The Technology of Change: The Van Nelle Factories in Transition

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‘We want artists in industrial relationship. We want masters in industrial method – both from a standpoint of the producer and the product. We want those who can mould the political, social, industrial and moral mass into a sound and shapely whole. We have limited the creative faculty too much and have used it for too trivial ends. We want men who can create the working design for all that is right and good and desirable in our life.’
Henry Ford[1]

The notion of technology in the modern sense of the word is rooted in the Enlightenment. By exploring nature and natural science a new kind of logic was created that shed new light on the relationship between material, which was used to create artefacts such as buildings, and the form to which these artefacts were shaped. The more man mastered material the more he was able to develop the products he desired, to an ever greater extent and in ever larger quantities. Understanding this relationship lies at the core of the concept of the industrial society and the role of technology therein. Technology, therefore, represents the balance between man and matter.[2]
In turn, industry generated evolution, pushing material properties to their limits and requiring new materials, composites and eventually synthetics to be developed. Industry spawned its own version of nature which was surveyed and calculated by engineers, and later, as far as the building industry was concerned, by architects. By solving existing problems with technology, technology created new demands that needed to be responded to; for example the introduction of early large-span structures created a demand for even larger spans.
In economic terms, industrialization required the production of quantity, for which adequate management was needed. Researchers like the Americans Frederick Taylor (1856-1915) and Frank Gilbreth (1868-1924) recognized that the relation between quantity and quality is ruled by time. These observations were transformed into the theory of Taylorism on scientific management for industry.[3]
Mass manufacturing required the rapid production and mobility of goods and products, distribution and, consequently, time planning. But because markets can change, the industrial infrastructure had either to be adaptable or short-lived. The notion of time became ever more prominent, and the balance between lifespan and life expectancy became increasingly relevant.

Industrial materials Industrialization allowed for the affordable production of materials like iron, later steel, and glass, which were soon used for the mass production of consumer goods. In the 19th century these materials began to be used for the construction of buildings by engineers and architects like Horta, Berlage, Guimard, Le Baron Jenny, Sullivan and Frank Lloyd Wright.
Armed with an understanding of the tensile strength of steel and the compressive strength of concrete, reinforced concrete was developed into one of the most universal and versatile materials in building construction. More than any other material, reinforced concrete became emblematic of the architecture of the Modern Movement – first in structural frames and still mainly plastered to hide the uneven surface, later as an exposed material appreciated for its particular texture and surface qualities.
Modern building materials were initially used in a hybrid form, in combination with stone, brick and timber, before eventually replacing the latter to a large extent as structural materials in modern architecture. The range of industrial materials was gradually extended by various metals, alloys, composites and synthetics. Particularly after the Second World War, many new materials that had been developed by the war industry became available to the building industry, most notably aluminium.[4]

Spiritual economy The determination to address contemporary social needs by exploiting new materials and constructional techniques lies at the core of the origins and development of the Modern Movement. Although the new aesthetics was partly derived from artistic movements like Cubism and De Stijl, as well as the imagery of cars, aircraft and ocean liners, a key factor was the idealized role attributed to technology[5] which, in the early period at least, was often well in advance of the realities of building construction.

Jan Duiker (1890-1935), the famous spokesman of the Dutch architectural avant-garde, relied on the principle of 'spiritual economy' which, as he wrote in 1932, 'leads to the ultimate construction, depending on the applied material, and develops towards the immaterial, the spiritual'.[6] The combination of an artist's inspiration and an engineer's knowledge spawned an 'engineer's art', which he compared to the lucid construction of mediaeval cathedrals, the brilliant composition of Bach's fugues[7] and the 'horrifying magnitude' of Einstein's theories.[8] The principle of 'spiritual economy' thus involved the efficient employment of material properties and construction capacities, scientific and technological developments, and human resources, pairing social responsibility with functional criteria.

Consequently, rather than designing the *icons* for the ruling classes and religious institutions, engineers and architects were increasingly challenged to design *ordinary* buildings[9] such as railway stations, housing, schools, medicare centres and factories, to respond to the needs of ordinary people.

Functional or rational? Due to the increasing prominence of time as a factor in decision-making, the building industry also underwent great changes even in the 19th century. The limited range of building typologies dating from earlier ages accommodated a variety of functions and appeared quite easily adaptable for other uses. Therefore, they had a long functional lifespan, and the technical life expectancy was accordingly great.

With the Industrial Revolution, the programmes for buildings became more diverse and specific, as did the buildings themselves. As the time-span for use changed as well, time and transitoriness ultimately became important issues in architecture. In the 1910s and '20s, architects acknowledged a direct link between the design, the technical lifespan of a building and user requirements over time.[10] Ultimately, this leads either to a transitory architecture or an adaptable one.

A stunning example of such reasoning is Jan Duiker's 1926-31 Zonnestraal sanatorium in Hilversum. In functional terms the lifespan of the sanatorium buildings was limited, since tuberculosis was hoped to be exterminated within thirty to forty years. The technical life expectancy was chosen accordingly, which allowed the building to be constructed for a very limited budget.[11] As a result, today, thirty years overdue, it is falling apart.

The changeability and manageability of the 1925-31 Van Nelle factories in Rotterdam, on the other hand, allows for a long functional lifespan, and the buildings have been constructed with a long technical life expectancy in mind. Adolf Behne's influential manuscript *Der Moderne Zweckbau* of 1923[12] gives us to understand that the theory of scientific management was tried out here in the building industry.

