year 1972, was the time in which FCB was established, and was a major turning-point for French industry. The contraction of industrial sector activities set in, and was to continue into the 2000s. Between 1972 and 2007, FCB's workforce fell by 53%, after rising by 11.3% between 1952 and 1972; in the capital goods sector alone, the drop was of 73%. These figures were not only due to slower industrial growth, but were also the result of industry's increasingly capital-intensive character. From 1983 onwards, in a deteriorating economic climate, companies had no choice but to adapt to the technologies of the Third Industrial Revolution. The heavy engineering industry was directly affected, since it relied on continuous production and the design and management of complex systems. However, new technologies had been successfully integrated, with servomechanisms, micro-chips and computers being used to set up entirely automated, efficiently controlled systems that required no human intervention. In all sectors of activity, industrial robotics was able to regulate complex and hazardous automated systems of production. Such innovations required companies to constantly update their technical know-how and skills. They also

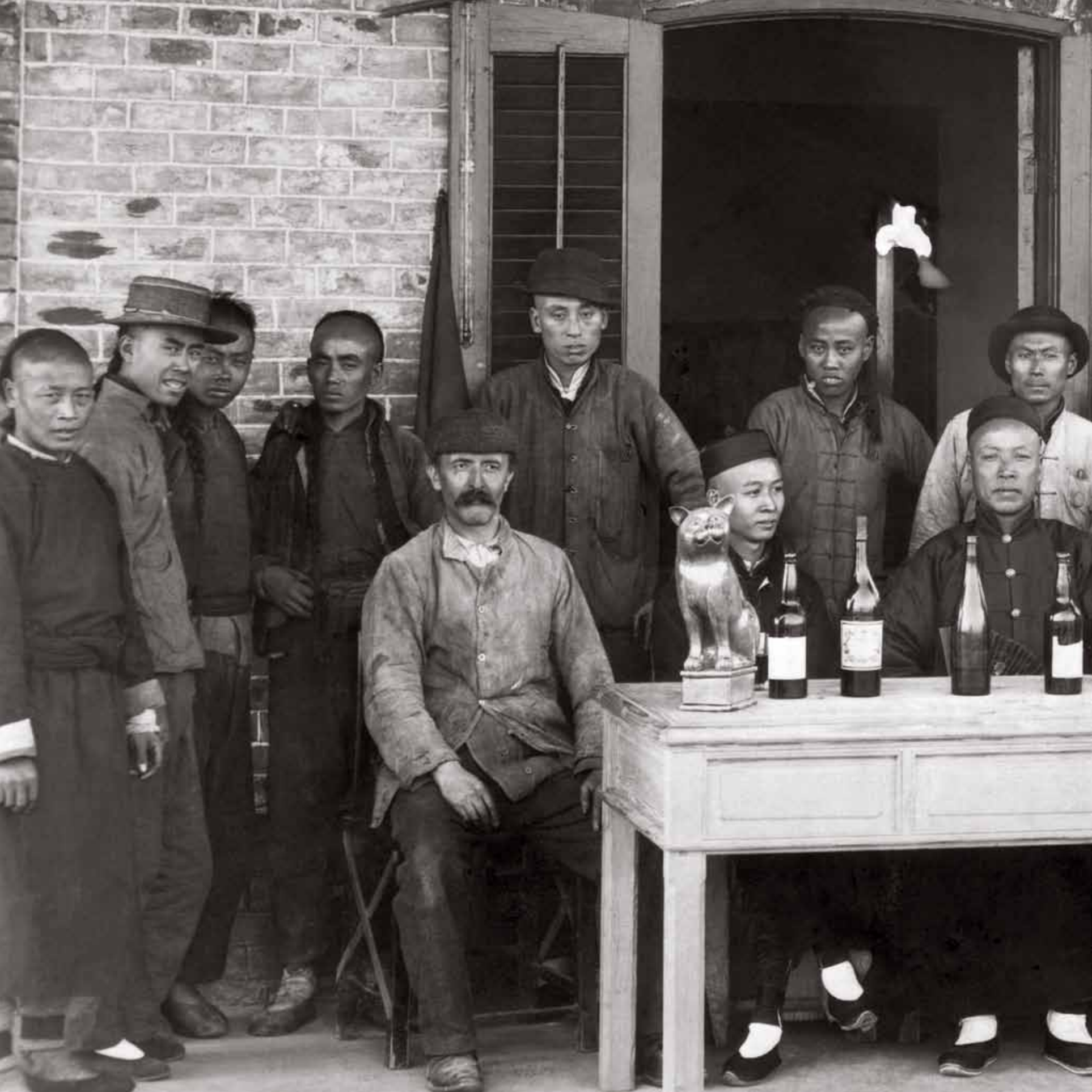
had to expand their research and development departments, as well as involving their production and marketing teams. New procedures for the collective development and manufacturing of products were introduced, as well as partnerships with other players.
These transformations are inseparable from the trend observed in the French industry and worldwide in the 1980s towards organizing work into networked units. The economies of scale, low transaction costs and integration of technologies achieved by company concentration had given way to decentralized models, in order to economize capital, simplify control and increase reactivity. Devolved structures resulted from the fragmentation of concentrated companies or the creation of conglomerates by acquisitions or equity participation. Fives-Lille took the latter path and in 2007 in its sector, 69.6% of their employees worked in groups, most of which were small, although some groups were larger. The ten largest groups employed 22% of the workforce. The management of these groups, and the communication relations between their constituents, were managed exclusively through information and communication technologies. These technologies had thus become indispensable to a devolved and decentralized organizational and management structure. Business conglomerates normally consist of several companies grouped around a central core, and this was the model which Fives-Lille eventually adopted. The first stage in this process began in the 1980's and where some specialized manufacturing factories of Fives were placed directly under the group's central control. However, when legendary workshops such as Givors or Lille had to close; a symbolic turning-point had been reached in the evolution towards a more decentralized, model. The latter was based on dialogue between a central instance and a group of units each with specific, highly technical skills. The central group contributed its expertise and financial support to ensure the development, and if necessary, the financial resurrection, of the units, without the working teams having to be replaced. Central research units were transformed into real research laboratories, with the result that the group's engineering activities expanded considerably. These activities became increasingly complex, mirroring the complexity of the expertise applied. It was the engineers who took charge of the design and programming of large turnkey projects.

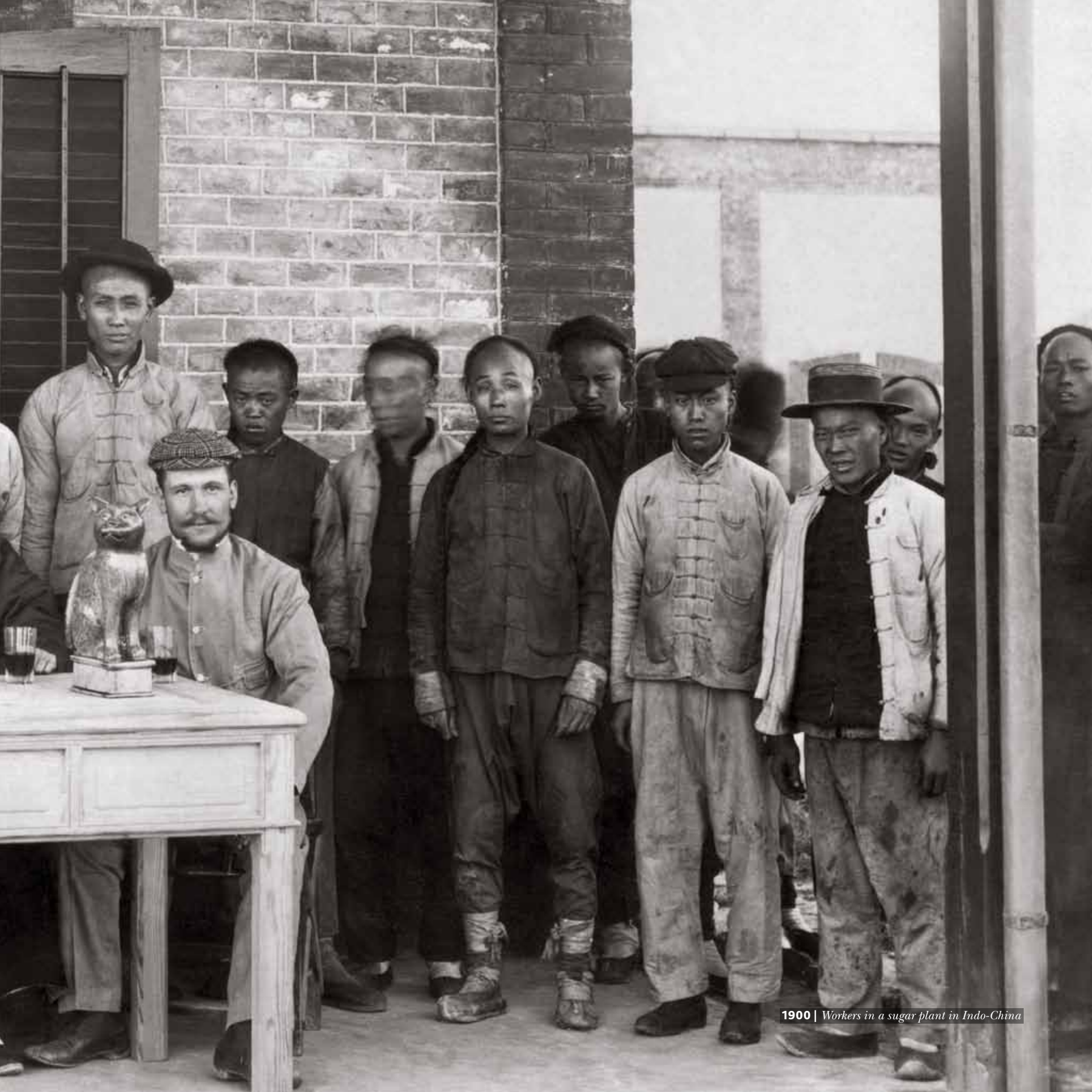
The sectoral consistency of the group was maintained and most of the companies comprising the conglomerate were in heavy engineering or related fields. The company had been organized around the concept of the business line in the mid-1980s, which greatly complemented each other. The unsuccessful run of *Nasa Électronique*, which was purchased around that time, showed clearly that it was unwise to diversify beyond the company's traditional competences. Thereafter, the group focused exclusively on its old or more recent core activities such as sugar refineries, handling, industrial piping, and equipment for the steel, cement and aluminium industries. The companies joining the group added their knowledge and skills, and were given the know-how and legal frameworks empowering them to introduce new processes. Fives-Lille also contributed its own expertise, to aid them in their development. In recent years all the fields of successful innovation have essentially concerned energy economies and pollution control. In conclusion, the group is thus not simply an accumulated mass of companies but a real industrial entity that is technically and organizationally coherent.

From 2001, the movement of salvation and equity, increased the focus on foreign markets and the efforts of research and development were directly channeled into the elements of the group. Surveys of the group's various activities and the markets it has entered show that the company has remained in the sector of heavy machinery. Fives has delivered even larger turnkey factories, in even larger numbers, principally in emerging nations such as China (steel industry), Qatar (the cement and aluminium industry), Brazil (cement industry), and the list continues. Some activities have unquestionably become world benchmarks, as were the firm's bridge construction techniques back in the 1880s. In both instances, the key advantage has been the deeply-rooted traditions that are continually updated.

It is striking that despite the broad range of sectors in which the company has interests, it has remained true to its original activities, such as sugar-processing and heavy mechanical engineering, but also to ones developed subsequently, like civil engineering, cement and steel production, and complex industrial systems. Each of these areas of expertise has

evolved over time by exploiting the benefits of the three industrial revolutions we have identified. The company's present success thus has three firm foundations: its ability to adapt traditional forms of technical know-how, an enduring company culture which has consistently strived for technical excellence and openness to international markets, and the successful transformation of a concentrated structure divided into specialized departments comprised of a structure of networked units governed by a central group. These changes reflect the transformations which have taken place in the world techno-economic system since the 1830s. But individual entrepreneurs like Jean-François Cail with whom we started out, still have a major role to play in the global dynamics of this economy.





1900 | *Workers in a sugar plant in Indo-China*

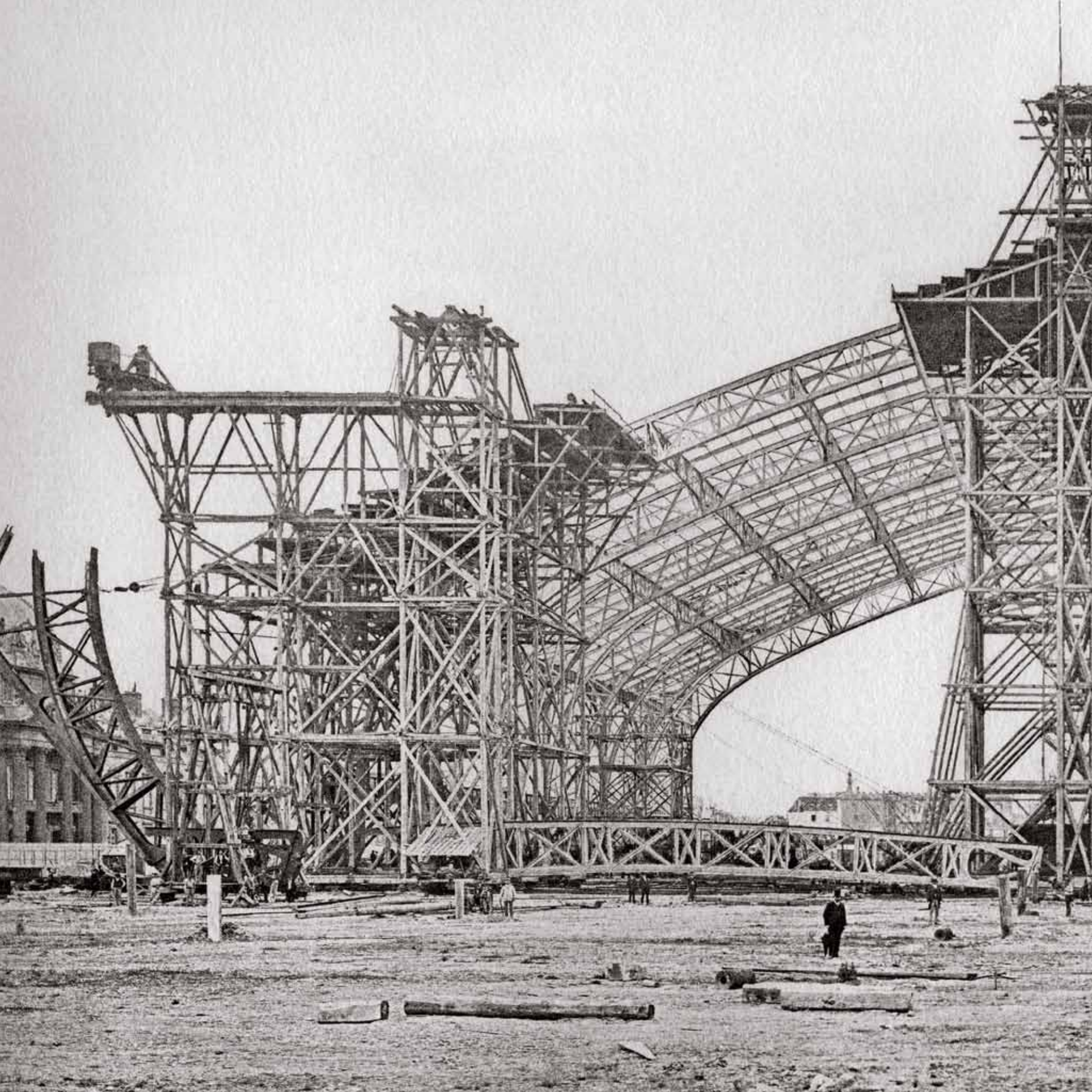
1812 | 1958 from Charles Derosne and Jean-François Cail to *Établissements Cail*

