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Invention, Innovation, Change in Architecture: Arguments from the Escalator of a Fantastic Mall, Conceived as an Apocryphal Illustration to *Little Women*

ABSTRACT: This article explores how invention, innovation and change work in architecture through the description of a project for an imaginary mall, where the four protagonists of Louisa May Alcott's novel *Little Women* are imagined shopping. The four characters are on an escalator, an innovative element of architecture invented to compete with stairs. Malls are also a recent invention, compared to thousands of years of architectural history. The project for this mall, that is titled "Mall of Progress," offers the opportunity to compare inventions and innovations from other fields with inventions and innovations in architecture, and to discuss how they can prompt change in and outside the discipline. Furthermore, the article discusses if architecture can be considered an agent of progress, as many inside the discipline do claim.

KEYWORDS: elements of architecture, architecture and science, architecture and technology, agency of architecture

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Introduction

Curvilinear stairs for palaces, churches and open spaces have been in the repertoire of architects for centuries. When escalators were introduced in architecture, at the end of the 19th century, there was an initial competition between straight-lined and curvilinear schemes. Mechanical problems, however, soon left architects with only one option, the straight-lined escalator; the innovation could not be molded to fit architectural ambition.[1] The escalator was an innovative element of architecture. It was invented in the field of mechanical engineering and its invention was made possible by inventions and innovations in other fields, in the foreground of the industrial revolution. When the escalator entered architecture, it was used typically in urban malls.[2] These were an architectural response to the change towards consumerism that was taking place in industrial societies. So, an architectural innovation, i.e., the mall, had to include the constrains inherent to an innovation in mechanical engineering, i.e., the escalator, and was prompted by a change in society whose roots in the industrial revolution were extraneous to architecture itself. Buildings such as factories, warehouses, stations, and housing for workers were designed in a specific way as a consequence of industrialization, but none prompted it. The steam engine was not invented to fill a vacant factory.

The escalator and the mall suggest that architecture is not a sovereign discipline, and as such its agency is limited, possibly even naught. Yet, in the 20th century, the architects of the Modern Movement and their acolytes claimed that their innovations could bring progress to society by changing its built environment. In different contexts, they claimed to be consistent to different political visions about what progress is, from totalitarianisms to democracies. In all contexts, innovations from other fields deeply affected the way in which their buildings were designed: sewers, aqueducts, electricity, telecoms, etc. Innovations from other fields also impact contemporary architecture, where the claim of bringing progress to society is also widely spread, with "sustainability" as a watchword.[3]

Since progress is such an important goal for modern and contemporary architecture, and claiming to be progressive seems often to be a

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[1] R. Koolhaas, AMO, Harvard GSD, "Escalator," in *Elements of Architecture*, Marsilio, Venice; Rizzoli International, New York, 2014, pp. 20–23.

[2] S. J. Weiss, S. T. Leong, "Escalator," in R. Koolhaas *et al*. (eds.), *Harvard Design School Guide to Shopping*, Taschen, Köln, 2001, pp. 337–365.

[3] On the use of the word 'sustainable' in contemporary architecture vocabulary, see R. de Graaf, *Architect, Verb: The New Language of Building,* Verso, London, 2023, pp. 65–84.

preliminary requirement for architects, it may be worth to investigate how change in architecture can be linked to progress.

In this article I discuss the following four terms: invention, innovation, change and progress.

For invention, I use a meaning from common language: "the creation of something not previously in existence: purposeful experimentation leading to the development of a new device or process."[4]

By innovation, I mean the process itself through which the "new device or process" is diffused on a vast scale. This can happen, for instance, through the commercialization of a product, or through the adoption of a tool or a method in the production or in the design of something.

By change, I again use a meaning from common language: "a passing from one state to another marked by radically different makeup, character, or operation, whether by sudden mutation or gradually by evolution."[5]

For progress, equally, I use the word's most common meaning: "the action or process of advancing or improving by marked stages or degrees: gradual betterment, *especially*: the progressive development or evolution of mankind."[6]

These terms can flow one into the other: an invention becomes an innovation, which brings change, and in turn progress. The link between innovation and change is given, but not all inventions become innovations.

For example, the wheel was invented in different times and places, including in Central America well before the arrival of Europeans. However, in Central America its innovative potential was thwarted by the absence of animals that could pull a cart; wheels were occasionally used for toys.[7]

Furthermore, not all change is progress. For example, the introduction of asbestos in the building sector at the end of the 19th century was a successful innovation. Panels, tiles, shingles and tubes made of it rapidly encountered the favor of contractors. "Asbestos was nicknamed the 'magic mineral' upon discovery due to its exceptional flexibility, tensile strength and fire resistance—it was present in over 4.000 products," but

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4 *Merriam-Webster Unabridged*, s.v. "invention, 4a," https://unabridged.merriam-webster.com/unabridged/invention, (accessed 12 April 2024).

5 *Merriam-Webster Unabridged*, s.v. "change, 2b," https://unabridged.merriam-webster.com/unabridged/change, (accessed 12 April 2024).