His book distinguishes a 'functionalist' and a 'rationalist' approach in architecture. Functional planning departed from the brief and involved the careful design of individual spaces for each particular function, with specific dimensions and performance characteristics, organically producing a 'tailor-made' suit. 'When the parts of a building are arranged according to a sense of their use … a cramped, material, stable equilibrium (symmetry) gives way to a new, bolder equilibrium, delicately balanced in broad tensions (polarity) that correspond better to our essence … And then through this suitability to function, a building achieves a much broader and better inner unity: it becomes more organic by abandoning the old conventions and formalisms of representation.'[13] This approach is ruled by a sense of short-term economy. As *form follows function* quite precisely, it is appropriate to structures that serve a relatively static use, such as single-family housing, but it applies as well to Duiker's original sanatorium due to its limited life expectancy.

Behne was well aware of the limits to this strategy: 'Functionalist deliberations are correct so long as they concern a specific matter, and they go wrong as soon as things have to fit together.'[14] The antithesis of the ‘functionalist’ is the ‘ossified formalist’, the consistent ‘rationalist’, in his search for objectivity. ‘Just as striving to dehumanize buildings, to eliminate the element of will, actually brings the functionalists to humanization, so the rationalists are led by a conscious emphasis of human will to objectivity and *Sachlichkeit*,’ concludes Behne.[15]

Le Corbusier took a rationalist position by promoting an abstract geometry: ‘The more human creations move away from direct contact, the more strongly they incline to pure geometry. A violin or a car that touches our body has a low degree of geometrical rigour, but a city is pure geometry.’[16]

Rational planning thus involved a neutral multifunctional layout which could be partitioned according to functional requirements even during construction.[17] It allowed for future adaptation depending on the functional lifespan of the initial solution and was eminently suitable for buildings that are subject to frequent change such as schools and factories. Also at Van Nelle, the architects’ rational approach departs from flexible solutions to respond to general insights, so as to allow unforeseen functional change in the future. Dimensioned to resist occasional overloading, the structure was easily changeable and manageable.

Structural frames Inspired by American examples and the industrial buildings designed by innovative engineers, modern architecture followed a rigorous distinction between loadbearing structural frames and infill. Buildings were liberated from the inhibiting constraints of traditional masonry loadbearing construction by the introduction of structural frames in modern industrial materials like iron, steel and reinforced concrete, allowing new freedoms in planning, daylighting and architectural expression.

Although common practice in America, where the balloon frame was a regular feature of domestic construction, timber structural frames were less used in modern construction in Europe.[18] The 1920s standardized mass production of prefab timber elements for housing construction by the German company Christoph und Unmack, devised by Konrad Wachsmann (1901-1980),[19] remained an exception.

The American engineering innovation in steel structures, together with Elisha Otis’s (1811-1861) invention of the elevator in 1852, boosted the development of high-rise structures. The creation of the modern skyscraper fuelled the idea of new social structures and collectivity.[20] In Europe, the use of steel was widely promoted by the 1898 Eiffel Tower – probably not the most refined steel structure when compared to such designs as Vladimir Shukhov’s (1853-1939) extremely light and elegant glass roof for the gum department store[21] in Moscow of 1889-93.

The concrete structural frame of Auguste Perret’s rue Franklin flats in Paris of 1903 heralded one of the most important features in the architecture of the 20th century. His idea paved the way for the *plan libre*, a conception that developed into a major principle and a prime expressive quality of modern architecture in the hands of his one-time apprentice Le Corbusier.[22]

Trained in matters of economy, some engineers[23] of the late 19th and early 20th centuries were ahead of the architects as far as modern construction technology was concerned. First Paxton and Eiffel, then Maillart, Torroja, Freyssinet and later Candela and Nervi created outstanding and original structures as designers in their own right. Some building engineers designed structures which anticipated Le Corbusier’s theoretical writings even before these were widely published. For instance, the Dutch engineer Jan Gerko Wiebenga (1886-1974) designed his remarkably modern Technical School in Groningen as early as 1922, with a full concrete structural frame, light infills and steel-framed windows arranged in horizontal bands.[24] It was still five years before Le Corbusier canonized the free plan with his ‘five points of a new architecture’,[25] and just four years before Duiker invited Wiebenga to help him work on the sanatorium project and before the architects Jan Brinkman (1902-1949) and Leen van der Vlugt (1894-1936) involved him as a structural consultant for the Van Nelle factories. After a three-year working experience in the usa, he introduced the idea of the mushroom column for Van Nelle,[26] while at Zonnestraal the technical elaboration of the project and the functional choice of finishes depended heavily on his expertise. Similarly, many other consulting engineers have been catalysts for the development of modern technology and greatly assisted the architectural avant-garde to realize its visions.

The structural frame became almost a precondition for the spatial concepts to accommodate modern life. The concrete frame was celebrated as new, versatile and liberating, but also as efficient, hygienic and fireproof. Despite the long-term practical experience of structural engineers with this ‘miracle material’ in civil engineering, concrete was still experimental in its architectural applications.[27] The idea that reinforced concrete would withstand the ravages of time and requires no maintenance has proved to be a myth, and today, historical concrete structures are a prime concern for the preservation professions.