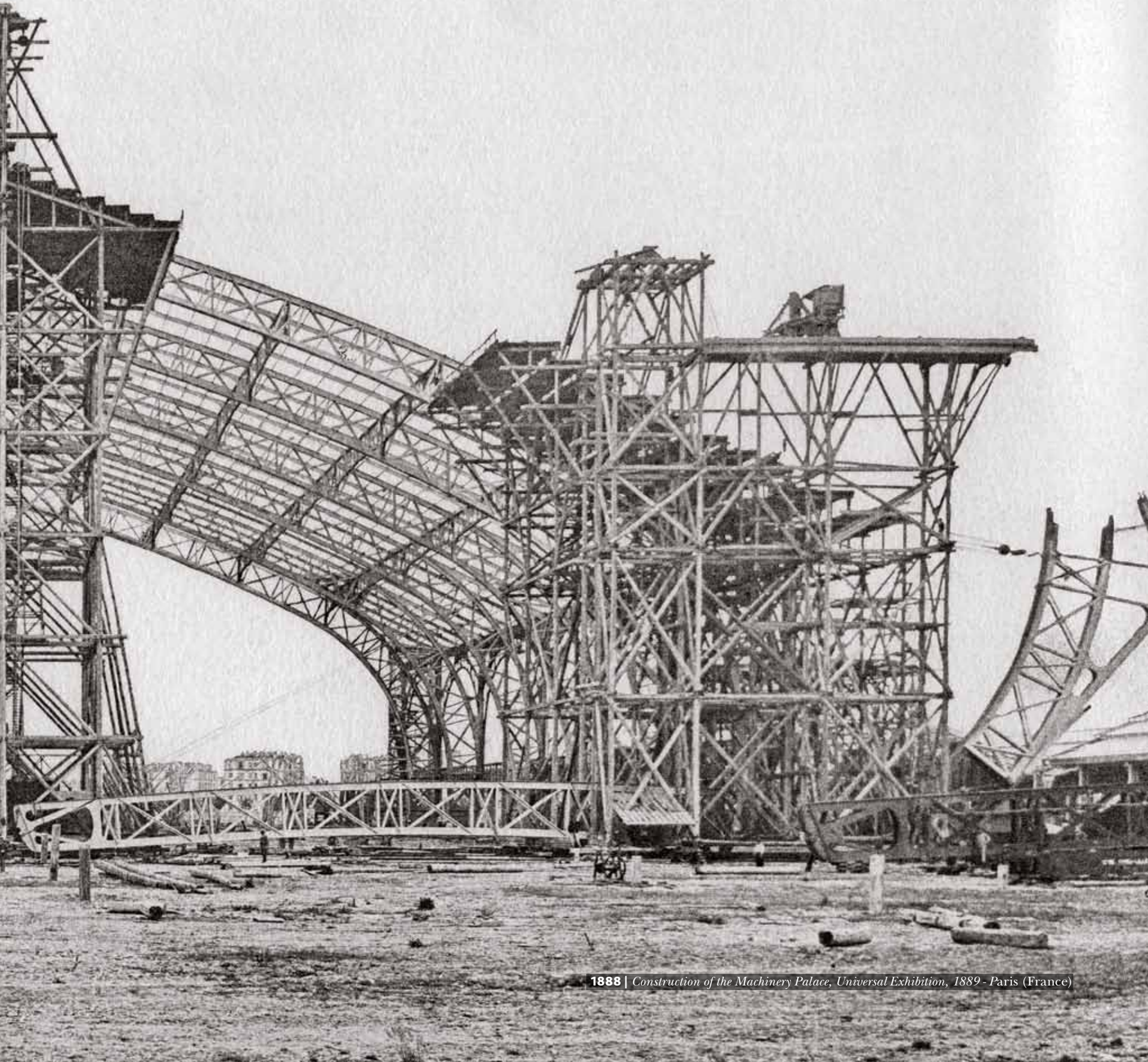
The *Établissements Cail* had a long history behind them when the merger was concluded with *Compagnie de Fives-Lille*, leading to the Fives-Lille Cail company; it was established in 1812, when the French chemist Charles Derosne set up workshops in Paris for the construction of sugar-refining material, particularly devices for the steam-operated distillation of sugar beets. Like many innovations of the time, the goal was primarily to circumvent the effects of the Continental Blockade, which since 1806, deprived France of all sugarcane from the Caribbean. Jean-François Cail, who later gave his name to the company, started work as a teenage apprentice boilermaker. Coming from a family of small farmers in the Poitou region, he was inventive and understood business. His promotion was rapid, and in 1836 he became the associate director of the company. The two men worked well together and made the company dynamic. Their equipment for the sugar industry was sold throughout the world and the Paris factory grew. Subsidiaries were established in Brussels, Valenciennes and then Douai in the north of France. The company participated in the development of Cuba, the West Indies and Réunion Island by installing large sugar factories.

This was not enough for Jean-François Cail. He quickly understood the interest of diversifying into the railway industry which was then in full growth. In 1840, the workshops began building steam locomotives and railway equipment that involved similar manufacturing techniques to those already used by the company. His strategy was very rewarding. Five years later, the *Compagnie du Nord* (railway) ordered seven locomotives. The Derosne workshops were unable to undertake the work, but this did not hold the company back. The workshops were entirely transformed and the company acquired a forge and a foundry as well as new workshops for boiler-making, machine-tooling and assembly. The orders poured in. In 1848, after building Clapeyron and then Stephenson locomotives, the company obtained the exclusive French rights to building the famous Crampton engines, the "hares of the track" invented by, and named after, an English engineer who was later nicknamed the "Train à Grande Vitesse", or TGV, of the 19th century because the cars were capable of running at 120 kilometers per hour in 1862. Two years earlier, Charles Derosne had died and Jean-François Cail found himself

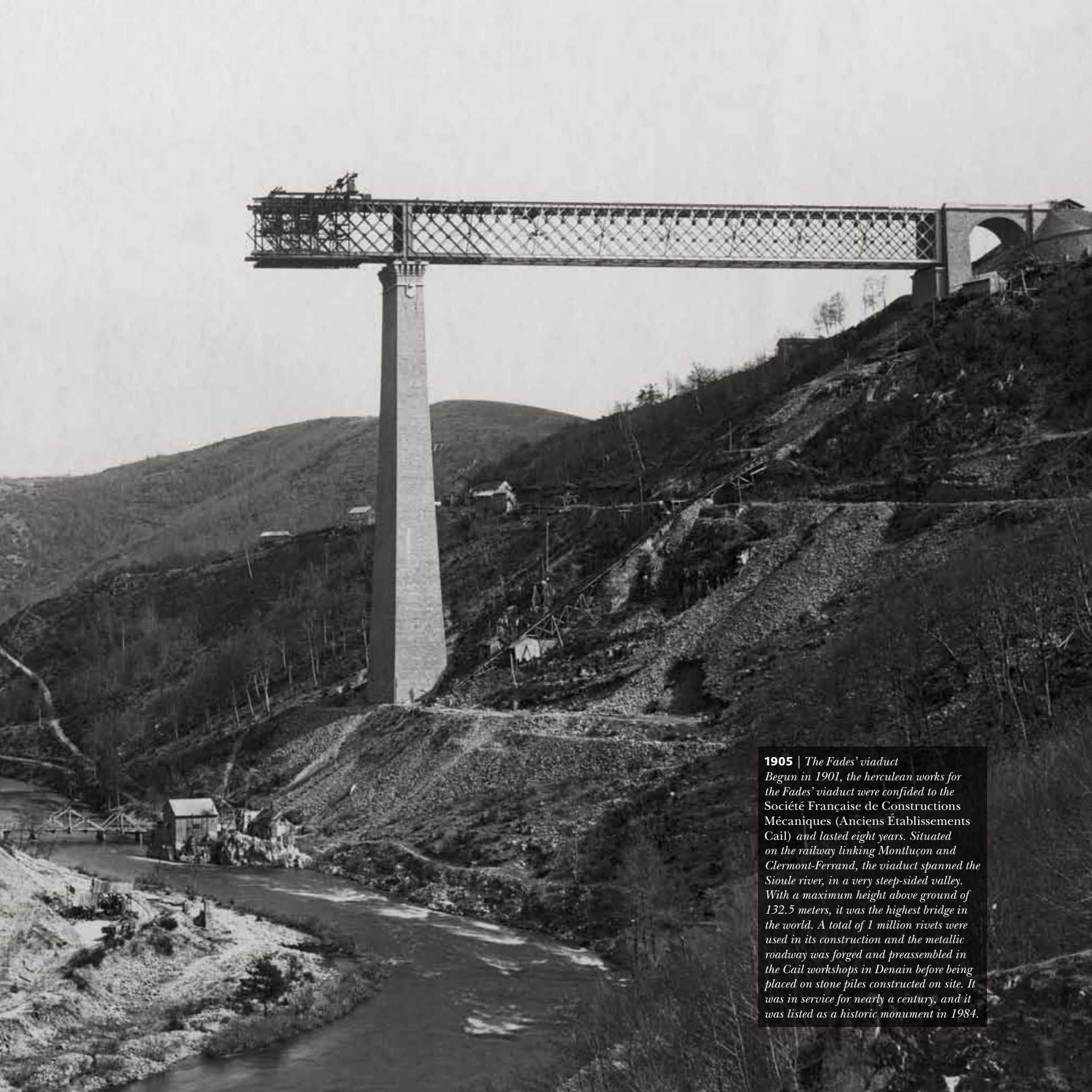
The *Ateliers Nationaux*, from February to June 1848

Set up under the provisional government of Louis Blanc, proclaimed in France following the revolution in 1848, the Ateliers Nationaux *were intended to reduce unemployment (184,000 workers in Paris were unemployed) and were organized as workers' cooperatives; at the time. Several factories were requisitioned and transformed into establishments financed by the state. Aiming to carry out infrastructure work for the railways and roads, the project attracted more than 100,000 applicants where only a few thousand had been expected. As there was also a lack of organization, the experiment was quickly terminated.*





1888 | *Construction of the Machinery Palace, Universal Exhibition, 1889 - P*aris (France)



1905 | *The Fades' viaduct*
Begun in 1901, the herculean works for the Fades' viaduct were confided to the Société Française de Constructions Mécaniques (Anciens Établissements Cail) *and lasted eight years. Situated on the railway linking Montluçon and Clermont-Ferrand, the viaduct spanned the Sioule river, in a very steep-sided valley. With a maximum height above ground of 132.5 meters, it was the highest bridge in the world. A total of 1 million rivets were used in its construction and the metallic roadway was forged and preassembled in the Cail workshops in Denain before being placed on stone piles constructed on site. It was in service for nearly a century, and it was listed as a historic monument in 1984.*

in sole command of the company which now had 2,000 employees and produced up to four locomotives a week. Derosne & Cail had become the largest French locomotive manufacturer. All was going well until just after the revolution of 1848, when the French government decided to set up production cooperatives; this halted the company's expansion. It was selected as an experimental center for these cooperatives called *Ateliers Nationaux* and production fell by half in hardly two years. Jean-François Cail was recalled in 1850 to take charge again and he gave the company his own name. The abolition (two years earlier) of slavery in the French colonies gave a boost to *J-F Cail et Cie*. By lending money to the West Indians and by taking a shareholding in several local sugar factories, it increased its own development as well as that of the islands. At the same time, encouraged by Napoléon III's interest, the railway activity took off again. New Cail factories opened in the north of France in Albert and Denain, and abroad in Brussels, Amsterdam, Moscow and Saint Petersburg. For the benefit of his employees, Cail set up a mutual aid fund that received 9% of the company's profits. The company built nurseries, schools and the theatre that later became the famous *Théâtre des Bouffes du Nord*. It also invested in property and bought housing in Paris for its employees.

The *Commune de Paris*, 1871

The Commune de Paris *arose out of a patriotic insurrection in reaction to Napoléon III's capitulation to the Germans in September 1870, after Paris had been besieged for 138 days. On the March 18, 1871, hardly two months after the truce, riots broke out in Paris and rapidly spread. The members of the provisional government fled the capital and the* Commune de Paris *was formed, a popular government based on a workers' organization. Paris was again put under siege, this time by the regular armies that were set against the insurgents. Half the population left Paris and the Commune was defeated on May 28, 1871.*

This was a prosperous period for Cail. The cooperation that began in 1861 with the *Compagnie de Fives-Lille* launched one of its most productive periods. Over the nine years of this association, the two companies together built 708 locomotives, 800 bridges and viaducts, along with many railway installations throughout France, Italy, Spain and Russia, where the line between Kiev, Balta, was a length of 600 kilometers and the metal frames for the Universal Exposition of 1867. In 1871, when the cooperation ended, the disturbances of the Commune paralyzed the Parisian factories of Jean-François Cail and he had to leave the capital. Exhausted, he died on May 22, 1871, at the age of 67, after handing the business over to his elder son, Alfred. The man had climbed the social ladder with his hard work and he left behind an industrial empire worth 28 million gold francs. His name still features among the 72 names of great men inscribed in gold letters on the pediment of the Eiffel Tower.

His son Alfred was quite different; he preferred social life to the management of the business, and so the company collapsed. It was taken over and renamed the former *Société Anonyme des Anciens Établissements Cail* in 1881, but it did not recover. In 1898, the company finally ceded all its industrial assets to the *Société Française de Constructions Mécaniques* (S.F.C.M.) which added to its own name the prestigious name of *Anciens Établissements Cail*. Meanwhile, the Parisian sites

were sold, the factories of Douai and Albert were closed down and all fabrication was concentrated on the 16 hectares in Denain. Despite these difficulties, the name of Cail remained a synonym for industrial excellence. In 1900, the company distinguished itself at the Universal Exhibition with its moving walkway which prefigured the electric walkways of today. Its rates of production remained unequalled. It was in this period that Cail built the Fades viaduct in the center of France. In 1908 alone, Cail built 125 steam locomotives; in 1912, it celebrated its centenary in great style.

The company was just starting to grow when the First World War broke out. In 1914, the Denain factory was emptied by the Germans. In total, about 50,000 tons of material disappeared. After the war, in 1918, the S.F.C.M. entirely rebuilt its factory. It then enlarged its steelworks and in 1928 its steel production rose to 7,000 tons per month. The company seemed to have finally overcome its reverses until, the great depression of the 1930s and the development of the car and of road transport, its future was again threatened. Needing to diversify, Cail launched construction of internal gas combustion engines and automobiles while still continuing its traditional activities. It weathered the great depression, but in 1939 the Second World War changed everything. A third of the workers were mobilized and the factory was taken over by the enemy for the production of special alloys for the Reichsbahn, the German national railway company. So the Denain factory was regularly bombed by the Allies and, again, everything had to be rebuilt. In 1946, Cail found the resources to participate in the construction of the rolling mills that France, lacking sheet steel, which was desperately needed. Steel production rose rapidly and it was indeed Cail that installed the first machine for continuous steel casting in France, with a capacity of 4,000 tons a month. But the health of the company remained fragile and its financial state was compromised. With a deficit of 506 million francs in 1956, Cail needed a rescuer. The merger with the *Compagnie de Fives-Lille* in 1958 came just at the right moment.