6 *Merriam-Webster Unabridged*, s.v. "progress, 4a," https://unabridged.merriam-webster.com/unabridged/progress, (accessed 12 April 2024).

7 J. Diamond, *Guns, Germs, and Steel: The Fates of Human Societies*, W. W. Norton, New York, 1997, p. 237.

asbestos was carcinogenic, as it emerged later.[8] In the change brought by the diffusion of asbestos-made materials there is no progress because the positive features, i.e., faster and less labor-demanding construction and fire-safer buildings, are counterbalanced by countless cancer diagnoses.

In my argument, I am using an imaginary poster as a prompter. This poster illustrates an imaginary mall that I designed, and which I will describe.

Poster

In a mall four young women are standing on different ramps of the escalator, each carrying an object that she just bought. It may seem an ordinary scene of shopping, but the goods they carry are peculiar. One, on the lower ramp, is holding a model of the steam engine perfected in 1776 by the English instrument maker James Watt, in a crucial step of industrialization. On the ramp above, another is holding a personal computer "Lisa," released by Apple in 1983, a milestone in the spread of informatics. The girl on the upper ramp is holding a model of the penicillin molecule, discovered by the Scottish physician Alexander Fleming in 1928, prompting a definitive move against bacterial infections. The girl on the upper ramp is holding a model of a Ford Model T, the first mass-produced automobile, launched in 1908. The four objects represent radical innovations in science, technology, and industry, whose consequences had an incommensurable and long-lasting impact.

The shoppers are the four sisters March, protagonists of the American saga *Little Women*, published by Louisa May Alcott between 1868 and 1880. In the years in which the novel is set, malls were yet to come, but this is an anachronistic episode that I allowed myself to imagine, in which the four sisters share a daydream about future America, on an afternoon of the 1860s when they are all together in their living room.

The first reason I selected the novel *Little Women* is that it is widely known, so that it is easy to find information about it for readers who are not familiar with Alcott's work. More relevant, the plot has four protagonists, allowing me to articulate the discourse in the four parts that I use to make my argument, each focused on an example. Another widely popular novel with four protagonists is, for instance, *The Three Musketeers* by Alexandre Dumas. But I selected Alcott's work also for reasons

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[8] G. James, P. Rahm, C. Mosbach, "Asbestos, UV Rays," in G. Borasi, M. Zardini, (eds.), *Imperfect Health: The Medicalization of Architecture*, Canadian Centre for Architecture/ Lars Müller Publishers, Zurich, 2012, p. 184.

of content, not only of structure. Indeed, each of the four protagonists has a specific character that can link her to one of the four examples that I am making, which cannot be said of Dumas' novel.

On the lowest ramp, Meg is holding a model of Watt's steam engine. Of the four sisters, she is the most hard-working, and thus she acknowledges the importance of a machine that allows for the conduct of an enormous amount of work. On the lower middle, Jo is holding a "Lisa" personal computer. Among the sisters, she is the one who strives to publish her own writings, and thus she fancies a device that facilitates writing in a way unimaginable to her. On the higher middle ramp, Beth is holding a model of the penicillin molecule that could have saved her life from disease, had it been discovered decades prior. On the highest ramp, Amy is holding a model of a Ford T. Among the sisters, she is the one who loves travelling, and she is thus fascinated by a means of transportation that would allow her to go all over the country, had it been invented at the time.

The mall is dedicated to progress. Souvenirs and memorabilia of inventions and innovations from a specific sector are on sale at each floor, recognizable from the color of the escalator's ramp that goes to it. The sisters are shopping on floors dedicated respectively to mechanical engineering, informatics, biology, and automotive. There is also a floor dedicated to architecture, but it is empty. We could try to fill it with architectural inventions and innovations. The March sisters are excited by the amazing experience of standing on automatic stairs in a vertiginous void. Certainly, they would be happy to receive something architectural from the mall, once they are back home; possibly something analogous to what they just bought. So, what could be sent to each of the Marchs? In playing this game, I am avoiding connections that historiography could suggest, for instance linking the Ford T to the spread of ramps, garages, motels etc. The links shall be based on analogies, not derivations.

I.

The steam engine is at the very origin of industrialization and of what came with it. Few other inventions could be more effective if one wants to defend the thesis that technology drives history.[9] The change brought about by the steam engine was so radical that a political movement was

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[9] On this vexing question, see R. L. Heilbroner, "Do Machines Make History?," in L. Marx, M. Roe Smith (eds.), *Does Technology Drive History? The Dilemma of Technological Determinism*, The MIT Press, Cambridge, Mass., 1994, pp. 53–65.