Infills The visual impact of Modern Movement architecture largely depended upon the impression of lightness, thinness and the minimalist aesthetic attainable in reinforced concrete.[28]
By abandoning the loadbearing function the infills could be designed to be very light and ‘monofunctional’, precisely attuned to specific performance requirements in terms of functionality and building physics, such as daylighting and ventilation. This ‘differentiation’, particularly suitable for outer walls, was promoted by ciam, among other things through their 1939 international inquiry into ‘functional outer walls’.[29]
Wiebenga, in 1926, rallied as well against the traditional usage of brick cavity walls for non-loadbearing facades and advocated a construction of metal laths supported by wooden or metal posts, plastered on both sides.[30] It is almost exactly according to this description that the infills at Zonnestraal were constructed in 1927-1928, producing a seamlessly plastered, pristine white image.
Yet by pushing material properties to their limits, buildings were designed with an extreme sensitivity as to building physics, notably with respect to thermal aspects and condensation. In search of formal clarity, Modern Movement architecture tends to lack surface relief and conventional details such as copings, sills, drips and overhangs. This often creates a weathering problem which, as modern buildings generally weather inelegantly, compromises the desired pristine character. In other words, we are disturbed by something that we generally appreciate in classic ‘monuments’.[31]
The Dutch architect J.B. van Loghem (1881-1940) claimed that ‘it is no coincidence that for the new structures, if not constructed as transparent masses, solid materials are chosen that are pristine white. This goes along with a seamless appearance. … The white plaster, enamel or tile work … are an interpretation of a desire for clarity and purity of expression, whereas the tension and tautness are expressed best by a smooth finish. … The whiteness is also explained as a means of reducing – at least for the eye and feeling – the remaining heaviness which is still preserved by the structural form, to the utmost. … Probably a more pure technology will allow for an even more lucid and sophisticated appearance of buildings, so that the still strongly pronounced white can be partly done away with.’[32]
Related to the idea of varied lifespans was the introduction of prefabrication for building components, since it allowed the easy replacement of deteriorated or malfunctioning parts, as well as later adaptation to respond to functional change.[33]
The curtain wall became a characteristic feature of Modern Movement architecture, particularly in post-war ‘corporate modernism’. As a non-structural enclosure making use of the loadbearing capacity of a structural frame, the early curtain wall consisted of a light, uninsulated, single-seal stick system comprising vertical mullions, horizontal rails, spandrel panels and window units assembled on site. More sophisticated versions, like the facade of the Van Nelle factories, involved complete storey-high units.
The concept of the curtain wall is eminently suitable for the prefabrication of standardized parts, related as this is to the ideals of mass production and the introduction of scientific management to the building industry. The introduction of the structural steel frame for high-rises in the mid-1890s in the us sparked a demand for industrially produced, light and transportable building parts, particularly for facade panels, for which new materials[34] like terracotta (1890s),[35] plate glass (1910s), stainless steel (1920s),[36] fibreboards (e.g. Masonite) and plastic laminates such as Formica (1930s), thin stone veneer and glass block (1940s), aluminium[37] and spandrel glass (1950s)[38] were tried. Also instrumental to the development of the contemporary, post-war curtain wall was the development of modern sealants in the 1950s.[39]
A similar drive for new materials was witnessed in the interior of buildings where linoleum (1860s), rubber and cork tile (1890s) and vinyl floorings (1930s) were introduced, followed by gypsum

board, plywood, plastic laminates and acoustic panels such as Celotex (1930s) and fibre reinforced plastics (1940s).

Standardization and the building process A fundamental debate within the Modern Movement as to whether standardization should lead to a simplification of forms reached a pinnacle at the first ciam meeting in La Sarraz in 1928.[40] Le Corbusier proposed using geometry to make standardized products more universally applicable, thereby increasing the economic viability of the idea. The German architect Hugo Häring accused him of formalizing the Modern Movement, and supported an individual and specific approach in response to each particular demands that would lead to more organic forms.

The ideal of the dry assembly of standardized, prefabricated building parts also brought fundamental changes to the construction site. The modern construction worker had little in common with the traditional craftsman, instead resembling the contemporary factory worker. The full-scale application of Taylorism drastically reduced the construction time of buildings. A spectacular demonstration of the modern building process was the construction of William F. Lambs's Empire State Building in New York of 1929-31: 'a dream well-planned',[41] involving the minute organization of well-timed supply and on-site management of building materials and parts, a precise division of tasks between the mostly untrained workers and the erection of a complete skyscraper in just eighteen months.[42] At the same time, on-site labour conditions were initially poor and not sufficiently suitable for modern construction processes, causing frequent accidents and injuries.

In physical terms, industrialization brought urbanization, creating a demand for economic housing in massive quantities, often realized in designated areas such as city extensions.[43] Eventually, the drive for standardization and rapid construction of housing in particular sparked the development of (largely) prefabricated houses, initially concrete block or panel structures and later metal-panelled 'prefabs', such as Gropius's corrugated copper-panelled houses at Finow in 1931, Kocher and Frey's all-aluminium Aluminaire of 1931, the aluminium-panelled housing in the uk of 1945-50 and the enamelled steel-panelled American Lustron Homes of 1947-50.[44]

Master designers like Buckminster Fuller (1895-1983) were inspired by the idea of mass production of housing as a means of fulfilling the individual and changing needs of consumers. In 1945 he regenerated an earlier 1928 patent into the fully relocatable Dymaxion House, marketed as a do-it-yourself kit, though in the end it was never produced commercially.[45]

Van Nelle The factories (there are in fact three on site) of the Van Nelle Company are amongst the most remarkable and influential examples of Modern Movement architecture worldwide,[46] and as prominent examples of the decisive influence of technology and spiritual economy on the development of modern architecture they deserve a broader assessment here. Like no other building, the ensemble represents the spirit of the Machine Age, to which the concept of economy was instrumental. Remarkably, the project was appreciated by avant-gardists as well as conservative traditionalists for the successful demonstration of the new architectural means of expression it held.[47] Designed by Brinkman & Van der Vlugt between 1925 and 1930, the factories also represent the enlightened spirit of enterprise that resulted from the *Weltanschauung* of the client, Kees van der Leeuw.[48]

Young Van der Leeuw (1890-1973) had become fascinated with the ideas of scientific management, Taylorism and marketing during his first trip to America in 1911. He was an enterprising organizer, and a practical man with few extant writings to his name. He was particularly interested in socio-economic theories (both the socialist and the 'enlightened' capitalist views of the likes of Henry Ford and Walter Rathenau) but also in psychology, psychiatry and oriental occultism. In 1912, he became a member, later Secretary, of the Order of the Star in the East, a Theosophical movement.[49] The members of the Order saw the young Indian Krishnamurti (1897-1986) as the new 'world teacher' on the eve of a fundamental religious and cultural regeneration of humanity. At the time when Van der Leeuw started considering the construction of a new plant, in 1914, Theosophy was very close to Freemasonry, which attributes an important symbolic meaning to the notion of construction.