Around 1880 | *Drawing of Edmond Morin - The forge of* Établissements Derosne et Cail

1925 | *A worker in front of a storage tank of liquid ammonia for the Dourges mines (France)*

1929 | *Steel foundry (France)*

1861 | 1958 From Parent, Schaken, Caillet & Cie to the *Compagnie de Fives-Lille*

The legend of the *Compagnie de Fives-Lille* to whom Cail entrusts his future in 1958, dates back to the early 1850s. It all began with the railways and the arrival of the Belgian company Parent & Shaken in Lille, which then belonged to Pierre Schaken, a civilian security guard in Belgium, and Basile Parent, a large property owner from Normandy. The company was already distinguished in 1835, when it built the first railway in Belgium, between Brussels and Malines. This allowed them to win virtually all of the railway market in France and was able to rent space in Oullins near Lyon from the *Compagnie du Chemin de Fer*, for the construction of its steam locomotives. The orders poured in, but in 1861 the lease was not renewed and the company had to relocate its production. Basile Parent bought 10 hectares of land in Fives, an industrial district in Lille. To build their factory, that they called the *Ateliers de Construction Mécanique de Fives*, in Lille, the two men took on two associates, Jules-César Houel and Ferdinand Caillet. The first was a director of the Parisian factories of *Établissements Cail*. The second directed the workshops of Oullins. Their common objective was to build steam locomotives and railway-construction equipment on a large scale. The resulting company was named Parent, Schaken, Caillet & Cie, and its journey in Fives began.

Basile Parent and Pierre Schaken had made the right choice by establishing itself in Fives, which offered a number of advantages. The location is well connected to river transportation, which made it easy to procure coal and iron. The plant prospered and the activity was quickly in full swing. However, the backlog continued to fill and they arrived at a moment where the company was no longer able to keep up, so they approached Cail who was located 50 kilometers from Lille. It was during this period that the two companies decided to join forces for a nine year period, until 1871.

At the same time, Parent, Schaken, Caillet & Cie expanded, with new workshops in Givors, near Lyon, where they manufactured wheels and wagon axles. The company was then the largest French manufacturer of railway equipment.

In 1865, the factory, now the *Compagnie de Fives-Lille*, had grown considerably since its arrival in Lille. There were 1,500 workers, 95 forges and 500 machine-tools on the site. Its locomotives

Late 19th century | *Aerial view of the Fives-Lille establishment - Lille (France)*

< **1881** | *Porto-Alegre railway, viaduct with two tracks (1 meter gauge) on the Rio-Taguary Uruguayana line (Brazil)*

1876 | *Mariinsky sugar plant built by the Compagnie de Fives-Lille (Ukraine)*

Under the reign of Napoléon III

Charles Louis Napoléon Bonaparte (1808-1873), nephew of Napoléon Ier was the first president of the French republic elected by universal male suffrage (in 1848). In 1852, following a coup, he became Emperor Napoléon III. Under his regime, France experienced strong economic growth, with the development of the textile, chemical, steelmaking and metallurgical industries. From 1852 until 1870, the railway network increased from 3,000 to 18,000 km of track, while Baron Haussmann's redesigned Paris, transforming the city's appearance.

Undated | *Fives-Lille Railway Station (Argentina)*

could pull more than 65 tons uphill at 20 km/h and reach 45 km/h downhill with a load of 180 tons; 80 locomotives were produced every year. The reputation of the Fives factory went well beyond the north of France and it reaped the rewards. On August 27, 1867, Napoléon III, who knew Basile Parent from receiving him at the Tuileries Palace with Empress Eugénie, personally visited the Fives workshops. In the same year, the company received an award at the Universal Exhibition of Paris. Four gold medals were awarded for its mechanical preparation equipment of ore as well as its steam engines, locomotives and metal bridges. The company from Lille seemed unstoppable.

When war broke out in 1870, the two companies became involved with the battles that lie ahead by producing weaponry. The *Compagnie de Fives-Lille* produced guns and ammunition. Cail produced canons and manufactured 300 flour mills that it had built hastily to supply the besieged French capital. As expected, the cooperation between the two companies came to an end. The *Compagnie de Fives-Lille* then began producing sugar-refining equipment. Moderately beginning, this diversification quickly grew. Many clients in the sugar industry were hit by the crisis of 1876 and found it impossible to pay their bills; Fives-Lille was obliged to redeem the companies and commenced the journey of sugar in Fives. But the war severely affected orders from the French market. However the company needed to react and showed great courage for this period, exploring the international market. Long, perilous voyages were all part of the export business and winning contracts meant travelling abroad for weeks or even months. The company was not discouraged by these difficulties and soon reaped the benefits from its decision.

About ten years later, its products were exported worldwide. The company took part in constructing two bridges on the Nile in Egypt, installed its steam engines in Guyana and built sugar-refineries in Australia. It operated in Spain, Hungary, Romania and Brazil. Between 1890 and 1950 there was even a village in Argentina called Fives-Lille. The company obtained two permits for railway lines, one of which was a 650 kilometer line between San Cristobal and Tucuman. It was one of the stations built on these lines that gave rise to the eponymous village, which has now been renamed. The international expedition was not easy. Confronted with the vagaries of the climate, with epidemics and local conflict, the company had several misfortunes. In Venezuela, the Civil War of 1890 prevented the completion of its railway line. In 1899, the Boxer Rebellion uproar in China interrupted work. Company growth nevertheless remained

impressive and its international journey was a real success, becoming one of its trademarks and selling points whenever it sought new markets around the world. Meanwhile, the opportunities on the domestic market were not overlooked.

Towards the end of the 19th century, great public works began again in France, and there were many new initiatives. The art of engineering was at its peak and *Compagnie de Fives-Lille* produced some of its most prestigious works. It built the first great French work in steel, the Boieldieu Bridge in Rouen, as well as a line for the Paris Metro and was involved in the construction of the Alexander-III Bridge, which was listed as a historic monument in 1975. The company made the hydraulic elevators for the Eiffel Tower which still operate today. The *Compagnie de Fives-Lille* developed a dual hydraulic piston system, 16 meters long that is not just an elevator system or cable car, but it uses a transmitting system to move a carriage, which then actuates a set of pulleys that move the cabins. These unusual elevators operated throughout the 20th century providing just eight thrusts of the pistons, which is enough to make the cabins rise or descend the 128 meters of their travel. They ascend and descend a hundred times each day, equivalent to an annual distance of 5,000 kilometers. Shortly after the Eiffel Tower was built, Fives-Lille built alongside Moisant-Laurent-Savey, the metallic structure for the roof of the Orsay Train Station which has since been converted into a museum of the 19th century. This monumental station provided services to Orléans from 1898 until 1939 and now houses the largest collection of Impressionist works in the world. The main hall is 173 meters long and 74 meters wide, with an outsize metal-framed roof weighing 12,000 tons. The framework needed more steel than the Eiffel Tower and was the pride of the engineers and workers of the company. From 1861 to 1905, the company workshops produced more than 2,000 railway bridges, about 100 road bridges, several stations and more than 2,000 locomotives. The forerunners of the present day R&D departments, design offices and engineers of Fives-Lille worked in all the innovative fields of the period. They set up new procedures for extracting sugarcane juice, invented hydraulic equipment for lifting and handling, developed electric turbines and produced traction solutions for tramways. The *Compagnie de Fives-Lille* also innovated in the social field, improving the working conditions of its employees. In 1882, it established provident societies, informing its workers of the benefits. The company supported the school of mechanical drivers and contributed to the training of student engineers of the *Institut Industriel du Nord* (now the *École Centrale de Lille*). With the outbreak of the First World War, the company's growth

Undated | *The Eiffel Tower elevators - Paris (France)*

From 1898 to 1900 | The Orsay Train Station

Construction began in 1897, on the site of the building used by the State Council (Conseil d'Etat) until it was destroyed by fire in 1871, and the train station was for 39 years the terminus of the Paris - Orléans railway line before becoming a national Museum in 1986. Like most of the great works of this period, it was built using a very large metallic structure that required about 12,000 tons of steel. Built by Moisant-Laurent-Savey and Fives-Lille, the enormous metal framework can now be seen through the great hall of the Museum which conserves thousands of works from the second half of the 19th century.

abruptly halted. On October 9, 1914, Lille was occupied by the Germans. The factory at Fives was plundered and its equipment was sent to Germany. In a few months, the company lost 40% of its workers. Fortunately, there was still the Givors factory. It became the home base and began to produce ammunition, gun carriages and the famous Hispano-Suiza aircraft engines, the jewels of French aviation. Eight thousand workers were employed on the site.

At the end of the war, the factory in Fives was rebuilt. By 1922, the company had regained its initial production capacity in the three activities of sugar-processing, railways and public works. Immediately after the First World War, the company began to develop its own housing units for its employees who were in need. This real estate experience was a resurgence after the Second World War. In the 1950s, the company management needed to find thousands of homes and continue to launch numerous housing constructions for its workers.
In 1933, the company acquired Dalbouze et Brachet, specialists in cement equipment. The *Compagnie de Fives-Lille* thus acquired a new activity which grew strongly after 1945. The war revealed the insufficiency of French energy supplies, and the company took part in the construction of the required large oil-refineries. The 1920s was a time of a carefree mindset, a time of dreaming about a getaway and a time of travel for the wealthier classes. A vast program of railway electrification was launched in France. The *Compagnie des Chemins de Fer Paris Lyon Marseille* electrified its lines on the Riviera and ordered a prototype from Fives-Lille. In 1926, the workshops at Givors introduced the first "clean" electric power unit that could reach 110 km/h. The great days of the steam engines, which had been great days for the company, were over. But steam remained important, and not only on the railways, but it also provided considerable services to agriculture industry. Fives powered machines combine harvesters that had previously been drawn by horses and oxen. The machines were very robust and some were still in service in the 1960s.

In 1939 the Second World War broke out and it too halted the expansion of the company. On May 31, 1940, Lille was found to be in the hands of the Germans. The Fives factory was commandeered after being bombarded several months before. It was on one of the largest industrial sites in the occupied area of France and it was then sabotaged, putting it out of service for several months by the Resistance. In 1944, Allied air forces also bombed the site, which was then rebuilt. But once the war was over, the entire site was reconstructed. It rebuilt

The First World War

Considered one of the most influential events of the 20th century, the 1914-1918 war broke out following the assassination of the heir to the Austro-Hungarian throne, when Austria-Hungary declared war on the kingdom of Serbia. Each side had made alliances with countries that subsequently joined the war: Germany, Russia, France and Great Britain, followed by Japan, Italy, Portugal and the United States. Several of these nations had colonial empires spreading over several continents, so the war spread worldwide. It greatly stimulated advances in the armaments industry and resulted in 9 million deaths.

1921 | *Construction of employee housing, Fénelon street - Hellemmes (France)*

The Second World War

In the Second World War, the forces of the Axis (Germany, Italy and Japan) opposed those of the Allies (France, Great Britain, the United States, the USSR, Australia, India, New Zealand, Canada and South Africa). It lasted from 1939 until 1945 and was the greatest armed conflict that the world had ever seen, with 100 million combatants from 61 nations. More than 62 million people were killed in the war and there were several particularly appalling mass crimes involving the intended extermination of entire populations. With the end of the war came an unprecedented era of prosperity in Europe.

1941 | *Occupied Fives-Lille workshops - Lille (France).*

the factory in Lille with the help of war damages paid by the Germans and led major projects necessary to rebuild France. Orders poured in, as much for metallurgy as for cement work. In the early 1950s, however, the company was in financial difficulty despite its commercial and technical success. It built the Tancarville Bridge and the drawbridge of Brest, it produced hydroelectric installations and its boilers and electric locomotives were in demand. However, the world economy was changing with the opening of the European Common Market, competition became more intense and employee wages increased in France, which led the company to make unprecedented efforts to reconvert and modernize. In 1952, Fives-Lille delivered an order for the first locomotives from the Brazilian government; it was one of the company's key operations in the early fifties. This affair was referenced as the Brazil locomotives, which involved the construction of 90 motor units, and is still remembered by the company. They were narrow-gauge locomotives that the presented a "cattle catch" front end which referenced a deflector that was mounted at the front of the locomotives to deflect any objects on the track. A bell was also fitted to scare the cattle. Maurice Roger, a worker at Fives-Lille stated that he remembers that the "Brazilian government was so satisfied that they gave us a bonus. It was shared between everyone who had worked on the order." In 1956, the company had a net loss of 966 million francs. Once again, it considered an association with its competitor, the *Établissements Cail.* There were unsuccessful negotiations in 1904 and 1954 and the merger finally took place on June 26, 1958. The company Fives-Lille Cail was then founded. It now had the size required to succeed on the international market.

1954 | *Vertical lift-bridge - Brest (France)*

1933 | *Workers in the Fives-Lille boilermaker workshop - Lille (France)*

1921 | *Mechanical workshop - Hem (France)*

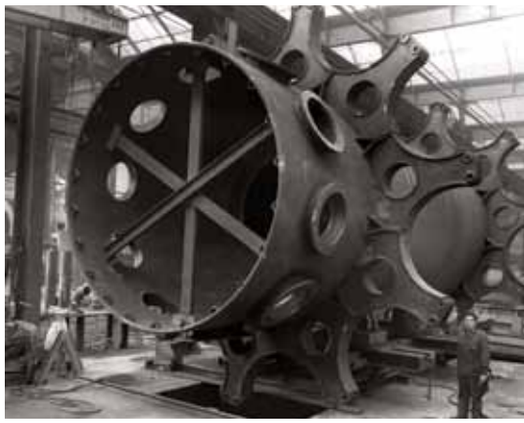
1937 | *Deburring of a mill wheel for the Ledesma sugar plant, Fives-Lille workshops - Lille (France)*

1953 | Brazil locomotives
The construction of the Brazilian locomotives was one of Fives-Lille's major projects in the early 1950s. It was the result of an order placed in 1949 by the Brazilian government, and occupied the workshops in Lille for more than three years. Before they were delivered, the locomotives were tested on a railway of the same gauge in Brittany.

1958 to the present day: from Fives-Lille Cail to Fives

1958 | 1973 Fives-Lille Cail

In January 1958, the European Common Market was introduced and a new form of European competition was developed. Fives-Lille and Cail had to optimize their strengths. Their means of research and production including their specialized factories became mutual, so as to rationalize production and reduce costs. The activities linked to sugar-refining, cement works, refineries, paper-making and conventional power stations were prioritized to the detriment of metallic and locomotive construction. The knowledge of international markets acquired in previous years and the good reputation of Fives-Lille in the cement industry saved the newly formed group: it won a contract with the USSR for the construction of the largest cement plant in the world, in Atchinsk, Siberia. Nine additional orders came in quick succession from Turkey, Iraq and Brazil, but even this was not enough. Fives-Lille Cail had to speed up its industrial conversion. The company needed money and Paribas took a stake. The governance of the company changed, with the bank naming the successive presidents of the group until the 1980s. Jacques Thibault presided over the company from 1958 until 1964, followed by Jacques Joly until 1980 and Raymond Fauvart from 1981 until 1985. In the early 1960s, with full employment in France, Fives-Lille was firing employees. It shed 1,500 of its 10,000 employees. The management closed down all the unprofitable activities, concentrating production on the four growth sectors which, at the time, were sugar-production, the cement works, iron and steel plants and ore-processing material.