formed to fight against it, i.e., Luddism, in the first decades of the 19th century. Members of the movement engaged in destroying machines powered by steam engines because they perceived them as disruptive for humans, eliminating their jobs, alienating their work, threatening their dignity.[10] Steam engines already existed in the 18th century, but only after James Watt in his Birmingham workshop introduced a number of modifications, the invention stepped up to innovation. "On Monday 11 March 1776, Aris's Birmingham Gazette carried an account of how 'a Steam Engine constructed upon Mr. Watt's new Principles' was set to work at Bloomfield Colliery, near Dudley in the Midlands."[11] Steam engines rapidly spread in England thanks to factors such as capital, a large labor force and the presence of a "knowledge economy" prompted by laws that protected intellectual property. Without these, the changes caused by Watt's invention would have been slower, but it is difficult to think that they would have been blocked, as the case of rapid industrialization in countries without a culture favorable to innovation show.[12] The steam engine had an inherent power for change; it was later replaced by other machines for generating power, but its crucial role in a cause-effect series that brought about the long run to globalization is difficult to downplay. In this perspective, the progress prompted by the steam engine consists of the exponential increase in the availability of goods of any type. Both capitalism and Marxism, the two contending ideologies on how to manage industrialization, acknowledged as progressive the increase in the availability and variety of goods. With the exception of radical ecologies invoking a return to a pastoral and agricultural society, progress has thus been considered inherent to Watt's invention.

So, what could be an architectural equivalent to the steam engine that could be sent to Meg March, to provide her with another souvenir from the Mall of Progress? It must be indisputably at the origin of a pervasive and durable change. It must also be something on which there is a wide consensus that it prompted progress. Furthermore, it must be something that passed rapidly from the step of invention to that of innovation. Starting from the first requirement, to make sure we are actually addressing

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[10] K. E. Hendrickson (ed.), *The Encyclopedia of the Industrial Revolution in World History,* vol. 3, Rowman & Littlefield, Lanham, 2015, s.v. "luddism."

[11] B. Russell, *James Watt: Making the World Anew*, Reaktion Books, London, 2014, p. 109.

[12] See chapters 4 and 5 in T. Kemp, *Industrialization in Nineteenth Century Europe*, Taylor & Francis, London, 1985.

something relevant, we may start from the very origins of architecture as a recognized discipline. The change would thus consist in the establishment of it as a specialized intellectual activity, distinct from the physical construction of buildings.

When we address what is at the origin of architecture, we enter inevitably into a heated and layered discussion, to which it is difficult to find a beginning. The climax of this debate was in the second half of the 18th century, in the foreground of the Enlightenment preoccupation with searching for the natural conditions of humankind before history. In the 18th-century search for the origins of architecture, powerful images were created to show how architecture descends from the observation and imitation of nature. Among those, the most prominent is the primitive hut which occupied the frontispiece of Marc-Antoine Laugier's *Essai sur l'achitecture*, published in 1755.[13] In the foreground of the illustration, a young woman embodying architecture points at a small grove where the branches of the trees intertwine to form a natural, leafed roof, while the trunks resemble columns. In the author's argument, this accidental hut is the origin of architecture, as already the Roman architect Vitruvius claimed. Indeed, the structure and the shape of the Greek temples have been inferred from it, wrote Vitruvius (Vitr. IV, 1–2). Laugier and numerous other authors in Europe spread this thesis, but there is no archeological evidence of the theory of the primitive hut. So, a model of it cannot be the architectural gift to Meg March from the Mall of Progress.

Then what about the Greek temple itself, from which the primitive hut was created as an ex-ante justification? Greek temples inspired countless buildings for thousands of years in all continents, with their combination of columns and capitals of various orders resting on a staired basis and holding architraves, tympanums and a roof. There are many more *minutiae*, and plenty of variations in the "temple-formula," but nevertheless this formula remains recognizable through different epochs, programs, places, and regimes. A canonic example, related to Watt's invention, is the AEG Turbine Factory built in Berlin in 1909 under the design of Peter Behrens, where the "temple-formula" is used to monumentalize industry.[14]

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[13] The drawing is by Charles-Dominique-Joseph Eisen who strictly followed Laugier's arguments. The original edition has been reprinted in facsimile: M. Laugier, *Essai sur l' architecture*, Gregg, Farnborough, 1966. On Laugier, see W. Herrmann, *Laugier and Eighteenth-Century French Theory*, Zwemmer, London, 1985.
[14] S. Anderson, *Peter Behrens and a New Architecture for the Twentieth Century*, The MIT Press, Cambridge, Mass., 2002, pp. 113–128.

The transmission of the formula from antiquity to modernity can be traced through authors and books, from Vitruvius to the Italian writers of the 15th and 16th centuries, such as Leon Battista Alberti, Jacopo Vignola, Andrea Palladio, and Vincenzo Scamozzi, to Colen Campbell, the *Vitruvius Britannicus* of the early 18th century, who ensured the transposition of the formula to the Anglophone world, to the French theorists who in 19th century adapted it to modernity, down to the more or less ironic or engaged disquisitions on its permanence in the post-modern. In all versions, each with different nuances, the "temple-formula" is identified as the most recognizable product of a specifically architectural intelligence. Therefore, can the Greek temple be identified as the origin of architecture?