For Van der Leeuw, the Order has been an important source of inspiration in terms of social consciousness on the one hand and the conception of the factory on the other. Krishnamurti's ideas about the purification of the inner self can be related to Van der Leeuw's demand that the appearance of the factories should reflect the functional requirements met in the interior. Light constitutes another link between the factory building and the ideology of Theosophy, in which daylight has a particular symbolic meaning.[50]

Around 1925, when the eventual layout of the plant was conceived, Krishnamurti adapted his doctrines and proclaimed liberation through modern science and technology, and the abstract arts. At that time, Van der Leeuw visited the Bauhaus regularly and was attracted by Gropius's ideas: 'What we can clearly see is the idea of the present world, what we can't see yet is the form. The old dualistic world view, the "I" opposed to the Universe, is disappearing. It is being replaced by a new world order dissolving all contrastive forces.'[51] The implementation of new achievements like modern technology and rational planning would finally result in a mystical moment of dissolution of subject and object,[52] something that is again reflected in the spiritual references used by Duiker in 1932.

During a second trip to America in 1926, Van der Leeuw focused on the processes to be accommodated by the new factories rather than the buildings themselves, including the social aspects of industrial society, and the position of women in particular.[53] Earlier, he had become a member (later chairman) of the iri, the International Industrial Relations Institute, which was primarily concerned with industrial efficiency.[54]

The American inspiration later resonated also in the numerous features of the factories imported from the us via the Van Nelle Company's tobacco shipments from Kentucky, including a window-cleaning system,[55] aeroshade sunblinds, suspended toilet bowls[56] which were celebrated for their hygiene, enamelled washbasins and the self-closing doors of the services shafts.

From product to process The site at the outskirts of the city was chosen for its accessibility for riverboats and rail and road traffic plus the availability of workers' housing in the new Spangen neighbourhood, but also for its strategic location for advertising purposes. The site adjoined the busiest rail track of the country, and one of the first things to be put up was a huge advertising sign.[57] The brief for the buildings was later summarized by the company director as follows:[58]

- the appearance of the factory must be the consequence of the requirements for the interior;
- the design must respond as much to human demands as to mechanical ones;
- additional costs for finishes can be considered legitimate, even without evident advantages.

The 1926 masterplan involved an extendable structure for a modern and transparent working environment in green space, modelled after the American ‘daylight factory’. The plant is arranged round a factory street with the long rectangular factory buildings to the west and a strip of warehouses, dispatch buildings, boilerhouse and mechanics’ department planned to the east, between the street and the canal. A curved office building was planned at the south end of the factories. Overhead conveyor belts ran through glazed gangways over the factory street to connect the various buildings.

Additional storage facilities could later be built to the east, while the factories could be extended westward where, for the time being, a soccer field and other sports facilities were located. To Van der Leeuw and the architects, the design and building process was almost as important as the result, and this process of continuous change was minutely documented by photos and films.[59] In 1931, the economic situation forced the company to halt further construction, despite the arbitrary stage of development reached by the complex of buildings.

The masterplan served as a blueprint for future developments and was continually adjusted to respond to new insights. This can still be appreciated, for instance, from the brackets that project from the factory stairwells to carry gangways across to the planned elevator towers between the series of dispatch buildings. By 1931, only the middle dispatch building opposite the coffee factory had been constructed. To reach it, the two gangways from the tobacco factory had to be projected diagonally, and the brackets remained unused. It is remarkable how such unplanned decisions have produced some of the most canonical images of the Van Nelle buildings.

Indeed, the factories’ scheme is ruled by ‘spiritual economy’. Governed by gravity, the products moved down floor by floor with each stage of processing. The decrease in height of the three factories, for tobacco, coffee and tea respectively, is therefore explained from the number of processing stages for each of these products. The layout reads as if the production processes were directly transformed into material, as if the buildings are nothing more than industrial activity enclosed by a membrane of glass and steel; if not a *machine à habiter* then surely a *machine à travailler*.

To Van der Leeuw, the company’s social commitment was part of the same agenda. This can be read from the great care given to the working conditions inside, the washrooms and showers (which were still missing from workers’ houses at the time), the sports facilities, the garden, the canteen and the library to unwind after work. Like some of their contemporaries, the architects adhered to the idea that daylight, fresh air, free space and greenery were preconditions for a healthy existence. These social aspirations blended well with the commercial considerations of the client – Taylorism and efficiency – as well as with his spiritual inspiration in Theosophy. Soon after completion of the provisional ‘final’ stage of construction, Van der Leeuw left for Vienna to study medicine and psychiatry under Freud and Adler.