1960 | *Piece of a rotary kiln for the Atchinsk cement plant in Siberia*

The restructuration had to be completed before Fives-Lille Cail could envisage extending its activities again. When the group acquired Applevage in 1963, it had already recovered. With this acquisition, Fives-Lille Cail became one of the big players in material handling. Among Applevage's achievements were the cable car of Puy de Sancy, which is still in operation today, the crane port in Nice which was classified as a historic monument in 2001 and, in Venezuela, the highest cable car in the world, which rose to an altitude 4,765 meters. In 1966, the *Maison Bréguet* and its subsidiary *Bréguet-Sautter-Harlé* were acquired by Fives-Lille Cail. This acquisition made the company the only French constructor of centrifugal sugar-dryers, allowing it

< 1959 | *Passenger cable cars, longest in the world in 1959 - Mérida (Venezuela)*

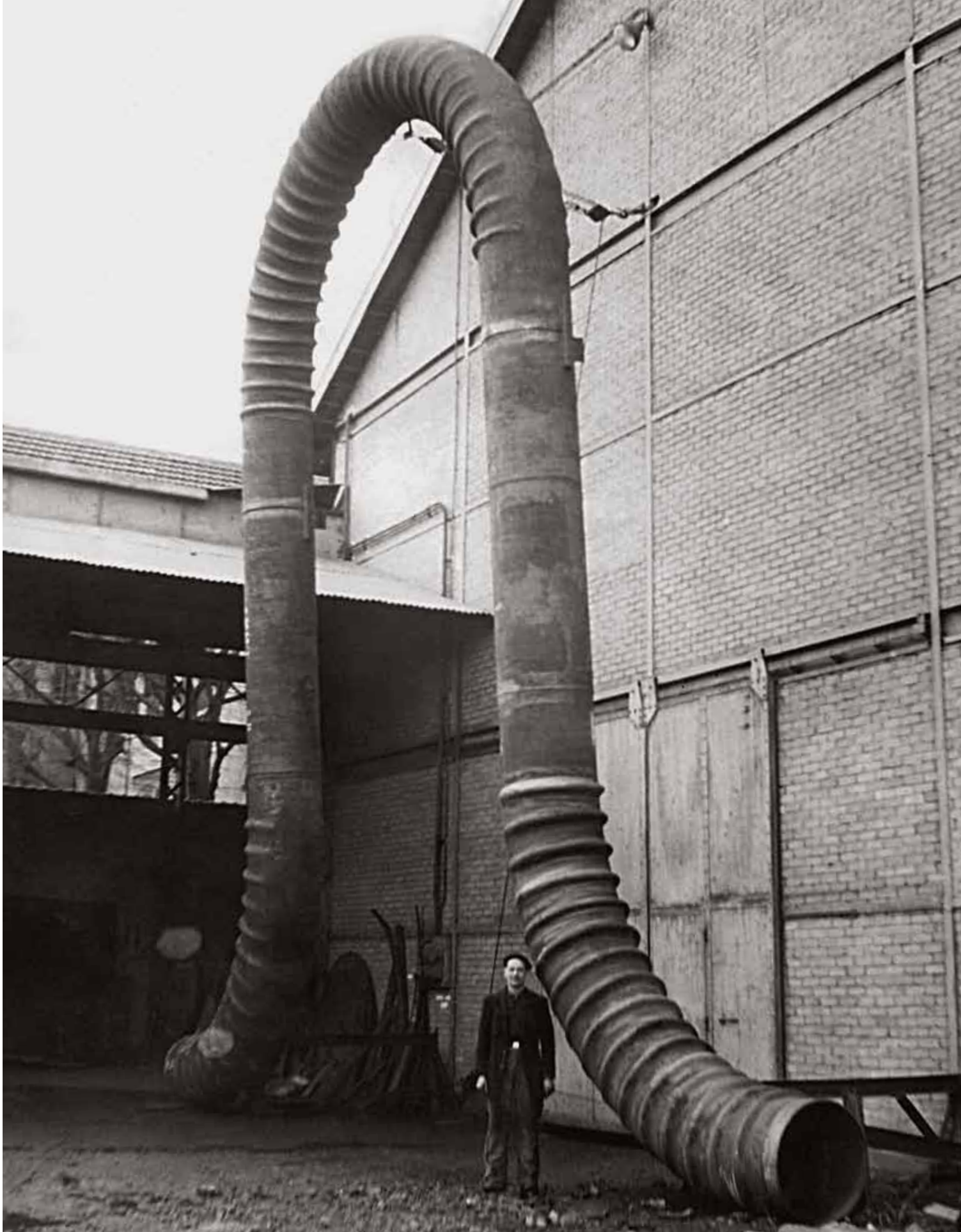
to increase its construction of steam turbines and to add industrial automation to its range of products. To move to the forefront of French heavy industrial engineering companies, all that was needed was a merger with the boiler maker Babcock-Atlantique, which took place in 1973.

1973 | 1983 Fives-Cail Babcock (FCB)

When Babcock merged with Fives-Lille Cail, it had been in existence for almost a hundred years; it was known for the quality of its boilers and gave credit for its existence to an invention of Stephen Wilcox and Georges Babcock: in 1867, the two men developed a safe water tube boiler. At a time when explosions of industrial boilers regularly caused death and injury, this was a real technological revolution. Thomas Edison, the inventor of the electric light bulb, went as far as to say that the Babcock & Wilcox was the best boiler that God had allowed man to make. Having set up the company in New-York in 1881, the two Americans worked in London and then built two factories in the Paris area. Until the end of the 1960s, their company was intensely active. They equipped the first New York Metro and more than half of the US Navy fleets. In 1945, Babcock and Wilcox were the main suppliers of EDF *Électricité De France*. In 1968, the French part of the company, along with the *Chantiers de l'Atlantique*, created the company Babcock-Atlantique, which was involved in the construction of the first nuclear power plants in France. But when the oil crises of the 1970s arrived, EDF was slow in selecting the companies that would construct its nuclear plants. The hesitation badly affected Babcock-Atlantique, its orders fell just after it had undertaken considerable investment. The merger with Fives-Lille Cail came to the rescue. On January 1, 1973, Fives-Cail Babcock (FCB) was created and became the largest French company in heavy industrial engineering. It was the beginning of a prosperous period which lasted for more than ten years. From the period 1974 to 1977, FCB took more than 240 large orders which resulted in the construction of many sugar-refineries, cement-works, rolling mills and boilers worldwide.

Until the early 1980s, FCB sought to complete its production activities by acquiring some engineering companies nearly every year. The strategy consisted of taking over smaller companies that were in difficulties and putting them back on their feet again so as to position the group as the leader in each sector of production. In 1975, the acquisition of Venot Pic reinforced its ore-processing activity. In 1977, the Ateliers Henri Lardet was acquired to

Around 1920 | *Babcock production workshop - La Courneuve (France)* >



complete the boiler production. A year later, FCB broadened its position in the food-processing market that previously had been limited to sugar, taking a majority holding in *Pierre Guérin*, a company specializing in material for the dairy and wine industries. In 1979, *Crépelle* joined FCB, bringing its skills in the production of compressors. The *Société d'Exploitation d'Usines Métallurgiques* (SEUM) (ironworks), Caillard (specialists in port services) and Babbitless (crusher manufacturers) joined the FCB group in 1980 and 1981. In 1981, the arrival of the Canadian company Syprim, which had become *Procédair* and then *Solios Environnement*, brought skills in aluminium, particularly in the continuous handling installations. At the same time, FCB became the centerpiece of a holding company which reverted back to the name of *Compagnie de Fives-Lille*. As well as FCB, the company controlled a part of *Nordon et Cie* and also Pillard, two companies established early in the century and which were among the leaders in their domains. Pillard produced burners and clean combustion systems, in France and Germany, for the minerals industries and for energy production. Established in Nancy in 1904 by Gustave Nordon, the company *Nordon et Cie* was involved in the construction of piping for nuclear power stations. When the nuclear program was stopped at the end of the 1980s, the company concentrated its skills in high pressure piping for conventional and combined cycle power plants. It diversified into dilatation compensator, aluminium boiler-making and clean piping for the ultra-pure gas that was used, particularly, in microelectronics. In 2002, *Nordon et Cie* became a 100% owned subsidiary of the Fives-Lille group, taking the name of Nordon Industries before becoming Fives Nordon in 2007.

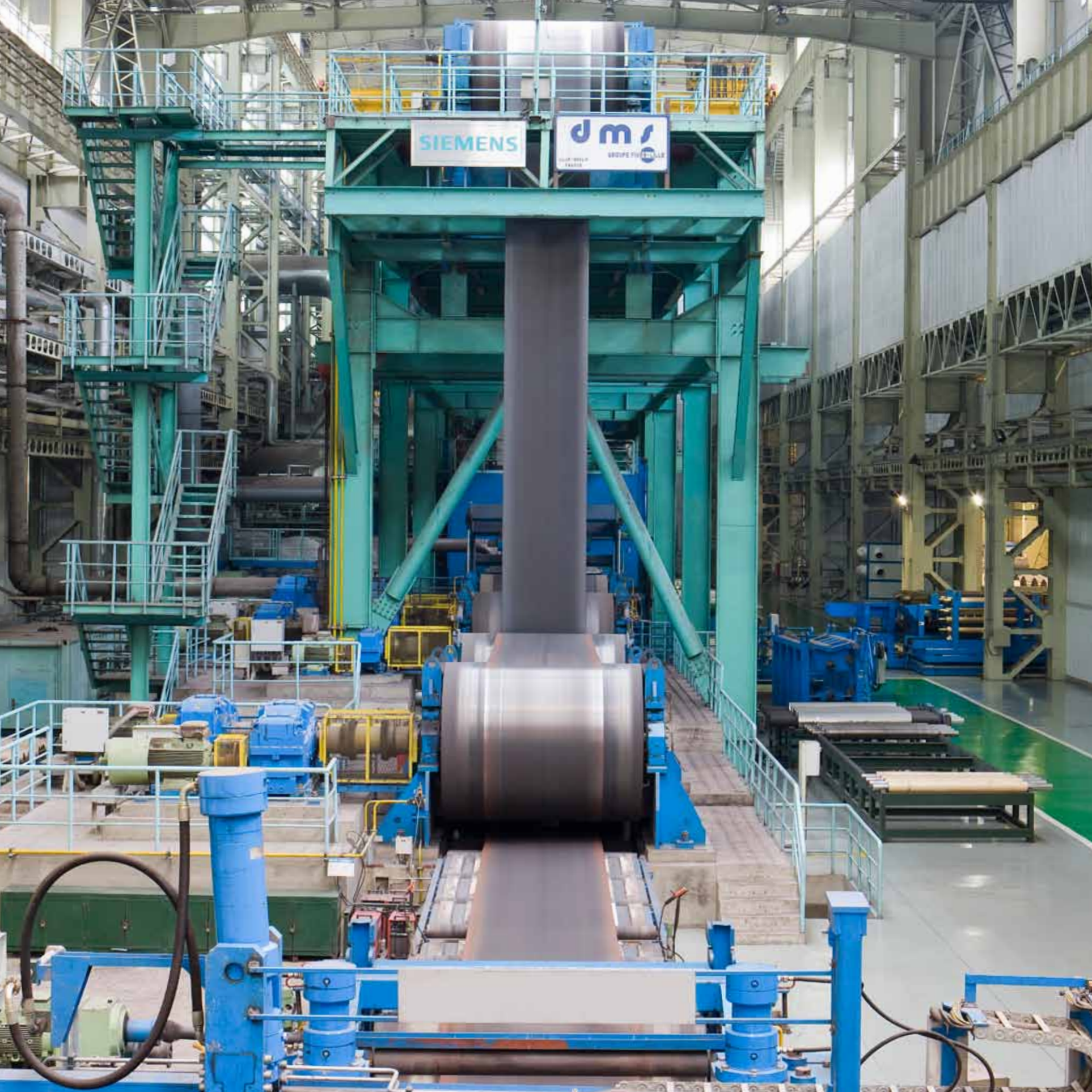
In 1983, the group was formed and a new chapter had begun.

1983 | 2001 Fives-Lille group

The 1980s were difficult years. With the oil crises of 1973 and 1979, the contracts for turnkey factories became rarer and both the domestic and export order books were empty. At this time, most of the great industrial companies around the group were failing.
In 1984, Fives-Lille decided to buy *Nasa Électronique*, a chain of shops specialized in the sale of brown goods (televisions, video recorders, hi-fi systems, etc.). Mass retailing was in full swing and shops selling domestic equipment, and owned by specialized groups, flourished throughout France. Fives-Lille saw this acquisition as an opportunity for development. So far, the group

The oil crisis of the 1970s

The demand for oil rose in the early 1970s and, with the price of extraction in the United States also rising, the Western nations decided to supply themselves cheaply from the countries in the Middle East. In 1973, however, the members of OPEC (Organization of the Petroleum Exporting Countries) limited the supply of oil to countries that supported Israel. This led to a considerable increase in the price of crude oil. Between October 1973 and January 1974, it rose from $2.32 to $9. There followed an economic crisis that ended the post-war period of strong growth in the West.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had always managed to get through crises by applying its innovations and technological skills to different industrial sectors and by entering new international markets. With the acquisition of *Nasa Électronique*, Fives-Lille embarked, for the first time, on an activity that it did not fully master. The diversification rapidly proved a very expensive failure. Fives-Lille need to restructure. Its workforce shrank from 7,200 employees in 1975 to 3,000 in 1985. The management left the magnificent headquarters of rue Montalivet in Paris, a stone's throw away from the Élysée, and found offices in Montreuil in the parisian suburbs. The Denain factory was sold in 1987 and the Babcock subsidiary in 1989.

Fortunately, there is more to the history of Fives-Lille in the 1980s than this unfortunate experience. Several acquisitions undertaken in this period were an indication of what the group would become in the 2000s. In 1984, DMS (Dujardin Montbard Somenor), until then a 100% subsidiary of the steel-tube manufacturer Vallourec, joined FCB, strengthening its steel sector, particularly in the field of rolling mills and steel-processing lines. Also in 1984, the company AIE (Air Industrie Environnement), a subsidiary of Saint-Gobain, was taken over by the group. This activity became a fundamental of the Fives aluminium offer. In 1986, *Nordon et Cie* group acquired Trane, a producer of heat exchangers in Golbey, France. Following this acquisition in 1998 was that of Cryomec, a Swiss manufacturer of cryogenic pumps, which allowed Fives-Lille to open up the market for cryogenics. In 1987, the acquisition of Stein-Heurtey, whose origins date back to 1872 and 1908, a specialist in industrial furnaces and thermal equipment, completed the acquisitions process of the 1980s. Stein-Heurtey was the result of the merger, in 1980, of Stein Surface, specialized in reheating furnaces for steel-working, and *Heurtey Fours et Thermiques*, a specialist in continuous processing lines for steel strips. They were each among the world leaders of their respective domains. In 1987, the group directed by André Launois began a real in-depth transformation, due to a persistently lifeless market. At this time of economic crisis, it was necessary to redefine the fundamentals of the group which had, in certain aspects, remained anchored in the 19th century. Fives-Lille relinquished some subsidiaries and reorganized itself around core businesses based on a small number of key techniques and increased its expertise in the core processes. The plan soon began to show a favorable outcome.

