Whirlwind
I: computer architectures as testing grounds for the spaces of modernity
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The interdisciplinary research Whirlwind I: computer architectures as testing grounds for the spaces of modernity explores how digital computers and computing technologies have influenced the formation, representation and reception of architecture since the mid-20th century. This article focuses on the link between architecture and computing, particularly as materialised in the architectural spaces generated literally by both disciplines: the technological device of the building and the technological device of the computer, which, in the cases of the First Generation, as we will see, correspond with each other.

The birth of the digital age of computing and the progress of modern architecture coincided in time and evolved in parallel. The evolution of the two specialties during these years can be described, studied and analysed according to common parameters and criteria.

A study of the spaces of the first digital computers reveals a series of specific characteristics that may have influenced or been influenced by the architectures that were developing in the purely architectural discipline at that same time.

This article explores and focuses on the architecture shaped by mainframes (or central units), the first digital computers belonging to the First Generation of Computing, which historians date back to the mid-20th century (1950-1960), after the end of the Second World War. Pre-generation computers

An orderly classification of these early examples of technological devices can be found in the research carried out by the American electrical engineer Gordon Bell, the co-founder, with Gwen Bell, of The Computer Museum (TCM) in Boston (USA). In 1980, Bell made a poster for the museum showing the first computer technology devices and their technologies, which had been involved in the birth of the digital computer, and organising them chronologically into four main groups [Fig. 01]: he listed the first electronic computers (computer technology devices), corresponding to the Pre-Computer Generations or Pre-Generations of computers, and later the first digital computers. He set the date for this birth between 1944 and 1945, when two events coincided: the launch of the Harvard Mark I (August 1944) and the publication of the “First draft of a report on the EDVAC” (June 1945) by J. Presper Eckert and John von Neumann.

In this classification, Bell organises the generations prior to the digital computer (or pre-generations) into four main groups: (1) the ‘manual generation’ (1600-1800), which included technological devices such as the Shicklunk calculator (1623) and punch cards (1720); (2) the ‘mechanical generation’ (1890-1890), which included Thomas’ arithmometer (1872), the comptometer (1887) and the analytical machine by Charles Babbage and his team (1833); (2) the ‘electromechnical generation’ (1890-1950) which incorporated examples such as the adding machine (1892) and the mechanical arithmometer by the Spaniard Leonardo Torres Quevedo (1920), located in the Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos of the Universidad Politécnica de Madrid; and, finally, (1) the ‘electronic generation’ (1935-1945), which was divided into two sub-groups: one for technological devices based on an electromechanical technology, which included examples such as the computers developed by Konrad Zuse (V1 or Z1.1936., Z2.1939 and Z3.1941), the Bell Labs Model I Relay Calculator or Complex Number Calculator (1937-1940) and the Harvard Mark I (MK I) (1937-1945); and the other for technological devices based entirely on an electronic technology: the Atanasoff-Berry Computer or ABC (1938-1942), the ENIAC (1943-1948) and EDVAC (1945-1951), developed in the United States, and the Colossus (1943) and Pilot ACE computers, together with their reports (1945-1948-1950), developed in the United Kingdom.

Bell’s diagram focused almost exclusively on American production and construction of mainframes. Thus, other cases belonging to the First Generation of Computing (digital computers) produced elsewhere could be listed, such as the BINAC (1948), the Whirlwind I (1945-1956), the SSEC (1946-1952), the IAS Computer (1946-1951), the SEAC (1950), the SWAC (1950) and the UNIVAC I (1951), all likewise developed in the USA; Manchester Baby (1948), Manchester Mark I (1949), Ferranti Mark I (1949-1951), EDSAC (1949) and LEO I (1951), all developed in the United Kingdom; BARR (1950), developed in Sweden; CSIRAC (1949-1964), developed in Australia.

The examples of electronic computers belonging to the ‘electronic pre-generation’ (1) shown on Bell’s poster (highlighted in the diagram with a black box – see top right of [Fig. 01]), are the precursors of the first digital computers belonging to the First Generation of Computing (1950-1960).

This last group, with all the examples mentioned above, constitutes the origin of the first computer architectures ever built. In these spaces of the first digital computers we can see a number of specific spatial qualities.
that we also find in the field of architecture, with a clear interchange between both disciplines during this period. Although these spaces are not usually counted in the modern story of architecture, they reveal an interesting testing ground, an alternative and complementary laboratory to the one being developed in purely disciplinary spaces.

In all these cases, the technology device of computer corresponds entirely to the technology device of building, as there is equivalence between both architectures, constituting a single inhabited space.