Amalgamation of innovations The unique and brief overlap of 19th-century building tradition with new and progressive technological developments makes Van Nelle a typical product of the 1920s. Most of its technological innovations had proved their merits elsewhere, but the many new insights and ambitions that converged in the project made the Van Nelle factory complex an interesting amalgamation of modern inventions, starting from its foundations.[60] Similarly, these innovative ideas had not been brought in by one particular person, but had rather been attracted from different sources by the ambitions of the Van Nelle board to create a truly new and unlimited industrious environment. In every sense, Van Nelle constitutes a nucleus for an uninhibited modernity.[61]

Studies had been performed to conclude that a depth of about 19 metres would ensure sufficient daylighting. This explains the 230-metre-long linear layout and the expanses of glazing that were also intended to serve the firm’s corporate identity. The adopted 5 x 5.70 metre grid of columns served the production lines but, remarkably, anticipated changes to ‘another purpose’ for the buildings in the future.[62]

The architects had planned the highest tie-beams perpendicular to the facade so as to maximize daylighting but Wiebenga – whose ideas about economy were more financially driven – argued that tie-beams over the shorter span would save construction height and would still allow good daylight qualities. Just a day later, he reconsidered and proposed a beamless mushroom floor that saved up

to half a metre of construction height per floor and would bring ideal daylighting conditions. Rather than the obvious constructional advantages Wiebenga stressed the benefits for the production process, the savings in internal transport, work time and so on. His Taylorist reasoning coincided with the views of the client, who finally adopted his proposal.[63]
Moving up through the building the column diameter is reduced every two floors. The complicated carpentry for the formwork was not uneconomical at a time when labour was cheaper than material. As power tools were not yet available, the concrete structure features steel rails concreted in at four sides of the columns and steel dowels in a 1 x 1 metre square grid in the floors, to allow for flexibility in fixing machinery, conveyors and ducts.[64]
As the columns are set about one metre from the floor perimeter, a moment reduction in the floor slabs again saves material. Pipes and conveyors run between the columns and the facade to leave the work floor free of obstacles.
The aluminium-painted curtain wall of storey-high steel fronts[65] runs in front of the floors smoothly and uninterrupted over the full height of the buildings, bolted to the same steel rails integrated along the perimeter of the concrete floors. The facade proportions are entirely based on 1 x 0.5 metre standard glass panels as used in Holland's green houses which were therefore cheap and readily available. American sunblinds composed of aluminium painted wooden slats controlled solar gain.
In the design of the buildings the architects adopted an abstract, transparent architecture. It is primarily due to their immense scale that the buildings appear stout and robust. In fact, the glass-enclosed volumes are characterized by the absence of material rather than its presence, fragile like soap bubbles that might burst if the balance between content and surface tension were disturbed. The apparent simplicity of the details demonstrates the idea of immaterialization, producing a universal aesthetic, enhanced by the seeming colourlessness of the exterior – in fact reflecting the colours of the at times dramatic Dutch sky and the surroundings.
On the other hand some of the interiors appeared surprisingly colourful, with yellow ochre and dark red floors in the factories, and ultramarine rubber flooring, aquamarine and beige tiles, volatile turquoise, light green and mellow yellow walls in the office building, next to bright red and blue, white, grey and black, polished chrome and matt aluminium. Still the use of colour remains restrained and lucid, enhancing the overall impression of lightness. Despite our connotation with coolness on seeing the aluminium and white volume, the natural colours of the factory floors reflect the daylight, creating a warm and humane interior atmosphere.
The machine aesthetics of the conveyors moving through the gangways and the transparent facades of the boilerhouse and control rooms revealing switchboards and steaming machines, created a stunning image of the dynamics of the Machine Age.

Epilogue Despite its rational planning and intended absence of specificity, the Van Nelle factories became obsolete in the late 1980s, mainly due to the general change from vertical, gravity-governed production lines to the horizontal arrangement of the modern post-war factory. In 1995, the foods company that owned the plant decided to put the buildings out of use and to abandon the premises in 1998.
To find a new and appropriate use has been a prime concern of the authorities and cultural lobby groups since the owner's first announcement.[66] Interestingly, their search for an alternative use can best be described by paraphrasing Gropius, as 'what we can clearly see is the form of the present building, but what we can't see yet is the idea'. The subject and the object – the dissolution of which had been pursued by Van der Leeuw and his consultants in the 1920s but was now reversed – had again drifted apart and, hence, *function follows form*.
Today, again in the hands of an enlightened entrepreneur,[67] the factories are heading for a new future in the Information Age as the Van Nelle Design Factory. Similar to the brief as formulated by Van der Leeuw in the 1920s, the redevelopment project seeks to bridge the gap between cultural mission and economic ends. The rational layout of the buildings again provides flexible solutions for 75 to 100 small and medium-sized 'digital' enterprises involved in graphic design, new media, communication, design, architecture, ict and education. Various consultancy teams[68] have developed a suitable environment for the 1500 to 2000 people who are expected to use the buildings on a daily basis in the near future.

The starting point has been that the new function will help to create a new identity for the existing buildings. As soon as the buildings have discovered their renewed personality, they will again be able to speak for themselves. The Van Nelle Design Factory must therefore not be regarded merely as rentable space, but rather as a dynamic and continuously changing whole of activities with its own character, so as to invite a dialogue between old and new. To this end a balance has been defined between historic meanings, future functions and relatively sustainable solutions in terms of energy consumption, daylight and so on.[69]

Within the perspective of the variable economic circumstances and socio-cultural developments of our post-modern society, the Van Nelle will inspire architecture today to aim at designing scenarios for the future – at the *process* of conceiving and using structures rather than the *product* of such a process, in other words much software and little hardware. Again, this requires an enlightened perspective on the part of the client, as architectural quality that can bear the test of time results from unconventional attitudes and a close cooperation between architects and client, rather than a premeditated understanding of style.