There are other theories on the origin of architecture, and many would claim that the question itself of the origin or the origins is useless, naïve or unresolvable. But nevertheless one could not deny that western European architectural culture which spread to other continents attributed to the Greek temple the role of prompting the change from the manual labor of building mere shelters to the intellectual activity of architecture. It is impossible to individuate a convincing "first," i.e., the specific place and time when the "temple-formula" was invented. Archeologists suggest that it was a long, gradual, collective process, so that the steps of invention and innovation blur, but the change that they prompted is undeniable. Further, what about the progress prompted by this change? Notwithstanding the opinion that one has about the aesthetics that derive from the "temple-formula," it may be inferred that it gave a crucial contribution to the emergence of architecture as a culturally specialized discipline and a socially recognized profession. In this way it contributed on a larger scale to the division of labor, responding more efficiently to the demand for hosting the functions of a complex society. Only from radical positions invoking a return to primitive conditions one could oppose to associate complex society to progress; as with the increase in goods' availability and variety prompted by the steam machine.

So, let us give Meg March a model of a generic Greek temple.

2.

The Apple Lisa is the first personal computer with a graphical user interface, commercialized in 1983. As such, it represents a pivotal moment in the path to our current condition of software-dependency, and indirectly to our online existences. Differently from other personal computers on the market then, Lisa featured a graphic representation of the file system and a mouse to navigate through menus and applications. The Lisa operating system was also innovative, offering cooperative multitasking and protected memory, which were cutting-edge for its time. Due to its high cost, Lisa was unsuccessful, which prevented its use as a real B2C product, and after three and a half years it ceased production. Its successor Macintosh, launched when Lisa was still on sale, used most of Lisa's characteristics at a more affordable price, and started the competition for mass-diffused personal computers, equipped with a graphic user interface. Hence, despite its lack of commercial success, Lisa paved the way for future advancements, shaping the evolution of the computer industry in ways that resonated far beyond its market impact. The innovative power of Lisa was fueled by a number of previous inventions and innovations, such as the microprocessor, which in the 1960s and 1970s allowed the development of the first personal computers. Actually, Lisa was not even the first personal computer with a graphic user interface, because in 1973 Xerox PARC developed its Alto personal computer with one. However, its power of innovation was limited by the fact that it was never commercialized. The change prompted by Lisa and the following personal computers was massively effective; it consisted in the enhancement of the human mind capacity to access and process data and information. Progress is thus in the fact that the personal computer increased individuals' knowledge to an unprecedented level. As with the industrial revolution, there can be radical positions that deny the progressive character of the digital revolution, of which the personal computer is a fundamental component. But if we do not embrace a return to primitive conditions, it is impossible not to equate progress to the change that was prompted by an innovation such as Lisa.

So, what could be an architectural equivalent to Lisa that could be sent to Jo March, to provide her with another souvenir from the Mall of Progress? It must be something that brought a change consisting in the increase of an ability, and this increase should be significant. It should benefit inhabitants, users and visitors of buildings, as well as an architecture audience, since Lisa was conceived as a B2C product. For instance, we may think about air conditioning, an innovation that from the 1930s allowed to live in "well-tempered" environments even on hot days, thus allowing humans to work and dwell in all climate conditions.[15] However,

[15] Despite its widespread presence in modern architecture, air conditioning received the attention of scholars quite late. See R. Banham, *The Architecture of the Well-Tempered Environment*, The Architectural Press, London, 1969.

in Anthropocene the spread of air conditioning could also be viewed as a cause of pollution and global warming, particularly of the "urban heat island" effect. The step from change to progress is questionable.

We may thus turn our attention from systems to structures, and consider that in modern times the invention of new structural materials dramatically improved the human capacity to shelter. The invention of reinforced concrete, for instance, allowed contractors to build huge buildings in much less time. Widening the view, we could infer that the empowerment also affected societies in general, dramatically expanding the number of available homes, and effectively improving the dwelling conditions of multitudes of families, freed from forced cohabitation or even homelessness. The migration of masses of formerly agricultural workers to cities would have happened in much harsher conditions of the newly urbanized had reinforced concrete not been invented. Though, going back to Lisa, we have to acknowledge that its designated clients were small businesses and individuals. Conversely, reinforced concrete required complex organizations and big capital, at least early in its diffusion. It needed specialized workforces that had to accurately follow the indications of specialized engineers, and it implied the use of specific machineries and of an extended supply chain. For these reasons, steel construction—another innovation of modernity—is even a weaker candidate, because its high costs limited its use almost only to corporate buildings and factories in countries rich in steel. New materials prompted the invention of prefabrication systems, so we may think also to prefabrication, but again large organizations and extended control over urban growth are needed.

But there is yet another structural and constructive system that appears in the history of modern architecture: the balloon frame. It is mentioned as a predecessor of a modern, utilitarian approach to architecture. Let us consider its candidacy: it was invented in Chicago in the 1830s and then rapidly spread from there to all the United States. There are disputes about who the inventor is and which building was the first to be completed with it, but its rapid and effective diffusion, so its innovative role, encounters no objections in literature.[16] The balloon frame implied no new material. It was a new technique to build timber structures

[16] For a reconstruction of the supposed first balloon frame building, a warehouse by George Washington Snow completed in Chicago in 1832, and of following early cases, see P. Andersen, J. Kelley, P. Preissner, *American Framing: The Same Something for Everyone*, Park Books, Zurich, 2023, pp. 154–158.

of limited height, so typically independent houses. As in the case of Lisa, the balloon frame was made possible by other innovations. One was the diffusion in the United States, from the early decades of the 19th century, of sawmills where the energy of water was replaced by that of steam engines. This allowed wood to be cut in less time and with more precision. As a consequence, the production of sturdy and neatly shaped slender timber beams became technically feasible and economically convenient. Another innovation was the industrialization in the production of metal nails, again thanks to the introduction of steam-powered nail-making machines, in the same period. The balloon framing combined those two: a cage of slender timber members joined with a profusion of metal nails.