As Gerard O’Regan points out, these early designs were huge architectures that occupied large spaces, even entire multi-storey buildings, as we will see further on. They were complete and complex computer architectures that were inhabited by both human and non-human agents. As Giorgio Agamben describes, they were devices inhabited by living beings (human agents: programmers, engineers; non-human agents: bugs, moths, mice; all of them considered ‘individuals’) or substances (objects, things), whose coexistence resulted in multiple processes of subjectivation, giving rise to polyhedral and diverse subjects. According to Agamben, there is not a single moment in the life of living beings or substances that is not modelled, contaminated or controlled by some device.

**First Generation Computing (1950-1960): The Whirlwind I project (WWI) as a case study**

The Whirlwind I or WWI project [Fig. 02], directed by Jay W. Forrester and his team, and developed by the Lincoln Laboratory (initially called Servomechanisms Laboratory and later the MIT Digital Computer Laboratory) at MIT in Cambridge (USA), between 1945 and 1956, was one of the three most important projects developed in the United States in the first half of the 1950s. It was a mainframe-type computer, one of the fully digital devices of the First Generation of Computing (1950-1960). At the beginning of the project, the engineers were trying to produce a single-purpose analogue device (part of the generation of electromechanical devices in Bell’s classification, group 2): a computer to calculate responses to pilot actions in US Navy flight simulators and to control such simulators in real time.

In 1945, after an injection of funding, the project changed course radically to begin designing, producing and building a real-time general-purpose digital device. Forrester gave the Whirlwind I project a transformational character, thanks to the influence of Von Neumann and Presper Eckert, who were developing the ENIAC. After several meetings, Forrester encouraged the team to be interdisciplinary.

Whirlwind I was the first computer or digital device with random access magnetic core memory, and could process 16 digits at a speed of 20,000 times per second, a technology later implemented in all Apollo mission computers. At the beginning of the project, in the autumn of 1946, Jay W. Forrester began to think about the design and construction of a container building to house this new type of device. He had to find an architect to supervise its construction before the spring of 1947.

During the design stage, it was envisaged that the project would be four storeys high to house the future headquarters of the Servomechanisms Laboratory, with average dimensions on the ground floor when compared with other laboratories of the same time at MIT. Initially, the project was intended to be a new ‘building’ technological device.

With a low budget available for execution, the choice of rainfall building (within the MIT Supersonic Laboratory complex) was no longer worthwhile for two reasons: the investment required and the execution times involved. At that time, the option of refurbishing an existing container began to gain strength. Before the end of August 1947, the Barta Building (N42) was considered as a possible location for the project and was finally chosen. The Barta Building (N42) was at the time one of the first computer architectures to be transformed, through refurbishment, into the Whirlwind I ‘computer/ building’ technology device.

This MIT campus building still stands today at 211 Massachusetts Avenue. It was built in 1904 by the architect C. Herbert McClure, originally with an L-shaped floor plan to house an industrial laundry for the E&R Laundry company. It has an elongated north-south floor plan with an exterior façade running lengthwise along Windsor Street, and a transversal exterior façade, the main one, facing Massachusetts Avenue. With three floors above ground, its exterior appearance is characterised by its red brick facing in its envelope and its distinctive gargoyle, mouldings, towers and ornamentation that frame the niches in the façade and finish off the corners and unique points of the building, such as its main entrance [Fig. 03].

Its main façades look much as they did 100 years ago, despite transformations in the floor plan, implementation of super infrastructures, changes in use, the recycling of the container and the works and refurbishments to which it has been subjected. The windows we see today on a walk along Google Street View (made up of vertical openings for groups of two or three windows) are an aluminium replica of the original ones, as are all the other materials and ornamentation, done to preserve its historical character in recent renovations (in 1998 and 2018).

As in the initial project, a container was sought that could hold the four storeys, for a volume that had been calculated to be filled by the device. In 1948, in the Barta Building (N42), the Whirlwind I project presented its four floors, distributed as follows: a basement floor that housed all the facilities for the device’s power plants (equivalent to the computer’s power supply, whose high energy demand was, on average, between 100-150 kW, the equivalent of $2500 of electricity consumption per month in 1964) and some associated laboratories; a ground floor at street level whose main entrance was on Massachusetts Avenue, where the storage device for the alternative computer, the cafeteria, the shop, the office and the warehouse were located; the first floor housed the computer room and the associated control room (equivalent to the CPU or central data processing unit, the control console and the CRT screen), as well as offices and the administration area. The rooftop area held all of the hyper-populated facilities used for air-conditioning. The original L-shaped floor (when the building was used as a laundry) was gradually filled in on the three levels above ground (first floor, second floor and roof). In total, the surface area of the container was roughly 3,300 m², not counting the rooftop area.