Asking the proper questions rather than eliciting absolute answers is, as it happens, essentially 'modern', as modernity is characterized by a continuous dialogue that dismantles the absolute.[70]

An essential inspiration that we can draw from the Van Nelle lies within the idea of 'spiritual economy'. In search of sustainable solutions, we may conclude that 'rationality', that is, the universality of the initial design, is a viable principle for the future.

Globalization, commercialization and individualization in the 21st century pose enormous challenges as well as dangers. Respecting human dignity, local characteristics and cultural values, the ideals of the Modern Movement may prove to be of great use to arrive at sustainable solutions for a better world for all. It is probably no coincidence that the Modern Movement's dedication to 'spiritual economy' regarding the use of resources, materials and constructions – inspired by the ethical principles of the Machine Age as well as the harsh economic circumstances of the era – appears most relevant again in view of the current world poverty and impending ecological disaster. It is in this sense that Technology must continue to inspire Change.

1 Henry Ford, *My Life and Work*, New York 1923, p. 104.

2 Ola Wedebrunn, *Character and Language of Materials*, English summary of PhD thesis, Copenhagen 2002.

3 Other noted scholars involved in scientific management research include the French experts Fayol and Bedaux and the American Gannt.

4 Stephen J. Kelley, 'Aluminum', in Tom Jester (ed.), *Twentieth Century Building Materials*, Washington 1995, pp. 47-51; and Guillemette Morel Journel, 'Aluminium', in Antoine Picon (ed.), *L'Art de l'ingenieur*, Paris 1997, p. 51. Early experiments in residential architecture include the Aluminaire, the first all-aluminium house in America, designed by Lawrence Kocher and Albert Frey for the New York Architectural League's annual show of 1931; see Ward H. Jandl, 'With heritage so shiny: the Aluminaire', in docomomo *Journal* 12, 1994, pp. 42-45, and Neil Jackson, 'Aluminaire House, usa (Kocher and Frey)', in Allen Cunningham (ed.), docomomo*. Modern Movement Heritag*e, London 1998, pp. 136-144.

5 Jean-Louis Cohen, 'Modern architecture and the rhetoric of engineering', in docomomo *Journal* 26, December 2001, pp. 28-32.

6 Jan Duiker, 'Dr. Berlage en de "Nieuwe Zakelijkheid"', in *De 8 en Opbouw* 1932, pp. 43-51.

7 Duiker was a gifted pianist, who had had to choose between a career as a musician or as an architect.

8 Einstein's 1905 Theory of Relativity demonstrated that the world was subject to constant change – to such an extent that change was in fact the only certain element – and introduced time as a fourth dimension.

9 Hubert-Jan Henket, 'The icon and the ordinary', in docomomo*. Modern Movement Heritage*, London 1998, pp. 13-17.

10 Hubert-Jan Henket, Wessel de Jonge, *Het Nieuwe Bouwen en restaureren. Het bepalen van de gevolgen van restauratiemogelijkheden*, Eindhoven/Zeist 1990, p. 20; English summary, p. 96.

11 The sanatorium was built for the Amsterdam Diamond Workers Union, and funds were in extremely short supply. From the minutes of the January 26, 1924 meeting of the building committee of the Zonnestraal Association (Studiecommissie exploitatie landgoed 'Zonnestraal'), it appears that the depreciation period was set at fifty years. The minutes were in the Zonnestraal historical archives (uncatalogued) which has since been donated to the International Institute for Social History (iisg) in Amsterdam, current file number unknown.

12 Adolf Behne's *Der Moderne Zweckbau* (Munich 1926) had already been written in 1923 but could only be published three years later, when publications by Walter Gropius, Erich Mendelsohn and others had already sparked a wide debate. Translated as *The Modern Functional Building (1923)*, Getty Research Institute for the History of Art and the Humanities, Santa Monica, Cal. 1996.

13 *The Modern Functional Building (1923)*, pp. 119-120.
14 Ibid., p. 129.

15 Ibid., pp. 134-135.

16 *L'Esprit Nouveau* no. 18, quoted by Adolf Behne, *The Modern Functional Building (1923),* p. 135.

17 As was the case with the 1923 Technical Schools in Groningen, designed by J.G. Wiebenga in cooperation with L.C. van der Vlugt.

18 Jan Duiker's 1924 balloon-framed market gardener's house in Aalsmeer (nl) may be a rare exception. It is based on the structure of traditional Dutch greenhouses.

19 Berthold Burkhardt, 'Konrad Wachsmann', in Antoine Picon, *L'Art de l'ingenieur*, Paris 1997, pp. 541-542.

20 Examples include Le Corbusier, 'La ville radieuse', *Collection de l'Equipment de la civilisation machiniste*, Éditions de l'architecture d'aujourd'hui, Boulogne 1933; and Jan Duiker, *Hoogbouw*, Rotterdam 1930, reprinted Amsterdam 1981.

21 Murat M. Gappoev, 'Bogenkonstruktionen mit einem System aus biegeweichen Zuggliedern', in Rainer Graefe, Murat Gappoev, Ottmer Pertschi (eds), *V.G. Suchov 1853-1939. Kunst der Konstruktionen*, Stuttgart/Moscow 1990, pp. 54-59.

22 In 1915 Le Corbusier and Max DuBois developed the seminal 'Dom-Ino' system involving reinforced concrete floor slabs on columns.

23 Some were even entrepreneurs themselves, like Eiffel and the reinforced concrete pioneers Monier (1823-1906?) and Hennebique (1842-1921). See Antoine Picon, *L'art de l'ingenieur*, Paris 1997.