The balloon framing did not need a specialized labor force, as opposed to the traditional timber construction that required skilled carpenters for carving the joints of massive elements, in times when nails were scarce and higly expensive. Conceptually, it consisted in the disassembly of heavy timber construction: each thick element was replaced by a number of slender elements that all together concurred to a sturdy structure thanks to their number and to the abundance of nails that connected them.[17] The name itself is said to be derived from the association of this light structure to a hot air balloon. The intrinsic lightness of the system secured its rapid diffusion from the sky-rocketing residential building market of Chicago to the rest of the United States. It allowed for a complete transformation of the land, with new towns or suburbs appearing everywhere. The balloon frame allowed small, often improvised contractors and developers, even lay members of the public to build their own homes as a DIY activity. Likewise, Lisa was aimed at empowering small businesses. The balloon frame changed an entire nation and beyond, Canada and some parts of South America.[18] The step from change to progress is evident inasmuch as one considers progressive the dramatically increased ability to build houses almost everywhere, quickly and cheaply. Millions of families have been housed in single homes thanks to the balloon frame and its improved versions. Surely, conversely, there is a wide literature opposing suburbanization and the spread of commuting as a lifestyle.

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17 P. E. Sprague, "The Origin of Balloon Framing," *Journal of the Society of Architectural Historians,* 40, 4, 1981, pp. 311–319.

18 M. Pizzi, "The Invention of the Balloon Frame, how it Affected Architecture in the New World. The Case of Chile," in S. Huerta (ed.), *Proceedings of the First International Congress on Construction History*, Instituto Juan de Herrera, Madrid, 2003.

Adding to the shipment books which speak against suburbanization, such as *The Feminine Mystique* or *Crabgrass Frontier*, let us send to Jo March the model of a balloon frame, taken from a 20th century carpentry handbook.[19]

3.

The discovery of penicillin by the Scottish physician and microbiologist Alexander Fleming marked a turning point in medical history, revolutionizing the treatment of bacterial infections and laying the foundation for the era of antibiotics. The discovery happened in a serendipitous way in 1928, when Fleming realized that a mold in his laboratory at the St. Mary's Hospital in London had contaminated a petri dish of staphylococcus bacteria, and had killed the bacteria surrounding it. The mold was later identified as arriving from a nearby room where a colleague was doing his own experiments, but Fleming quite immediately identified it as belonging to the *Penicillium* genus. This discovery was not a fortuitous event in Fleming's scientific path, since his interest in treating infections started in the hospital fields of the First World War, where he served as a medical officer of the British army. In this position, he had to see how the antiseptic treatments in use were tragically ineffective. After the war, he started to research the topic and was recognized as a brilliant scientist. Despite his reputation, when in the late 1920s he disseminated his discovery of a bacteria-killing mold, i.e., an antibiotic, he did not find much enthusiasm in the scientific community. This was due to the fact that nobody, including Fleming, could see how penicillin, if properly developed, could be produced on a mass scale. There are different views among historians on whether in the 1930s Fleming actually continued to believe in the innovative potential of his discovery, although he made experiments on a few individual cases. The turning point arrived only after a decade, during World War II. It was when Fleming had the chance of joining his experiences with a team of microbiologists and pathologists in Oxford who were researching antibiotics. They found a way to produce a proper quantity of penicillin to start trailing it, and it proved successful. Soon the American and the British medical military authorities acknowledged

[19] B. Friedan, *The Feminine Mystique*, W. W. Norton, New York, 1963; K. T. Jackson, *Crabgrass Frontier: The Suburbanization of the United States*, Oxford University Press, Oxford, 1985. The illustration is from: *Audel's Carpenter's and Builder's Guide*, Theo Audel, New York, 1923.

the life-saving potential of Fleming's discovery against bacterial infections in field hospitals.[20] A number of different antibiotics, specific to different bacteria have since been produced. Fleming's discovery became a globally diffused innovation, and it massively changed medicine, producing a radical benefit through its effectiveness. Recently, mutations of bacteria that "learned" how to survive antibiotics caused concerns about their use as a global panacea, but even their most vocal critiques cannot deny the role of antibiotics in saving millions of lives.

So, what could be an architectural equivalent to penicillin that could be sent to Beth March to provide her with another souvenir from the Mall of Progress? At first, it should be something that has brought a vast, long-term change, and this change should be widely recognized as beneficial. If we start the search by acknowledging how the discovery of penicillin effectively contributed to improving the resilience and the health of humans, we may think of a building or a class of buildings that did the same. However, all buildings perform a basic sheltering function and are thus beneficial to humans, so it would be difficult to justify choosing one over another. Maybe we could replace humans with buildings: what could be an invention that benefited buildings, making them more durable, resilient, and sturdy?