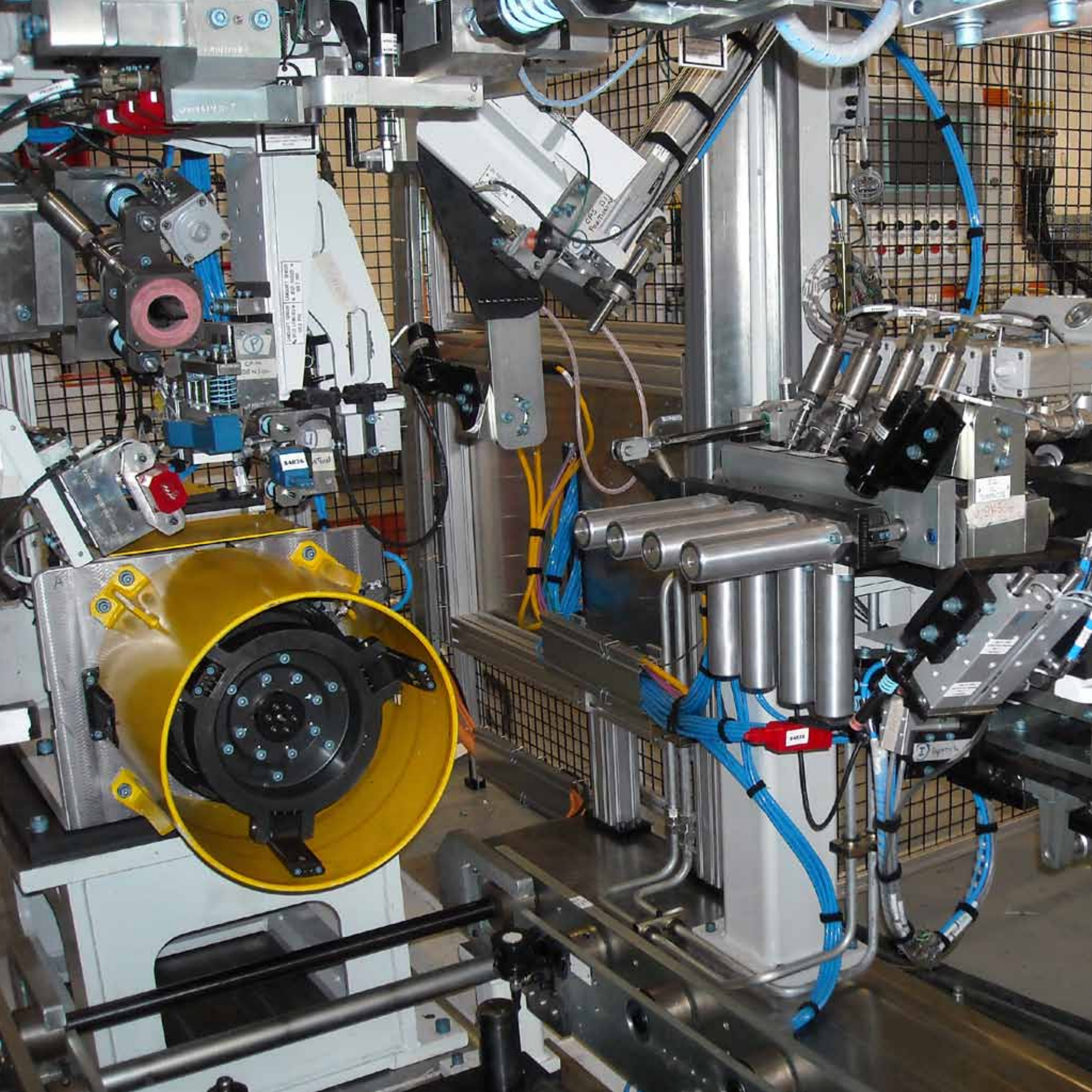
A pioneer and leader at the cutting edge of technology in the 19th century, Fives still held this reputation through the 20th century. At the end of the 1980s, Pechiney ordered a green

anode plant for its future plant located in Dunkerque, France. It was one of Pechiney's largest industrial projects and the largest aluminium smelter ever built in Europe. The group provided the installation ahead of schedule. More than 20 years later, it returned to the site to successfully supply a tilting holding furnace with a capacity of 45 tons. In 1998, Fives-Lille was contracted to construct a factory in Mozambique capable of producing 250,000 tons of aluminium per year. This order confirmed FCB's and *Procédair's* subsidiaries as market leaders. At the same time, the tunneling activities of Fives-Lille, which no longer exist today, were producing fine works. Its tunneling machines were intended for boring tunnels of all sorts and were used for the construction of the Channel Tunnel which, in December 1990 linked Great Britain and France. They were also used for the Shanghai Metro.

From its origins as a constructor and manufacturer, the group transformed itself into a design and engineering company. Despite the closure of its main and most prestigious workshops (Givors, Lille, etc.), it capitalized on its skills by maintaining workshops dedicated to machining and the assembly of key plant components. This period had a scattering of successes such as the development of an assembly workshop for the Jaguar X-type, in 1999. The story began when Cinetic, which joined Fives-Lille in 1997, was awarded the order of an assembly workshop for the Jaguar S-type that had a design reminiscent of 1950s styling. Cinetic owed this prestigious order to the installations that its German subsidiary had for years supplied to the automobile manufacturer Ford. The acquisition of Cinetic occurred during the construction of assembly lines for Jaguar. Ford, which had recently purchased Jaguar, wanted it to benefit from these technical solutions. It was the first time that Cinetic had manufactured a complete assembly workshop and the work took only two years. At the same time, Fives-Lille was seeking to increase its sales in the European and American markets. The acquisition in late 1999 of the automation activity of Ingersoll Rand in the United States later opened the door to the American market, followed by the global automotive market for Cinetic. Named Cinetic Automation, the new entity designed and installed automated assembly lines for engines and gearboxes, as well as washing systems for the parts machining processes. Earlier in 1996 Rouchaud-Gendron, a designer of machine tools also joined the group. As the 21st century approached, Fives-Lille had found a new balance thanks to its involvement in the automotive sector. The company had diversified its activities, organizing itself around each specific market and sought other forms of development, such as strengthening its international presence. In the early 21st century, the

1997 | *Jaguar assembly line (United Kingdom)*

< 1994 | *In the Fives workshops, assembly of a tunnel boring machine for the Lisbon subway - Lille (France)*



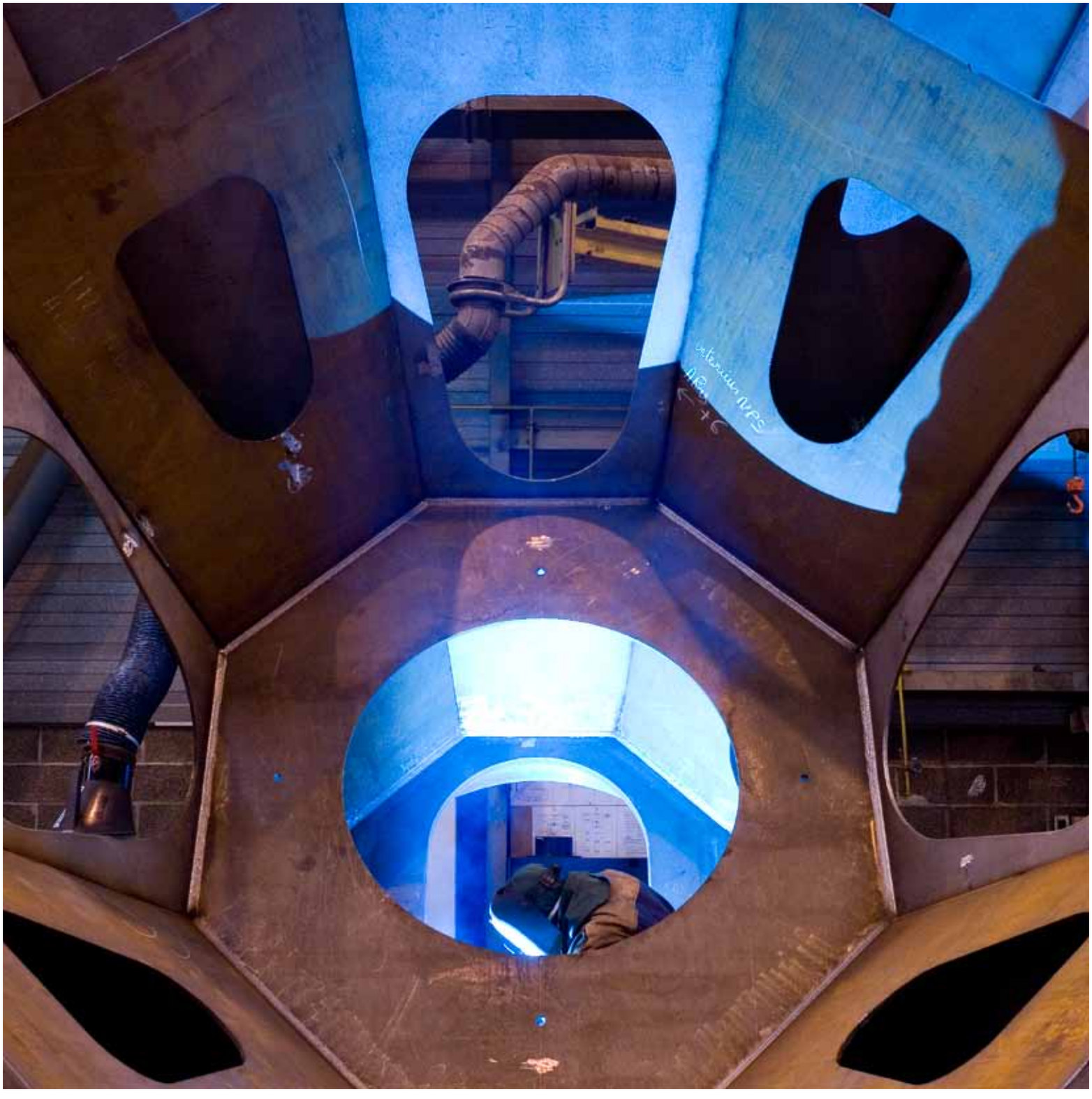
group also changed its shareholder and took new initiatives which would gradually allow it to reclaim its place as leader and forerunner that it had always occupied until 1950.

From 2001 to the present day: the metamorphosis of Fives-Lille to Fives

On February 12, 2001, Paribas, which had recently merged with *Banque Nationale de Paris* (BNP) ceded all its industrial holdings. The group entered the portfolio of a Swedish capital investment company. Finding a buyer had not been easy. In the age of Internet, heavy industry does not inspire many investors. But in the case of Fives-Lille, there were good opportunities for development, particularly in view of the emergence of new economies whose growth depended on the urbanization of emerging nations and the development of their infrastructures. Under the presidency of this new shareholder, the company accelerated its transformation by exploiting, as it always had done, its capacity for innovation and international development. The group is changed its main shareholder again on August 18, 2004. Fives-Lille continued its transformation and in May 2002, Frédéric Sanchez, the current president of Fives, took over as head of the group. He had been the general director under Jean-Pierre Capron since 1997. The new president accelerated the transformation. As a designer and installer of equipment for key processes, the group gave its clients a competitive edge in terms of productivity, energy consumption and the reduction of polluting emissions. In the meantime, Fives-Lille incorporated many companies that were leaders in their sectors and focused its activities on the aluminium, steel, glass, cement, energy, automotive and logistics sectors. The most significant acquisitions of the period were those of Landis (in 2005), the Anglo-American leader in grinding, and of a part of Sandvik Sorting Systems, in 2007. With a history of over a century, Landis strengthened Cinetic's automotive offer, while the Sandvik operation, renamed Cinetic Sorting, allowed the development of an innovative offer intended for the logistics market. The constructor of locomotives had become an industrial engineering group with subsidiaries that were among the leaders in each of their specialties. In all its sectors of activity, Fives ensured its mastery of the technologies that formed the basis of the industrial procedures. Its research and development budget increased each year. The group thus permitted its clients to improve their productivity while reducing their energy consumption and their emission of pollutants. Always present in the international scene, it strengthened its presence in many countries where it now operated as a designer and installer of solutions to sectors ranging from capital goods

< 2010 | *Engine cold test machine, including drive line - Detroit (United States)*

2008 | *Fives Cryomec - Allschwil (Switzerland)*



2008 | *Fives Industries workshop - Seclin (France)*

2006 | *Landis, worldwide leader of grinding machines, joins Fives-Lille*

to turnkey factories.

In 2007, the transformation was complete and Fives-Lille group changed its company name and visual identity. It became Fives and made its logo more dynamic with a color that was resolutely unconventional in the industrial world. It appeared as a key player in sustainable industrial development at an international level. Fives took advantage of the highly recognizable brand names of the companies that had joined the group.

At the beginning of the second decade of the 21st century, the centers of world economic development have moved to China, South America and the Gulf states, where new industrial champions are appearing. Fives involves itself in their birth and growth by taking part in the construction of the largest steel-producing installations and cement works in the world. This is the era of large and extremely large projects. In 2006, the Chinese steel giant Baosteel contracted the company to produce and install mechanical and thermal equipment for two hot-galvanizing lines for carbon steel sheets intended to serve the Chinese automotive market and two continuous annealing lines, among the quickest in the world, for the packaging market. Since that date, Baosteel has entrusted Fives achieving a total of eight galvanizing or continuous annealing lines for carbon steel and two annealing lines for silicon steel. In the same year, the Qatar National Cement Company ordered a cement production plant with a daily capacity of 5,000 tons. In 2009, Fives sold to the Chinese steel-producer Shougang Jingtang furnaces for its galvanizing and continuous annealing lines within the framework of a large project to relocate its plant in the suburbs of Beijing to a new site located on an artificial island just a few hundred kilometers east of Beijing. With a capacity of more than 1 million tons per year, these steel production lines are among the largest in the world. In 2010, Fives was involved with the construction of the largest aluminium production complex ever built in Saudi Arabia, and supplied two turnkey plants for manufacturing anodes; they each had a capacity of 40 tons per hour. The group showed itself to be one of the most efficient international industrial companies in the design and installation of equipment for the production of aluminium, steel, glass, cement and energy. It is also a recognized player in logistics and automotive markets, thanks to its automated production systems. Fives intends to retain its position. The companies that it acquires are always brands having an undisputed position as a world leader. Such is the case of North American Combustion, one of the world leaders in combustion systems and

2007 | *Steel production line - Benxi (China)* >


fives stein

2011 | *Complete cement plant for Holcim Apasco - Hermosillo (Mexico)*

high-temperature burners, which joined the group in 2009. The company (headquartered in Cleveland, Ohio) has a range of equipment that perfectly complements that of Fives Pillard in the minerals and energy production sectors. Towards the end of 2010, the acquisition of the American company Bronx International and its UK subsidiary Bronx Taylor-Wilson provided Fives with the skills of a world-leading group in the design and supply of finishing equipment and mechanical processing for pipes and tubes in steel and non-ferrous metals. Fives had thus strengthened its position in metallurgy activities.

The group has become a coherent ensemble, consisting of small businesses, each one an expert in a market segment, each with its field of excellence and each one has the support of a group. Ten years after his appointment, the president of Fives remains in position. This continuity in the management contributes to the new industrial success of Fives. Over the past ten years, the group's turnover has doubled. More than 70% of its activities are now outside Europe. The history of the company has always been shaped by the men who have directed it; almost 200 years ago, with Jean-François Cail, Basile Parent and Pierre Schaken, and then for each of the directors. It is still true today.