24 Jan Molema, Peter Bak (eds), *Wiebenga, Apostel van het Nieuwe Bouwen*, Rotterdam 1987; Wessel de Jonge, 'Wiebenga and Van der Vlugt: the teamwork which had to stop', in Joris Molenaar (ed.), *Leen van der Vlugt*, Wiederhall, Amsterdam undated, pp. 18-21; and Eleonoor Jap Sam (ed.), *The Wiebenga complex. Conversion and restoration of the Technical Schools in Groningen*, Rotterdam 2000.

25 Le Corbusier, Pierre Jeanneret, untitled, in *L'Architecture Vivante*, Autumn/Winter 1927, pp. 13-27.

26 Wessel de Jonge, 'Wiebenga and Van der Vlugt: the teamwork which had to stop', in Joris Molenaar (ed.), *Leen van der Vlugt,* Wiederhall, Amsterdam undated, pp. 18-21.

27 Ola Wedebrunn, 'A Miracle Material. The Abstract Expression of Concrete', in docomomo *Journal* 17 (1997), pp. 32-37.

28 See John Allen, 'Conservation of Modern Buildings', in Edward Mills (ed.), *Building Maintenance and Preservation*, Butterworth-Heinenmann, 1997, p. 151.

29 *De 8 en Opbouw* 1939, pp. 175-190; and Jos Tomlow, 'Sources of MoMo Technology ...', in *Fifth* docomomo *Conference Proceedings*, Stockholm 1998, pp. 158-162. This extensive inquiry was compiled by Helena and Symon Syrkus (Warsaw) and Carl Hubacher (Switzerland). In the Dutch publication it is suggested that the inquiry had been published in 23 countries, but procedures are likely to have been disrupted by the outbreak of the Second World War.

30 J.G. Wiebenga, 'Amerikaansche bouwmethoden een economisch succes', in *Gewapend Beton* 1926, pp. 32-35: 'It is just as good and lighter to leave the brickwork out, but to maintain the two layers of plaster on either side and to choose a more appropriate material for support. ... Metal laths, plastered on both sides, will satisfy requirements just as well. Strict scientific research, Taylorization and – being used more and more – the pneumatic application of stucco results in almost waterproof plasters that justify the last step: the wall constructed of plaster on metal laths supported by wooden or metal posts.' His description of pneumatic application apparently refers to 'shotcrete', a compound of the words 'shot' and 'concrete'; see Anne T. Sullivan, 'Shotcrete', in Tom Jester (ed.), *Twentieth Century Building Materials*, Washington 1995, pp. 102-107.

31 David Leatherbarrow, Mohsen Mostafavi, *On Weathering. The Life of Buildings in Time*, mit Press, Cambridge, Mass. 1993.

32 J.B. van Loghem, *Bouwen Bauen Bâtir Building*, Amsterdam 1932, pp. 24-25. Translated by the author.

33 The prefabricated plaster-on-mesh spandrel panels of the 1931 Dresselhuys Pavilion at Zonnestraal are believed to be the first known prototypes of precast concrete panels. Hubert-Jan Henket, Wessel de Jonge, *Het Nieuwe Bouwen en restaureren. Het bepalen van de gevolgen van restauratiemogelijkheden*, Eindhoven/Zeist 1990, with English summary, p. 42.

34 Tom Jester, (ed.), *Twentieth Century Building Materials*, Washington 1995; the dates between brackets are the approximate periods of introduction to the American market as mass-produced building materials; their introduction to the European market tended to be some decades later. The following notes give the data of first or early seminal buildings where the material was used as an architectural cladding.

35 The Reliance Building, Chicago, by Burnham and Root, 1894.

36 The Chrysler Building, New York City, by William Van Alen, 1930.

37 The Alcoa Building, Pittsburg, by Harrison and Abramovitz, 1953.

38 The Lever Building, New York, by Gordon Bunshaft/Skidmore Owings and Merrill, 1951-1953.

39 Michael Scheffler, James Connolly, 'Building Sealants', in Tom Jester (ed.), *Twentieth Century Building Materials*, Washington 1995, pp. 272-276.

40 Colin St. John Wilson, *The Other Tradition of Modern Architecture*, Academy Editions, London 1995, pp. 12-25.

41 *Empire State Building. A History*, New York, Empire State Inc. 1931, as quoted by Rem Koolhaas, *Delirious New York: A retroactive manifesto*, London 1978, pp. 114-118.

42 Ibid. The Empire State Building was designed – from the first sketch – and completed in eighteen months.

43 The separation of workplace and residence again involved mobility, creating a demand for public transport and other infrastructural facilities.

44 Gropius developed an asbestos-cement panel prototype as early as 1927 for the Werkbund (Weissenhof) exhibition in Stuttgart; see R. Michael Rostron, *Light Cladding of Buildings*, The Architectural Press, London 1964, p. 24. Furthermore see Miles Glendinning, 'Moredun Housing Area, Edinburgh. Prefabricated metal dwellings of the 1940s housing drive', docomomo *Journal* 12, 1994, pp. 51-55 and Robert A. Mitchell, 'Whatever Happened to Lustron Homes?', apt *Bulletin* xxiii (2) 1991, pp. 44-53.

45 Joachim Krausse, Claude Lichtenstein (eds), *Your Private Sky: R. Buckminster Fuller: The Art of Design Science*, Baden 1999, pp. 135-137, 238-249, ; and Antoine Picon (ed.), *L'Art de l'ingenieur*, Paris 1997, pp. 156, 199.

46 The factories were shown at the 1927 Werkbund exhibition in Stuttgart even before they were finished.

47 Joris Molenaar, 'Blank verse in architecture. An introduction', in *Leen van der Vlugt,* Wiederhall 14, Amsterdam, undated, p. 3.