Lots of candidates could be picked in the history of the science of materials. For instance, products against weathering, or against pests? All these brought great benefits to buildings, but it is as difficult to select one among dozens, as it is to find "the first." Or should we look again to structural materials such as cast iron or reinforced concrete that made buildings sturdier? Provided that the life span of reinforced concrete is shorter than that of cast iron, we could tentatively go for the latter. But what would be the invention or the discovery? A new technique for producing steel such as the one that Henry Bessemer developed in Sheffield in 1856? Perhaps, but William Kelly did something very similar in Pittsburgh at the same time. Moreover, multiple studies on stainless steel that dramatically prolonged the life span of metal products took place in the early 19th century, but with a first focus on cannons, not on buildings. To bypass those intricacies, we might step back in the process, and address the science of construction which comes before a structure is built. In this discipline we can find an equation that allowed to drastically simplify

[20] For a scholarly history of the discovery of penicillin, see G. Macfarlane, *Alexander Fleming: The Man and the Myth*, Oxford University Press, Oxford, 1985.

the calculation of steel structures, marking a turning point in civil engineering that is proxy to penicillin in medicine. This is the equation of de Saint-Venant, published in 1855 by the French mathematician, mechanician and engineer Adhémar Jean Claude Barré de Saint-Venant.[21] Having graduated in 1816 from the newly founded École polytechnique in Paris, de Saint-Venant had a quintessentially polytechnic mentality which brought him to investigate a range of different topics, among which the theory of elasticity. Without him, the innovative potential of inventions and discoveries related to steel would have been dwarfed by the impossibility to predict the behavior of structures built with it. These structures are typically made of slender elements with a certain level of elasticity, and the equation of de Saint-Venant investigated the behavior of an abstract, elongated solid that is a generalization of a beam.

Regarding this solid, de Saint-Venant formulated some hypotheses about the geometry, the behavior of the material, and the loads applied. As to geometry, he worked on the hypothesis of an elongated shape, where the surface of the cross section is very largely minor to the length of the longitudinal axis. Additionally, the cross section must be constant and the longitudinal axis line must be barycentric and straight. As to the material, it is hypothesized as being homogeneous and isotropic, and that its behavior is linear elastic. As to the forces, de Saint-Venant postulated that the lateral surfaces of the volume, so the elongated ones, are free from any load; that the volume forces are zero; that loads are applied exclusively at the bases. The principle of de Saint-Venant states that the difference between the effects of two different but statically equivalent loads becomes very small at sufficiently large distances from the load itself. In this way it simplified the elastic problem formulation that otherwise involves solving a system of extremely complex differential equations.

Allowing an analytical solution of the problem, de Saint-Venant created the basis of structural mechanics, because this solution can be used to study the state of stress of one-dimensional beam-type elements. Structural engineers have been empowered by de Saint-Venant to approximate the effects of complex load distributions with simpler ones, as long as they shared the same resultants. Moreover, the de Saint-Venant's solid and its resolving equations allowed not only to study how beams deflect but also to develop the theory of torsion in beams. On the long

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[21] A. J. C. B. de Saint-Venant, "Memoire sur la torsion des prismes," *Mem. Divers Savants*, 14, Paris, 1855, pp. 233–256.

term, well into the 20th century, the finite element analysis replaced the method of de Saint-Venant, but it was actually developed from it. The innovative consequences of de Saint-Venant's are thus to be found in further theories as much as they can be detected in the history of modern architecture, because they allowed to fully exploit inventions and innovations in the production of steel. The change towards verticality in the urban skylines of the 20th century is the most visible consequence of these innovations, since countless high-rises have a metal structure. The progressiveness of this change would be questioned from anti-urban positions and, as always when anything is built, from the standpoint of radical ecologies.

But if we admit that more sturdy, long-lasting offices and residences are positive for billions of humans, we send to Beth March the model of a de Saint-Venant solid, in semirigid rubber as it usually is in demonstrations in classes of architecture and of engineering.

4.

The Ford Model T had a pivotal role in automotive history, prompting the advent of mass-motorization in the United States. The Model T was sold in more than fifteen million units during its years on the market, from 1908 to 1927, and provided the inspiration to European and Japanese manufacturers to replicate the success.[22] The model was conceived as an exercise in simplification by Henry Ford, founder of the eponymous Detroit-based motor company in 1903. In pursuing simplicity, the goal of Ford was to make the car cheap enough to be affordable also to the working class, strong enough to be used on all streets of America, and intuitive enough to be repaired even by handymen with no specific training. "Every man is his own mechanic with a Ford," claimed a 1916 advertisement.[23] Ford pursuance of simplicity was addressed to the car itself as well as to its production. As to the car, the components of its motor and chassis were studiously limited in number and kept elementary at the cost of avoiding evolution. For instance, the obsolete planetary gearsets were never replaced with the sliding gear transmissions.[24] As to production, since 1913 the Model T was assembled on a moving assembly line. This