Thanks to the consolidation of the group's presence, the subsidiaries benefit from the support of local offices which have a very good knowledge of the local industrial setup. This new organization has not only established a synergy between the various activities of the group, but it has also strengthened the image of Fives as seen by the private and public players in the country where the group is involved. Selling a sugar factory in Thailand is not so very different from selling a cement plant. It needs the same understanding of the language, the culture and the local marketing mechanisms. In each country the offices promote Fives locally, coordinate its activities and seek new sources of growth where the skills of the company will stand out from those of its competitors.

In 2012, the group consisted of 80 enterprises in 30 countries. Fives always aims at excellence and it only acquires companies that are experts in their field. Each time an integration goes well the existing management remains in place. There is no logic in dismantling a competent team that performs well, on the pretext that the company has changed hands. Fives has always operated in this way. Already, in the 19th century, the partnership between Fives-Lille and

2007 | *Fives-Lille becomes Fives - Shanghai (China)*

Cail was built on a good understanding between the directors of each company. The group benefits from this practice which allows it to maintain, over time, its capacity for innovation as well as its position as a world reference in many fields. Its various acquisitions have allowed it to incorporate new talent. Fives gives everyone the opportunity for professional development which is all the more interesting as the group is involved in many fields and on markets where it is the world leader.

Like yesterday, employees of Fives have a strong sense of belonging to their business and are proud to work there. In Lille, the former, now retired, employees speak fondly of the Fives plant to this day. It was the pride of the neighborhood, their lives. "The time of *Saint-Éloi's* Day, steelworkers would celebrate, playing cards in the shops", said one former worker. "There was an accordion and dancing with friends. They laughed." Many young people came into learning this business at 14 years old. This training was very popular because it was known to form skilled workers and was recognized in the industry. Some starting apprentices rose through the levels, becoming supervisors or managers. Today, graduates who enter Fives know they will find great opportunities for professional development.

Undated | *Fives-Lille workshop, welding of a boiler collector - Lille (France)* >

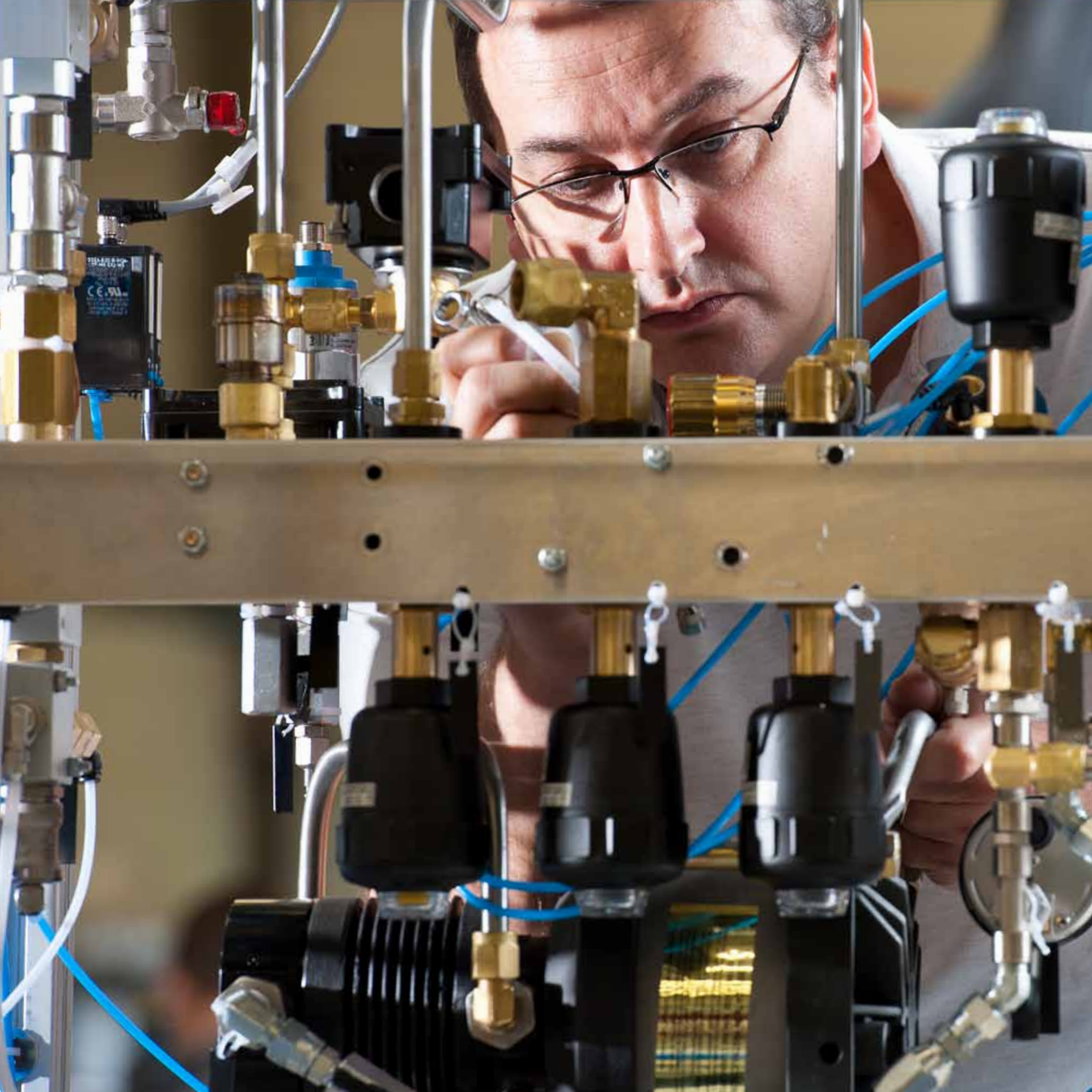
2009 | *Fume treatment center, Sohar Aluminium Smelter - (Sultanate of Oman)*

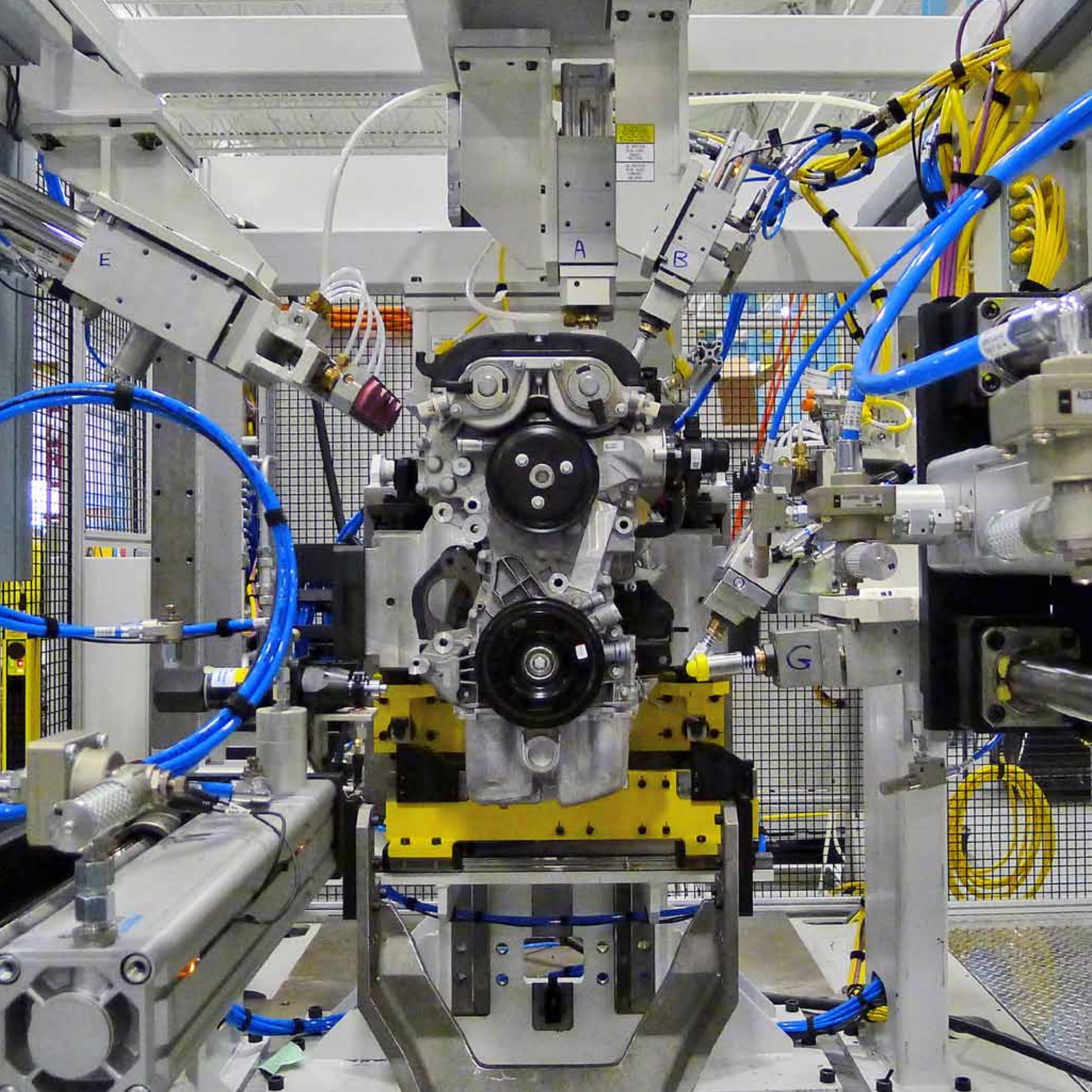
10 years of sustainable technologies and achievements throughout the world

Over the last 10 years, the adventure has continued and increased in scale. It has resulted in many achievements that have called for creativity and ingenuity, the capacity to manage large industrial projects and industrial skills; all this was supplied by the men and women who make Fives an engineering enterprise capable of performing on all the continents. Workmen, engineers, project managers, commissioning supervisors, enterprising teams in France and in the four corners of the world thanks to whom Fives successfully carries out large projects, using sustainable technologies. Today, there are over 6,000 employees, all proud to work in the group.

Pioneer in the filling of liquid CO_2

In 2003, the company Rapidcharge Frigofrance was acquired by the group; it brought with it more than 25 years of experience in the design and manufacture of machines for filling liquid gas. The acquisition in no way limited the creativity of the team in place, actually quite the reverse happened. In 2004, Fives produced a new machine for filling liquid CO_2, to replace the traditional refrigerants that damage the ozone layer. Designed originally for the automotive sector, the equipment can, under vacuum conditions, fill circuits with liquid CO_2 at a pressure of over 100 bars. As the automotive manufacturers hesitated to use this refrigerant in their vehicles, Fives sought other applications for its innovation and found them in a growth sector. In 2007, the machine was retained by Sanden, the Japanese constructor of heat pumps that were in demand as an alternative to fossil-fuel boilers. Cinetic Filling, the name taken by Cinetic Rapidcharge Filling in 2005, was in competition with Japanese companies, but the company's solution had greatly superior performance and user safety. This was achieved through Cinetic Filling's skills in the manipulation of refrigerated liquid gases under pressure. Attracting and securing new talent is not enough; one also has to keep them sustainable. This is Fives' credo and, thanks to this strategy, the company is succeeding, in the early 21st century, in many highly technical industrial markets so that the order book is full of exceptional contracts.

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Automation innovation…

In 2004, Fives Cinetic won an order from DaimlerChrysler to design, fabricate and install an assembly line for a new four cylinder world engine. The GEMA engine program included other Fives subsidiary company products, Landis grinders, ETFA gantries, Centri Spray washers, ETFA elevators, TruTight fastening tightening equipment, DyAG hoist controls systems and Cinetic servo press systems. The GEMA engine project was a Global Engine Alliance between DaimlerChrysler, Hyundai motors and Mitsubishi motors. The factory is located in Dundee Michigan and the engine production started in 2005. After the GEMA engine program was completed, Cinetic Automation continued to engineer and manufacture assembly lines for other automotive companies. Cinetic Automation has delivered equipment globally to plants in India, China, South Africa, Mexico, Russia, Japan, Korea, South America, Canada, Europe and Australia. In 2009, General Motors awarded Fives Cinetic a contract to develop an assembly line for a Family 0, new generation, low displacement four cylinder engine. The Cinetic Automation build process for the engine assembly line included forty robots to part handle, part orientate, torque, press, error proof, gage, vision inspection, and dispense. The Family 0 engine is offered in the Chevrolet Volt and Chevrolet Cruz vehicles. The engine production launch started in 2010 and the plant is located in Flint Michigan.

< 2010 | *General Motors Family 0 engine cold test station in Flint Michigan (United States)*


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Turnkey installations for PSA in Trnava, Slovakia

In 2004, PSA Peugeot Citroën selected Fives to supply turnkey assembly lines for its factory in Trnava, Slovakia. The group was selected because of its knowledge in the automotive sector and also its ability to manage large projects around the world. Thanks to the work undertaken in synergy by the Cinetic subsidiaries in the automotive sector and Nordon Industries, the project was a great success. Cinetic Assembly supported the section of the assembly line after the vehicles pass through the paint booths. Cinetic Automation handled the automation system for body fitting, while Cinetic Filling carried out the leak testing and fluid filling. As a supplier of the American company Haden Drysys, Fives Nordon (formally Nordon Industries) delivered the circulating tubes for the paint shop. To find the local sub-contractors that they needed, all the subsidiaries relied on the Cinetic Industries purchasing team. The project lasted 15 months and Cinetic managed up to 400 people on site, nearly all of them employees of local sub-contractors. By strengthening the relations between its subsidiaries, the Trnava project led to Fives winning similar orders in Russia, Romania, Morocco and Brazil.

Continuing confidence of the Chinese steel manufacturer Baosteel

Fives makes every effort to successfully establish a partnering relationship with the major players in the various markets on which it is positioned. This was the case in 2005; after several years of exchanges with Baosteel, Fives landed its first contract with the company that was then the largest Chinese steel producer. The order was for furnaces and strip processing lines that were to be supplied and installed in a fifth cold rolling plant that was under construction in a Shanghai steel plant. Since then, the Chinese company has commissioned Fives to produce its eight continuous annealing and galvanizing lines for steel coils. This was proof of Baosteel's confidence, a company producing one of the best steels in the world for the automotive market and which only dealt with suppliers having innovative technologies and a proven track record. Fives conformed to these requirements with the excellence of its proprietary solutions and by its good performance on earlier Chinese orders. The Digit@l Furnace® reheating furnace and the Flash Cooling® rapid cooling technology from Fives Stein are unique, while Fives DMS had over a century of expertise in the segment of rolling mills and steel-strip processing lines.

Having arrived in the steel Chinese market in the 1980s, Fives had already sold several furnaces and processing lines in China. The first significant order was placed by Baosteel in 1985 for a slab reheating furnace for their steel plant in Shanghai. The relationship between the two companies was established through a long-term partnership based on mutual trust between the two groups and collaboration between teams.