48 Frank Kauffmann, 'Kees van der Leeuw. A Principal in Search of Synthesis', in *Leen van der Vlugt,* Wiederhall 14, Amsterdam, undated, pp. 4-6.

49 Other noted figures of the Dutch avant-garde who were members of Theosophical organizations include Piet Mondrian and Leen van der Vlugt.

50 During his second tour of the usa in 1926, Van der Leeuw extensively visited the General Electric home office and laboratory headquarters in Nela Park, Cleveland, where he discussed the lighting schemes for the new factory in Rotterdam to send them to Brinkman and Van der Vlugt immediately afterwards.

51 Walter Gropius, *Idee und Aufbau des Staatliches Bauhauses*, Weimar/Munich, Bauhausverlag 1923. Van der Leeuw was a regular visitor at the Bauhaus, and also visited the building with Van der Vlugt to prepare for the planning of the factories. The Van Nelle curtain wall is derived from the Bauhaus workshop wing rather than from American examples.

52 Frank Kauffmann, op. cit., pp. 4-6.

53 In October 1926, in four weeks time he visited thirty-five industrial plants, research institutions and social organizations, among them the New York Metropolitan Section of the Taylor Society, R.H. Macey & Co., The Russell Sage Foundation Library, The American Posture League, and the Bureau of Women in Industry – as the majority of Van Nelle employees were female.

54 According to Frank Kauffmann, the iri was founded in 1922 but it is not precisely known when Van der Leeuw enrolled.

55 From ‘Cleveland, Ohio’ according to the inscriptions on the remaining rails.

56 Produced by the Crane Company, us.

57 Inspired by American examples, Van Nelle was the first Dutch company to develop a sales strategy for prepacked products, supported by the strong and remarkably modern graphics for their packagings and advertisements.

58 Van der Leeuw’s lecture given at the Netherlands Institute for Efficiency, Amsterdam, November 1930.

59 The photographers E.M. van Ojen, who had a documentary style of working, and Jan Kamman, whose artistic interpretations were more poetic, were both commissioned by Van der Leeuw to make photographic reports periodically. In between, Van der Leeuw himself made series of photos at various stages of the building process. Among other film-makers, Joris Ivens shot footage at Van Nelle.

60 It was one of the first factories in the Netherlands to be constructed on a concrete foundation, the on-site pile production being supervised by professors of the nearby Polytechnic of Delft; Joris Molenaar, ‘Van Nelle’s New Factories, American Inspiration and Cooperation’, in *Leen van der Vlugt*, Wiederhall 14, Amsterdam, undated, pp. 7-13.

61 Ibid..

62 Kees van der Leeuw, lecture given at the Netherlands Institute for Efficiency, Amsterdam, November 1930.

63 One of the first applications on record of the mushroom column system was that of Maillart’s experimental structures (patented 1908) in his warehouse of 1910 at Giesshübel, Zürich. It is not absolutely clear whether this type of construction had already been used in the usa. The reduction of half a metre in construction height per floor saved a full floor of the seven-storey tobacco factory.

64 James Lewis, ‘How does the bolt get into the concrete?’, in docomomo *Journal* 23, August 2000, pp. 43-50; the first power drill was patented by Black & Decker in the us in 1914, but was not commercially available until around 1923. The first European power tools were produced by Bosch in 1928.

65 The spandrel panels were originally insulated with impregnated peat and featured ventilation inlets. Due to production failure, the spandrel seams cracked and penetrating water reacted with phosphoric elements in the peat producing an acidic environment that devastated the panels within a few years. They were replaced by single-sheet panels, also omitting the inlets.

66 The owner, the Douwe Egberts Company, must be praised for its consideration in allowing the heritage authorities and the City of Rotterdam sufficient time to develop, in cooperation with that company, a working strategy for the building's future.

67 By late 1998, a commercial developer's proposal for the Van Nelle Design Factory was selected out of three nominations for an alternative use. Remarkably, the developer had no experience with redeveloping architectural heritage, but recognized the challenge of an emerging market for the re-use of large-scale historic industrial environments.

68 Various consultancy teams are active under the supervision of Wessel de Jonge architects. The infill for the three factory buildings has been designed by Claessens Erdmann Architects & Designers, Amsterdam; the redevelopment of the storage halls and dispatch building is the work of Wessel de Jonge architects; the landscaping is by ds Landscape Architects, Amsterdam; Molenaar & Van Winden have been invited to tackle the future project of the office building.

69 A major book on the original Van Nelle factory complex, the protagonists of its creation and the Design Factory project, is scheduled for publication in 2003 by De Hef publishers, Rotterdam. The redevelopment project is outlined in the 1996 Masterplan conceived by Wessel de Jonge architects. The first stage of the project has been reviewed in Bruno Reichlin, 'From product to process. The Van Nelle Factories in Rotterdam ...', in docomomo *Journal* 26, December 2001, pp. 44-51. The project involves large-scale maintenance of the original envelope and an infill created by secondary glazing, leaving corridors at the shadow side and creating a climate-wall on the sun side. Partitions between rented units are transparent above 2.25 metres and nowhere encroach on the original facade. In addition, the impact of new lighting fixtures, interior fittings and the positioning of tall furniture has been carefully assessed.

70 Hans Blumenberg, *Die Legitimität der Neuzeit/The Legitimacy of the Modern Age*, Frankfurt am Main 1966/Cambridge, Mass. 1985, as paraphrased in Ola Wedebrunn, *Character and Language of Material*, English summary of PhD thesis, Copenhagen 2002.