[22] L. Brooke, *Ford Model T: The Car That Put the World on Wheels*, MBI Publishing Company, Minneapolis, 2008, p. 18.
[23] *Ibid.*, p. 11.
[24] *Ibid.*, p. 16.

system already proved its efficiency in the meat packing industry, but, applied to the automotive sector, it magnified the effect, and each unit's assembly time was reduced from over 12 hours to circa ninety minutes. This improvement was based on the discretization of the work into single operations so that each worker was dedicated only to a few of them; it was thus a radical simplification. The Model T was relying on a number of previous inventions, among which the "vehicle powered by a gas engine" patented by the German Carl Benz in 1886 is the most obvious. Though, it brought those inventions to an unprecedent level of innovation because of the effort for simplifying them that Ford did, including the adoption of the moving assembly line. The innovative power of the Model T prompted a gigantic, long-term change, transforming cities and territories in de facto infrastructures for cars and giving the daily rhythm to the lives of billions. Of course, this came with pollution, traffic jams and accidents that sometimes brought to the consideration of car as an enemy of humanism; though as far as we understand individual mobility as an attribute of freedom, this change is also progressive.

What then could be an architectural equivalent to the Model T that could be sent to Amy March, to provide her with another souvenir from the Mall of Progress? First, it must be something that has its rationale in simplification or at least in being simple.[25] Second, it should be something rooted in modernity.

Maybe, the history of modern architecture could be again a source of suggestions, as with the balloon frame. In this case, an obvious candidate appears, the standard-bearer of simplicity as the essence of modern architecture, whatever essentialism could mean in architecture. This character is Ludwig Mies van der Rohe, German and then American hero in the narrative of modern architecture, among whose widely popular aphorisms, "less is more" is probably the most praised and the most contested. In Mies' ideal, the architecture for the 20th century had to exploit the new building materials and new building techniques to reach what he considered the core of architecture itself, i.e., a simple, well-recognizable order. In another, quite obscure dictum, Mies identified this order as the "will of the age conceived in spatial terms" and in another, more plain and widely popular, he explained a secret for reaching this order: "God is in the details." When it came to Henry Ford, Mies was blatant: "what

25 On the concept of simplicity in modern architecture, see A. Forty, *Words and Buildings: A Vocabulary of Modern Architecture*, Thames and Hudson, London, 2000, pp. 249–255.

Ford wants is simple and illuminating."[26] In pragmatic terms, Mies' design was based on regular layout in plan, on vast homogenous, preferably transparent surfaces in elevation, marked by a few vertical straight lines, and on the limitation of visible joints in the detailing. All the prolific activity of Mies that spanned from the 1910s to the 1960s and from Germany to America was inspired by this ideal.

If one admits the prominence of Mies, then a building could be found in his repertory to be an equivalent to the Model T. And what could be this building? It is of course difficult to pick one that is more "Miesian" then all the others, but since there is a component of irony in the game of finding architectural souvenirs from the Mall of Progress, this difficulty does not prevent the search. And since for the Model T the simplification was not only inherent to the product but also to the production process, it could be worth considering the techniques employed in the building process and not only the features of the completed building. In this case, a building from the late years, one that Mies saw only in construction, could be an interesting candidate: the New National Gallery in Berlin, opened in 1968. In terms of the object, more than half of its volume is hidden under an urban pedestal from which the upper part of the museum emerges. This is a self-standing, independent, neat pavilion with a simple square plan. The dominant element is the roof, a massive cast iron structure coated in black, with each side spanning 64 meters and with a height of almost two meters. On each side only two slender columns are holding the roof, almost disappearing thanks to their black coat, the same of the roof. The façades are recessed by 18 meters and made of large glass panes with thin frames that maximize the transparency, so that they disappear under the shade projected by the roof. The interior of the pavilion is free from any support, an open space of large scale. All these features make the NNG a radical exercise in simplification. First, because it is a complex series of volumes whose urban visibility is reduced to a pavilion. Second, because the pavilion is designed to appear as a floating roof, unbothered by other elements of architecture.[27]

The construction process of the pavilion was also simplified because the roof and the eight columns were erected all together on the building site, using the so-called "lift slab" technique. This came into fashion in

[26] *Ibid.*, p. 254.

[27] On the roof of the Neue Nationalgalerie, see M. di Robilant, "Gridding off the Sky: The Roof," in J. Jäger, C. von Marlin (eds.), *Neue Nationalgalerie: Mies van der Rohe's Museum*, Deutscher Kunstverlag, Berlin, 2021, pp. 153–161.

the US construction industry around the mid-1950s, so that it was not innovative in 1965, when the construction of the NNG started. In the same way, the moving assembly line was not an innovation introduced by Ford for the Model T. The "lift slab" technique consisted in assembling a slab on the ground, and then lifting it to the desired height, 8,70 meters in this case. The eight load-bearing columns were attached to the same hydraulic jacks that were used to lift the roof up, so that from a quasi-horizontal position they were brought to their final, vertical position. After the columns were fixed to the pedestal, the cover was dropped from the circa 15 centimeters added to the final height of 8,70 meters and fixed to the heads of the columns. The process was inherently spectacular and lasted a couple of days, during which the roof was slowly, constantly lifting, dragging the columns with it.[28]