2007 | *Steel production line - Yichang (China)*

Cold boxes at the heart of Hamworthy Gas Systems' gas tankers

By acquiring Nordon, the piping specialist, Fives provided itself with the best skills in brazed aluminium plate heat exchangers. The acquisition led to large contracts won for equipping the gas tankers of the Norwegian company Hamworthy Gas Systems several years later. The skills were those of the workforce in a factory in Golbey, near Épinal in France that Nordon has acquired in 1986 from Trane, a manufacturer of heat exchangers. In 1998, it was Cryomec's turn to enter the group, becoming a subsidiary of *Nordon Cryogénie* and bringing its expertise in the design and manufacturing of cryogenic pumps. It was thanks to this expertise that, in 2005, Fives won an order for the first cold boxes to equip the gas tankers of Hamworthy Gas Systems. The boxes are an essential element for the on-board re-liquefaction of the part of LNG (Liquid Natural Gas) that naturally evaporates from the liquid while being shipped to the consuming countries. They contain the brazed aluminium plate heat exchangers, the pumps, piping and the instrumentation necessary for re-liquefying the gas. It is all contained in an airtight box that is 5 meters long, 3.5 meters wide and 6 meters high and its refrigerating cycle maintains a temperature of -160°C. Today, the 31 tankers used for exporting LNG from Qatar are equipped with these exchangers. Since only about 50 gas tankers in the world are equipped with re-liquefaction units, Fives Cryogenie covers 70% of the market. The 300 other ships used do not recuperate the LNG, so it boils off every day from their cargo. In this time of regularly rising fossil fuel prices, the cold boxes of Fives, that prevent these losses, lead to a promising future.

< 2008 | *Welding on a cold box - Golbey (France)*

2006 | *Transport of a preassembled module for an aluminium smelter - Fjardaal (Iceland)*

An ingenious use of modular construction for the Fjardall aluminium smelter

Fives knows how to innovate and provide clients with sophisticated technologies that have long-term reliability; it can also be innovative and find unusual or custom solutions when necessary. In 2005, when building an aluminium plant on a fjord in Fjardaal, Iceland, the constructor Alcoa contracted Fives Solios to build a processing workshop for a bath processing unit, two gas treatment centers and four holding furnaces for the foundry. The extreme climatic conditions that prevail on the fjord subjected to rain, wind, snow and storms, made on-site construction very problematic. So, Fives reduced the on-site construction time by making prefabricated modules that were then assembled on site. The modules, some weighing more than 100 tons, were mainly manufactured in Portugal and France and were transported by sea to Iceland. This prefabrication not only reduced costs and time, it also improved the quality of the work. From an estimated six months, the on-site assembly time for the filter for the gas treatment center was reduced to two and a half months. Thanks to its ingenuity, Fives Solios satisfied its client by the speed of the operation and the quality of the work. It had already done the same for the Alouette Aluminerie in an isolated part of northern Canada. While still working in Fjardaal, Fives Solios began the prefabrication of modules for the construction of the Ma'aden Aluminium smelter in Saudi Arabia.

2007 | *Aluminium smelter on the fjord - Fjardaal (Iceland)*

2008 | *Grinding machine for a ship engine crankshaft (Germany)*

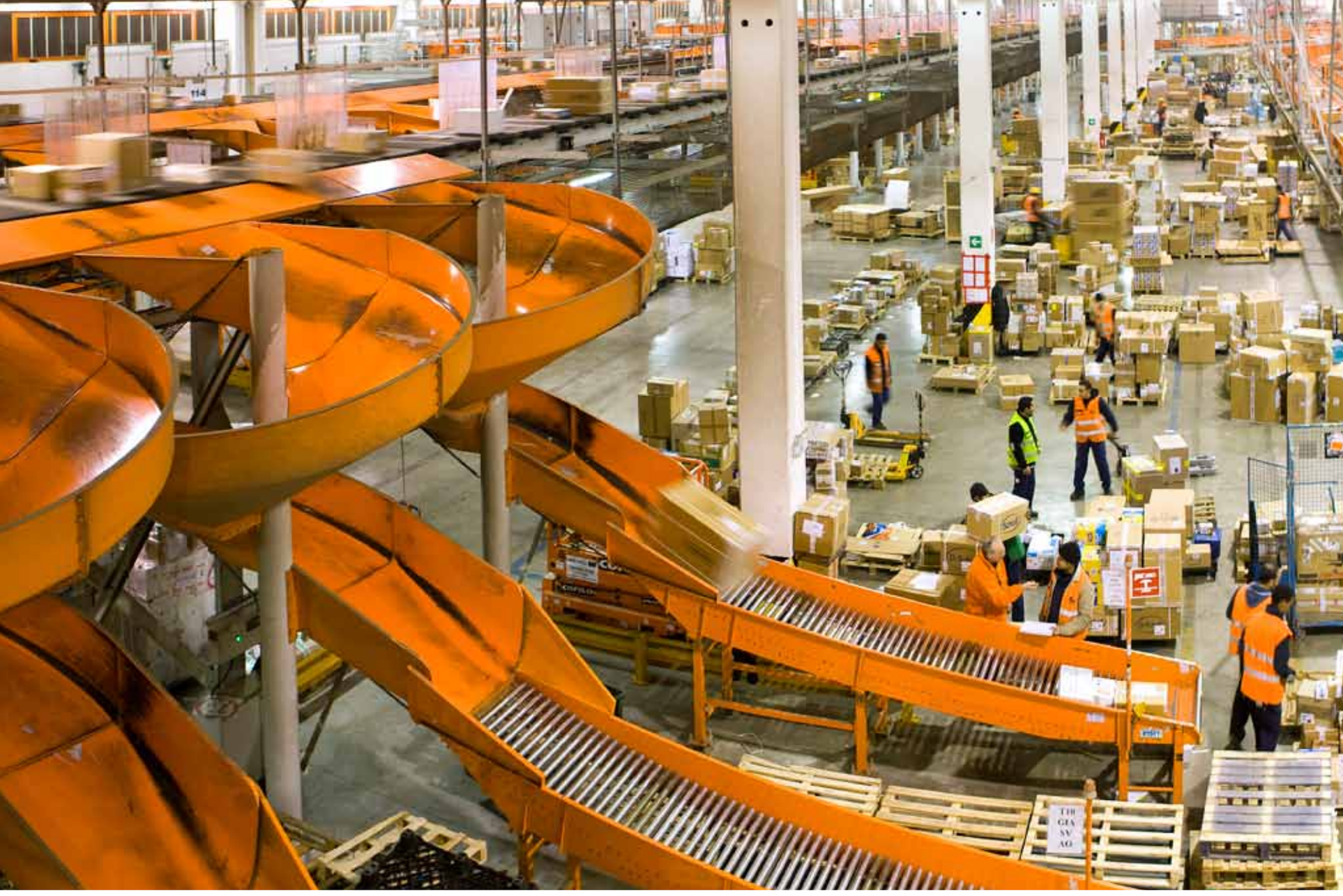
World leader in grinding machine manufacturing

In December 2005, Fives acquired Landis, a designer and manufacturer of grinding machines primarily focused for internal combustion power train components such as camshafts and crankshafts, with engineering and manufacturing facilities located in the United States and Great Britain. The company was established in the late 19th century and in 1899 the first recognized name of an automobile manufacturer showed up in the company shipping records. Business increased during these early days of the automotive industry. More and more parts were being processed by grinding - such as pistons and valves in addition to camshafts and crankshafts. The required accuracy for parts in a “high-speed” engine could only be achieved by grinding. Landis was the first to place CNC “orbital” grinding machines on the market in the early 1980s. It was this technology and manufacturing excellence that Fives acquired in 2005 and the group continues to grow and maintain leadership position as new innovations in grinding are continuously developed. Today, in addition to grinding automotive and truck crankshafts, Cinetic Landis grinding machines are capable of grinding to less than 5 micron geometrical tolerances, crankshafts that measure from 4.5 to 12 meters long that are used in industrial power generation, in the diesel engines of ships and railway locomotives. Since the first order, delivered in 2009 to the German manufacturer Alfing, Fives has sold ten machines, of which six were sold to Germany, three to China and one to Korea. The group had built an innovative company and has a creative dynamic which gives it a leading edge over its competitors. Once again, Fives had taken advantage of cutting-edge technological know-how to open new markets and grow as a world leader. As automotive engines become smaller and more energy efficient due to the need to economize, they develop increased power. This advancement can only be achieved through the increased precision of the grinding process. The Cinetic Landis machines are both increasingly precise and highly productive, and today grind 100 pieces per hour, as opposed to 60 pieces per hour a few years ago. As a designer and supplier of grinding machines to the global automotive and truck power train market, the group is a world leader, with 40% of the global market share. By acquiring Landis, Fives strengthened its position in the machine-tools sector and the partnership gave rise to continued innovation and the development of new niche markets.

2009 | *Cement plant - Umm Bab (Qatar)*

Production of 3 of the 4 lines of the Umm Bab cement plant in Qatar

As international industrial competition increased, Fives technology and know-how in project management allowed it to successfully establish relationships with world leaders that secured major contracts over competitors. For example, one major contract included the QNCC (Qatar National Cement Company) contract signed in 2006; it was the third between the two companies. That year, the Qataris reaffirmed their confidence in the group by ordering a turnkey cement production line, their fourth line for its cement plant at Umm Bab, on the west coast of the Qatar peninsula. The line was put into service in 2008, and processes 5,000 tons of clinker per day. This order marked more than 15 years of teamwork. The first contract was signed in 1995, for a line with a capacity of 2,000 tons per day which was added to an existing line. The second contract was signed in 2004, and focused on the supply of a third turnkey production line, with a capacity of 4,000 tons a day. Each time, production commenced on time or ahead of schedule. The Umm Bab cement plant produced 15,000 tons of cement per day and 5 million tons per year. It is one of the largest and most modern cement plants in the Gulf region. By supplying three of its four production lines, Fives FCB has marked this plant with its footprint.



The SBIR cross belt sorter at the forefront of automated parcel sortation

With the acquisition of Cinetic in the late 1990s, Fives entered the material handling sector. In 2007 the purchase of the automated sorting specialists, Sandvik Sorting Systems, allowed the group to considerably increase its offer in this domain. Sandvik Sorting Systems was composed of several companies in Italy, the United States and Japan; it became part of Fives Cinetic and took the name of Cinetic Sorting. With this acquisition, Fives positioned itself in the postal, express courier and distribution sectors, as well as baggage handling in airports. It became the leader in high throughput and high performance sorting solutions. The acquisition also offers opportunities for synergies with Cinetic Transitique, another subsidiary of the group that is very active in the field of logistics. At the time of the acquisition, Fives also acquired the SBIR cross belt technology that, since its invention in 1982, was reserved for high-end, high-speed

2009 | *Automated parcel sorting center (Italy)*

automated sorting. With this sorter, each item is placed on a transverse conveyor belt mounted on the main conveyor. When it arrives at its destination, it is gently ejected by the belt which moves perpendicular to the movement of the main conveyor. All the large worldwide postal operators and express couriers have equipped their sorting centers with the cross belt sortation system. To date, there are more than 1,000 automated SBIR cross belt sorting applications in operation throughout the world, and the number continues to rise.

2008 | *Aluminium smelter (Qatar)*

Nearly 15 million hours worked on site for the Qatalum project

Fives owes its success not only to the excellence of its proprietary technologies, but also to its ability to carry out large-scale projects, even when access is difficult. The largest project ever built at one time was the construction of the Qatalum aluminium smelter in Qatar. With the production capacity of 585,000 tons of aluminium per year, this project brought Solios Carbone, Solios Environment and Solios Thermal together to supply a turnkey green anode plant with a capacity of 60 tons per hour, the most important in the world, four gas treatment centers, a fume treatment center, several foundry equipment, a firing equipment and process control system for the anode baking furnaces and a liquid pitch marine terminal. Fives Solios incorporated many innovations such as the use of a water scrubber to enhance the treatment of electrolysis fumes. The Fives teams were responsible for all stages of these projects, from the initial planning through the purchasing, manufacturing and installation, right up to the commissioning, with the responsibility of choosing and managing the subcontractors. Fives' involvement started at the end of 2007, and lasted until the end of 2010; it mobilized a maximum of over 2,500 personnel, mostly teams of subcontractors. In all, twenty nationalities were represented; people from different cultures that were managed to work together in conditions that were often difficult, such as sand storms and temperatures that occasionally exceeded 50°C. Once again, Fives Solios succeeded, putting into operation the installations within the required timeframes.

Partner of choice for the French nuclear industry

In 2007, France re-launched its nuclear program and began the construction of a European Pressurized Reactor (EPR) in Flamanville. Nordon, which had supplied the power stations in France since the beginning of civil nuclear power in the early 70s, had a resurgence of growth as Fives Nordon. From 1975 to 1990, the company built the steam-water piping for the machine room and some nuclear auxiliaries. Already the leader in the supply of piping for the secondary circuit, Nordon began work, in 2000, on the primary circuit of the French power-station in Fessenheim for a maintenance operation. Since the construction of EPR (Olkiluoto 3, Flamanville 3 and Taishan 1 & 2), the company is also involved in the supply in the primary circuit. Since entering the Chinese market in 2005, and with its expertise in French nuclear power, the group received all the procurement orders and prefabrication expansion lines for pressurizers in the 600 and 1,000 megawatt power-stations in China. In France, the company was heavily involved in the maintenance of the 19 nuclear power stations with a total of 58 reactors. Fives Nordon remains one of their referral partners.

2008 | *Fives Nordon workshop - Nancy (France)*

The Mexican cement plant of Hermosillo - the best in sustainable development

In 2008, Holcim entrusted Fives FCB for the engineering and supply of a complete cement plant with a capacity of 3,500 tons per day in Hermosillo, Mexico. This plant features of the latest technologies developed by Fives FCB, such as the Horomill® grinder, the Zero-NOX precalciner, and the TSV™ separator. The Hermosillo cement plant is one of the most modern and most environmentally-friendly in the world. Commissioned in late 2010, it produces high quality cement while minimizing the consumption of electricity, fuel, water, and CO_2 and NOx emissions. The contract was a result of a collaboration dating back to 2002 between Fives FCB and Holcim. The cement company had then ordered the supply of a complete production line with a capacity of 3,000 tons per day for its factory in Cartago, Costa Rica. Another order followed at the end of 2007 for the construction of a cement plant in the Mexican desert. At the end of 2011, the two "partners" signed another contract for a production line, adjacent to the existing line at the cement plant in Barroso, Brazil, that would provide a 50% increase in production. For all these installations, Holcim went beyond the objectives of the Kyoto protocol regarding reductions in CO_2 emissions, thanks notably to the technology supplied by Fives FCB.

2011 | *Cement plant - Hermosillo (Mexico)*

Xelios, a new-generation anodes vibrocompactor

Fives makes every effort to minimize its environmental footprint; the history of the Xelios machine is a perfect example. On November 18, 2008, in the French factory of Rio Tinto Alcan in Saint-Jean-de-Maurienne, the first carbon anode was produced using the Xelios vibrocompactor; the technology involved would revolutionize aluminium production. It is through this new generation of vibrocompactors that, three years later, the two production lines at the Qatalum aluminium plant in Qatar produce anodes at a rate of 60 tons per hour. This was a great step forward, as the capacity of most installations at the time did not exceed 35 tons per hour. After Fives Solios analyzed the value of the first anode production machine designed by FCB in the 1960s, the Xelios not only provided better productivity, it also increased energy efficiency of the carbon anodes required for the manufacturing of aluminium by electrolysis. Ultimately, this helps to produce, more metal using the same amount of anodes, and therefore reducing CO_2 emissions per ton of aluminium produced. At the time of Fives'200th anniversary, the Xelios has a promising future. Since delivery of the three operational machines in Saint-Jean-de-Maurienne and Qatar, many more have followed. Solios Carbone has just installed four machines, in two factories built by the Indian company Hindalco Industries in Mahan and Aditya located in central India. In Saudi Arabia, Solios Carbone is commissioning four more for the two production lines orderer by Ma'aden Aluminium. Rio Tinto Aluminium has ordered two for its Kitimat smelter in British Columbia. The Xelios machines have even arrived in China. There will be two in the new Chalco smelter in Liancheng and two more in the planned plant of Shaanxi Nonferrous Metals Holding group. In total, 17 Xelios machines should be operational by the end of 2013.


fives solios
MADE IN FRANCE

Taking the lead with the Novaflam® cement burner

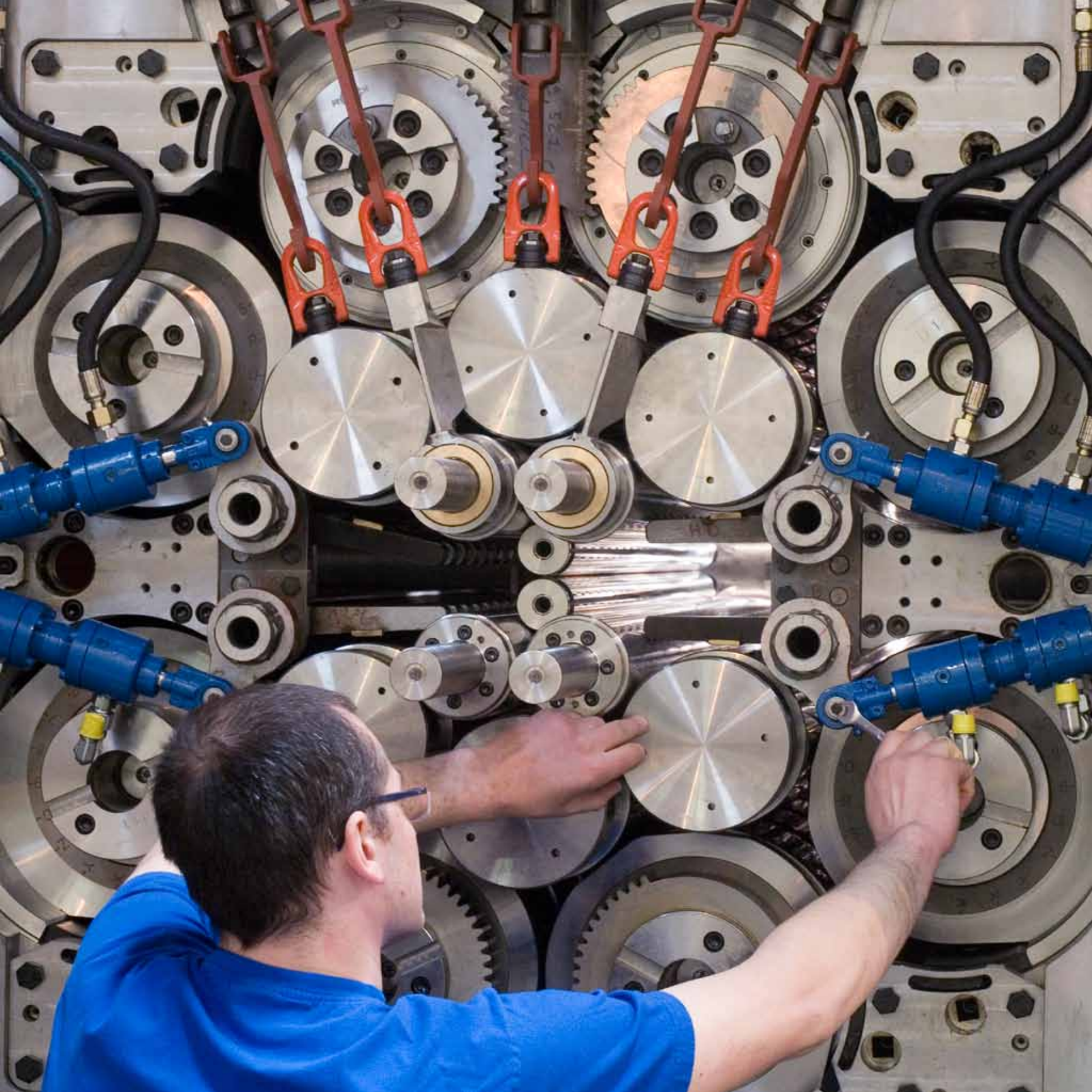
To innovate, is to take a lead over competitors. The Novaflam® burner, developed by the Fives Pillard team, is an illustration of innovation. Fives Pillard was recognized for decades as a pioneer in the cement industry for its clean combustion equipment and rich past. The company was founded in France in 1920 and was taken over by *Compagnie de Fives-Lille* in 1969. Fives Pillard itself was the world leader in rotary kiln furnaces for the cement and mineral industries. The Rotaflam®, which was launched in 1990 was improved over the years until, in 2009, it was completely redesigned, leading to the design of a new burner, now known as the Novaflam®, which features simplified settings and highly improved energy efficiency. Regardless of the quality of the fuel used in the furnace, the flames produced are in the correct form and length required for the production of high-quality cement. This is an inestimable advantage, as cement producers now use increasing amounts of alternative fuels that have a lower energy output than fossil fuels. The Novaflam® also drastically reduces emissions of pollutants, including CO_2. In the 20 years of existence, the Rotaflam® has sold over a thousand burners. Since the release of the Novaflam® in 2009, cement-producers have installed nearly 240 units per year worldwide. This represents between 20% and 25% of the market, more than half of which are in China.

2008| *Commissioning of a burner (China)* >

Exemplary expertise in the fabrication of the Sendzimir rolling mills

Although Fives has become an engineering group, it continues to maintain, in-house expertise of core processes for the construction of key equipment. The Sendzimir cold rolling mill, designed by Fives DMS, is still manufactured under license in Lille, in the Fives Industries workshop. In 2010, the Chinese steel manufacturer Tisco ordered a Sendzimir for the production of thin stainless steel strips with a polished finish. This equipment has made new records; it produces up to 133,000 tons of steel per year at a maximum rolling speed of 1,200 meters per minute. These performances are the result of a long-term process conducted since the late 1950s in Lille, first in the *Anciens Établissements Cail* from Denain, then in the Fives DMS factory, that later became Fives Industries. Since the group began manufacturing these rolling mills that were invented in 1931 by Tadeusz Sendzimir, an American Citizen of Polish origin, the French teams have continually improved their design and manufacturing. This led Fives to become a world leader in supplying Sendzimir mills. Steel strips with a thickness between 6 to 8 mm pass through 20 compression cylinders, reducing it to several tenths of a millimeter thick to micrometers. The machining of the equipment's center for the Sendzimir machines, which weigh more than 100 tons, is achieved by using tooling manufactured by Fives Industries in a closed environment maintained at a temperature between plus or minus 2°C. The total operation takes approximately a month to complete, considering the time of tooling assembly, machining and dismantling. The same care process is applied for the machining of the cylinders and their assembly inside of the machine. To date, Fives has delivered more than 50 Sendzimir rolling mills of all sizes around the world, through to the expertise that continually enriches over the years.

2008 | *Sendzimir rolling mill, Fives Industries - Seclin (France)* >



L'Horomill®, the most energy-efficient cement crusher on the market

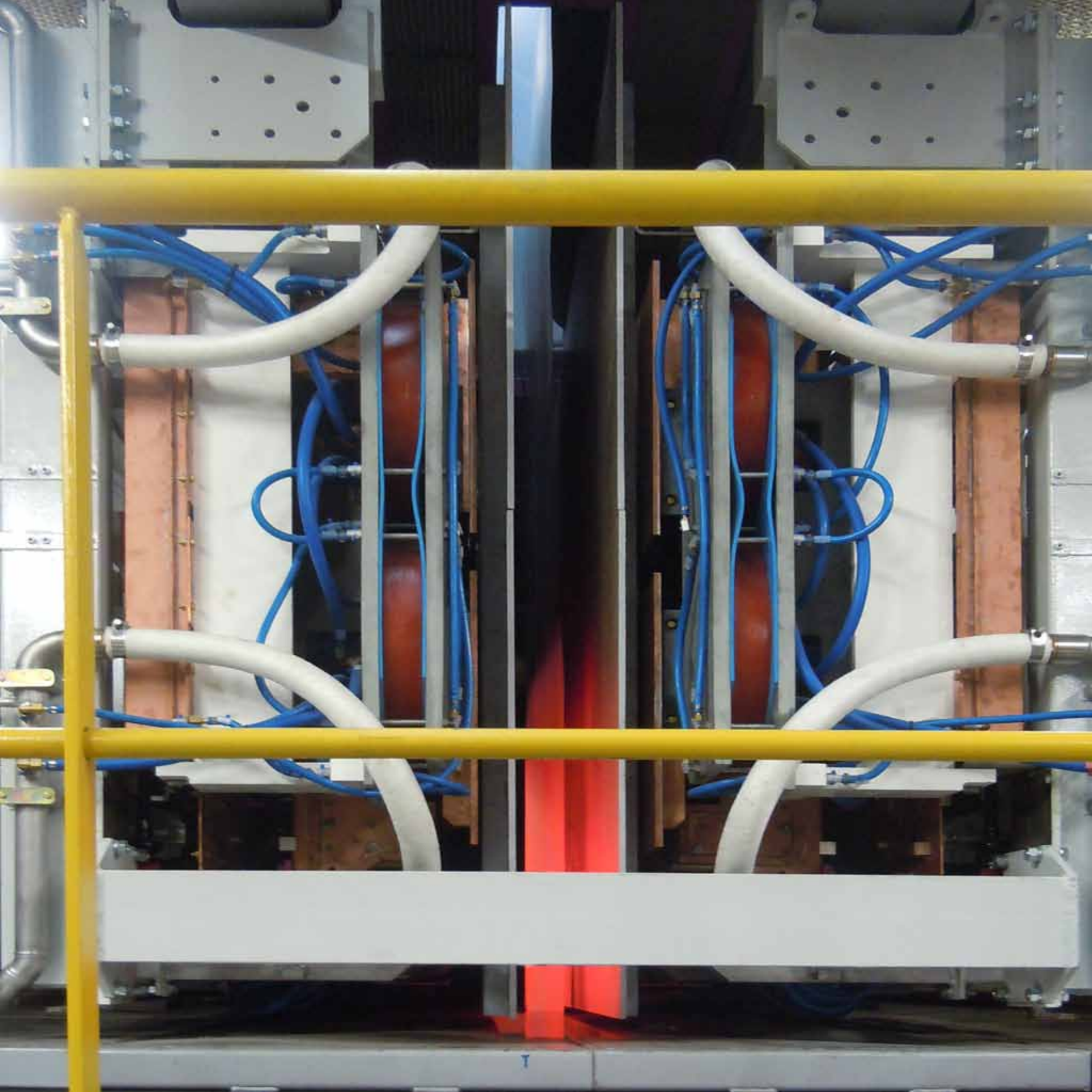
Fives' proprietary technology, the Horomill® has been a resounding success. On October 31, 2011, Fives FCB signed a contract with Holcim for the supply, installation and commissioning of an additional production line in a cement plant located in Barroso, Brazil 300 kilometers south of Rio de Janeiro. As specialists in the design and construction of cement plants and grinding plants, this subsidiary of Fives will install its largest Horomill®, Horizontal Roller Mill, designed to date. The Horomill® was invented by FCB in the early 1990s and is a novel compression design, which refines the materials used in cement production. The system consumes 30% to 40% less energy than traditional crushers in which large metal balls are used to shatter material inside of a drum. As the most energy consuming activity of the industry, cement production alone generates 5% of greenhouse emissions in the world. With the urbanization of emerging countries, this activity is increasing by 5% each year, hence why the crusher designed by Fives is of such great interest. On the Barroso site, where production is expected to reach 7.9 million tons of cement per year in 2014, the Horomill® will produce 420 tons per hour of raw material obtained by crushing limestone. The history of the crusher dates back to the early 1990s and demonstrates Fives' innovation capacity, which has been for many years focused on energy and environmental issues. The Horomill® consumes less energy, requires no additional water and is much more compact and flexible. This product can produce either raw material or cement, as required. The first Horomill® was designed in partnership with the Italian cement-manufacturer Fratelli Buzzi, which was founded in 1907 and has since become Buzzi Unicem; it began production in September 1993 at the Trino factory in Italy. Since this time, 56 products have been sold around the world. Today, this type of crusher was such a success that it has been copied several times, but none of the copies were as productive or efficient. This innovation continues to give Fives FCB a lead over its competitors.

Revolutionizing an industry: Induration furnace NOx emissions reduced by more than 95%

When the Essar Group proposed construction of a greenfield taconite plant in Northern Minnesota, the regulatory limit for NOx emissions created a significant hurdle. Fives North American Combustion was able to combine its advanced NOx control technologies and vast application experience to propose a revolutionary combustion system to meet these requirements. In order to risk-manage Essar's $2B investment for this new plant, Fives North American Combustion constructed an innovative 5MW regenerative air heater as part of a quarter-scale process simulator and demonstrated the performance of the system to Essar and the regulatory authorities. The final result: NOx emissions levels were more than 95% below those of traditional induration furnaces and the new combustion system averted the release of over 12,500 tons per year of NOx into the atmosphere, allowing permits to be issued and construction to continue. The total avoided NOx production is equivalent to the annual emissions of over 13.6 million vehicles, nearly three times the number present in the state of Minnesota!

EcoTransFlux®, breakthrough technology in metallurgy

In this symbolic year of 2012, the future of Fives is already taking shape. One simply needs to look at its innovations underway to see which markets the group will continue to pursue its industrial adventure. By considerably improving the quality of sheet steel, its EcoTransFlux® solution will undoubtedly open new doors in the sector of metallurgy. This breakthrough technology allows temperatures to heat steel sheets more than 200°C per second using electromagnetic induction, while reducing greenhouse emissions and acid waste in factories for cold rolling steel and increasing productivity. Nearly two years ago, in the September 2010 the construction of the prototype for the induction furnace began. The story began well before Celes became part of the group. The company was founded in 1967 and in 1987 had already revolutionized the fabrication of steel sheet with its induction heat-generators. In the same year, *Compagnie de Fives-Lille* bought the company Stein-Heurtey to which Celes had belonged since 1980. The needs of the metallurgy companies, in tonnage and rate of production, were continuing to rise, so the power of the induction generators also had to increase. Fives had found the solution to meet this expectation by designing an inductor capable of transmitting several megawatts per square meter in thick products, a real technological masterpiece, but the Celes teams went further. They launched the technology of rapid heating by induction with transverse flux inductors placed on either side of the sheet being processed; the new solution was tested by a demonstrator installed in its Lautenbach factory in Alsace. The famous EcoTransFlux® may, in the near future, triple the production capacity of the bright annealing lines that conserve the finish of the cold rolling stainless steel strips. It could also improve the fabrication of carbon steels for stamping by limiting the addition of rare metals. The producers could also reduce the thickness of objects made with these steels for the automotive and domestic appliance sectors. The future has now become brighter.



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This anniversary book deals with Cail's and Fives-Lille's outstanding industrial epic, who gathered together and gave birth to today's Fives group. With a presence on all continents, Fives is a key player in the sustainable industrial development. The group's history started 200 years ago and has merged with the three industrial revolutions which happened in a row since the beginning of the 19th century and which are at the origins of many technological and organizational breakthroughs. The group's journey has been supported by exceptional women and men, and goes on nowadays through major achievements all around the world, which make the 6,500 employees so proud.

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