The NNG is an invention that emerged from Mies and his office, together with the civil engineering office that calculated the structures. As any complex building, it was embedding previous inventions and innovations in architectural thought and in building techniques. Among the firsts was Mies' own "less is more" formula, which he had been practicing for decades. Further, there was the "lift-slab" technique, imported from America. The NNG brought an obvious change to the urban surroundings, still scarred by the war, in the very fact that it was built. Part of this change was not due to the agency of the architectural project because the building site was selected through a planning activity that happened before Mies was chosen as the architect. The NNG also brought change in the cultural landscape of west Berlin and of west Germany, for the very reason that it is a museum. However, how much this change is due to the institution and how much to its architecture, is an open question. The nearby concert hall designed in the same years by Hans Scharoun, successfully participated to the same effort of consolidating the cultural image and scene of a new Germany, but when it comes to architecture, it is based on complexification rather than simplification.[29] It is not a Model T. As to progress, which would consist in contributing to the identity of a free nation, it makes sense to consider it as far as we admit that the architecture largely prevailed on the institution, and that the contribution of urban planning was almost irrelevant. Both these positions seem arduous to be supported with documents. With these cautionary observations, we

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[28] *Ibid.*, p. 159.

[29] C. Krohn, *Hans Scharoun: Buildings and Projects*, Birkhäuser, Basel, 2018, pp. 140–147.

can send to Amy March a model of the Neue Nationalgalerie, in a scale that allows her to still hold it, while keeping the details recognizable, as Mies would have appreciated.

Conclusions

The Greek temple, the balloon framing, the solid of de Saint-Venant, and the New National Gallery offer insights into how the flow from invention to innovation to change to progress works in architecture. The four cases are deliberately drawn from different phases of the architectural project.[30] The Greek temple is a design concept, the balloon framing is a construction system, the equation of de Saint-Venant is a method of structural calculus, the New National Gallery is a built project. As far as we consider the links between invention and innovation, they behave similarly: disciplinary innovation is prompted from a collective or an individual invention, which is in turn prompted by other inventions or innovations from within and outside the field. As to the link between innovation and change, it is strong in the first three cases because they recognizably introduced changes in processes of design and construction. And when it comes to societies in general, the massive quantity of buildings that have been built under their influence seems in itself a factor of change. It is not about how these buildings changed the lives of their own users and inhabitants but about their impact on long-term cultural, economic, and political histories. Conversely, in the fourth case, change is less recognizable because we come across the conundrum of the agency of a specific architectural project. We cannot tell how far the history of the NNG after the opening of the building has been determined by its architectural design, or simply by decisions and actions that have been taken beyond it. When it comes to the link between change and progress, the first three cases show different nuances of evidence and, of course, they would find larger or smaller consensuses. The fourth, again, questions the very agency of buildings, and thus of architecture as an object out of the control of its designers. Referring to the "clouds and clocks" discussed by Karl Popper in his 1966 lecture on determinism in the philosophy of science, the NNG may suggest that buildings—even if they

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30 I am considering the "architectural project" in the sense of A. Armando, G. Durbiano, *Teoria del progetto architettonico: dai disegni agli effetti*, Carocci, Rome, 2017.

are designed with the ambition of making clocks—are more like clouds, once they are in use.[31]

Under these considerations, filling the floor dedicated to architecture in the Mall of Progress seems to be more controversial than filling other floors. But being controversial seems to be a constant of architecture that is not subject to change.

Intertwining architecture with philosophy, we may try to find some reasons for this, and a possible reason lies in the ambivalence of buildings between aesthetics and technology. Architects cultivate aesthetic ambitions for their buildings, and in the public discourse a common dichotomy for evaluating architecture is beautiful-ugly. Therefore, with reference to a seminal article by Mikel Dufrenne, we can consider buildings at the same time "technical objects" and "aesthetic objects."[32] As Dufrenne claims, "an aesthetic object distinguishes itself from the world" in opposition to a "technical object" which is made for the world.[33] The New National Gallery is a patent example of this: the upper pavilion is conceived to appear detached from the city surrounding it. On the other hand, as technical objects do, the NNG performs a number of functions. The performances of "technical objects" can be measured. In the case of the NNG, for instance, we can measure the performances of its systems and the strength of its structure. But when it comes to aesthetics, there are no measurements to rely on. How many people visited the building for its architectural features, and how many just because of the cultural programs hosted in it? How many people actually changed their opinion—to give a random example—about *Ostpolitik* because they appreciated the work of an architect who in his young years designed a monument to the Spartacists? These questions cannot be answered, for the simple reason that "aesthetic objects" put themselves out of the world, and therefore out of cause-effects sequences.

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[31] K. Popper, *Of Clouds and Clocks: An Approach to the Problem of Rationality and the Freedom of Man*, Washington University, St. Louis, 1966.

[32] M. Dufrenne, "The Aesthetic Object and the Technical Object," *The Journal of Aesthetics and Art Criticism*, 23, 1, 1964, pp. 113–122.

[33] *Ibid.*, pp. 116, 120.

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