As a ‘computer/building’ device or physical architectural object, Whirlwind I was a large project whose computer room or CPU took up more than 300 m². It was not designed and built to reduce floor space. Its size was intended to ensure perfect operation: Forrester knew that reliability was crucial, so he wanted to ensure that every component, cables, wires and vacuum tubes were easily accessible, repaired and replaced. To this end, a layout was designed to distribute the flows of ‘living beings’ in the computer room in the form of a central backbone, as a distributor hall or main corridor, from which various side distribution corridors branched, like perpendicular backbones that gave access to the circuit and memory modules. He organised the floor of the computer room (CPU) as would an architect of Modern Movement, with some spaces serving (corridors and distributor halls) and some spaces serviced (large cabinets or racks that kept all the components and elements of the system in sight, making their arrangement visible). In 1951, the CPU floor was located on the first floor. It held five rows of cabinets or racks specialised in one type of component, with different functions, parallel to each other and separated by server corridors. These cabinets were built of modular metal frames that incorporated the different components of the device [Fig. 05]. Its layout was perfectly zoned and distributed by specific functions (rows C, A, E and F and P).

Running in plain sight along the ceilings in these corridors was the powerful air-conditioning and cooling system that took up the whole upper part of the living spaces [Fig. 02 and Fig. 08], which operated 24 hours a day, in an attempt to remove the build-up of heat in these interior spaces. The installations were left uncovered for inspection purposes, as an essential part of these computer architectures. The design of the installations played a very important role in these architectures. They were the potential for correct operation of the ‘computer/ building’ technology devices, thus ensuring their reliability, a fundamental quality for this type of space.

Whirlwind I was a walk-through ‘computer/ building’ device; you could walk around inside it and see all the components that made it up, as Forrester described it. These new ‘computer/building’ technological devices were enormous inhabitable.
architectural spaces that were inhabited not only by thousands of vacuum tubes but also by the many different bodies of ‘living beings’ that both configured and constituted an essential part of these devices. Individuals inhabited the technological device, spent long periods of time in it, working, programming, operating inside it. They were able to move through and across it, resulting in flows of people, of energy, of information. Human and non-human agents were ‘inside’ the digital device, ‘inside’ the computer, inaugurating a new use of these two prepositions in the relationship between two disciplines: architecture and computing. The bodies of individuals, substances or ‘living beings’ mixed and moved in an integrated way with the devices that they walked around in, thereby constituting different new subjectivities and subjects. These examples of digital computers constituted new architectural configurations, new typologies, new types, new examples of spatial relations, relations between body and space, new articulations between parts, new proportions, new materialities, etc. They were huge inhabited ‘prototypes’ that defined these new architectures of computing.

The dimensions of this ‘computer/building’ technology device did not end at the Barta building’s outer shell. The 3,300 m² of apparent and real space in fact amounted to more than 29,000 km². This computer architecture spread out across the territory of Massachusetts Bay, spreading its rhizome-like physical network of interconnected nodes. The node centre was located at 211 Massachusetts Avenue. Whirlwind I was finally launched at the beginning of the new decade: in June 1950 the project was successfully launched, and in 1951, during the Cold War, it held together called the Cape Cod System, a network of American radars that was a smaller version of the SAGE (Semi-Automatic Ground Environment) programme. The Whirlwind I computer/building’ technology device, with the Barta Building (N42) on the MIT campus as the sentinel node, connected to 15 other long-range radars more than 160 km away (such as the Cape Cod (Lawrence) or Martha’s Vineyard island) [Fig. 06].

The architecture of computing through the Whirlwind I (WWI) Project

The Whirlwind I project has been chosen as an important case study, as a model of the first computer architectures, for all these architectural considerations and various others:

For being a pioneer project:

Its development started at the dawn of the First Computer Generation (around 1950), and is one of its main examples. Charles and Ray Eames considered it the most influential example of the first digital computers47. Whirlwind I was the fastest* and largest† technological device in its day as well as being the first general-purpose computer to work in real time48. In fact, it is considered the forerunner of commercial mini-computers, or even the first example thereof50. It was conceived and built as a prototype for future devices49, networked with other nodes to incorporate an interscalar condition into its architecture (working with a building scale and a territorial scale) [Fig. 06]. Thanks to the hallowed status that spaces for such devices acquire over time, Whirlwind I is an architecture that history is determined to preserve, to reconstruct and reconvert into museums, foundations and institutions, although many of them have become mere shadows and talismans of their former selves, due to the dismantling, mutilation and decontextualisation of their elements and parts46. This new architecture of immediacy, of real time, had a decisive influence on the development of many computer/building technological devices, such as the massive concrete buildings that made up each four-storey node of the SAGE programme; the SSEC (IBM’s Selective Sequence Electronic Calculator), a device located in the lobby of IBM’s Manhattan headquarters, at street level (1946-1952); the IBM Development Lab in Poughkeepsie (1955) and the Westinghouse Tele-Computer Center in Pittsburgh (1964), both examples of the work of the modern architect and director of IBM’s design department, Eliot Noyes56.

Because its architecture is the hardware:

In early computer architectures what prevails is the hardware. The external shells become the computer casing, the basement, the power supply; the rooftop becomes the fan and the offices, cafeteria and store room, the device peripheral. This is an architecture that re-appropriates the existing architectural heritage, for the sake of rehabilitation. It is a reliable and functional hardware that can be designed and developed as a transparent architecture, one that makes use of all its infrastructures and facilities visible and accessible from anywhere inside the space’s envelope and structure. It is a hyper-dimensional, luminous and resounding architecture, the first to include an interface (created for Forrester’s closest collaborator in the development of Whirlwind I, Robert R. Everett) as a construction detail57 [Fig. 07], this element being the first example of what Nicholas Negroponte 20 years later called the machine architecture interface58. It is a hardware architecture resulting from the transfer, reuse and recycling among innovations and materials used in the military industry and civil architecture59. It even uses the same materials: steel, aluminium, copper, brick, concrete, glass, plastic, etc., are the materials from which both devices are constructed. So obvious is the correspondence between the ‘building’ device and the ‘computer’ device that when they suggested disconnecting both because it had become obsolete, on 1 April 1959 William M. Wolf, one of its programmers, asked to buy it and MIT told him that he should buy the building in its entirety for $250,000 (thereby establishing an indivisible union of the two devices)60.

Because its inhabitants are the software:

In these first architectures the software is secondary. Human agents were an indispensable component for the operation of the computer/building technological device, just another cog in the general wheel; they were part of the hardware that made up its architecture as well as the software that made it work with a given program. They introduced, read and interpreted the inputs and outputs of the computer. Verbs like plugging, perforating, switching and toggling were physical forms of contact, relationship and interaction that constituted those first hardware- and software-oriented human-computer interfaces. Photographs of these first architectures show that the presence of ‘living beings’ or ‘substances’ was a constant in all of them because their existence was necessary for their functioning [Fig. 08]. The human was always ‘inside’, within the technological device, inhabiting that space of the computer. The various human dimensions are the basis of the origins of computers. Their configuration serves as a design and structure model for computer architectures and for modern architecture, as well as a dimensional model for their elements, as a kind of Modulor, which uses the dimensions of the bodies that will inhabit them, humanizing those spaces and bringing them closer to our everyday life61.

Because it is flexible and reprogrammable:

These first computer architectures worked with prefabrication and modulation62, using standardised elements and materials from the catalogue, like many modern architectures, thereby maintaining their flexibility, together with the use of prefabricated and modulated components. Because it is inclusive:

This architecture is collaborative, inclusive towards the greatest possible number of agents, and is recognised as such. It is made by large interdisciplinary teams63, unlike modern architecture featured in histories, which fosters individualism64. Furthermore, it is democratic, inclusive of other bodies and ‘living beings’ or ‘substances’, and plural, in comparison with other architectural spaces of modernity or working environments of the time [Fig. 10]. The Whirlwind I computer/building’ device is the first to incorporate an African-American programmer/operator in its design and development65 and even the presence of women in relevant productive work is considered normal. It is a type of unexplored space that seems to have no connotations associated with race, gender or any other condition66, which serves as a laboratory to test and incorporate other...
bodies and other possible relationships into these architectural spaces. For all these reasons, the history of the discipline would do well to pay attention to these other architectures – of the computer – and bring them into the contemporary architectural discourse: because of their influence, their dimensions, their weight, their materiality, their spatial configurations, their physical laws, as a way to understand the formation, representation, computation and reception of 20th-century architecture.

Computer/building technology devices such as Whirlwind I or the ESCAC constitute some of the earliest First-Generation computer architectures that deserve to be considered disciplinary spaces. The case study chosen, in fact, is that of the first moment in which a computer existed in a building, a building is a computer. This first digital device is an inhabitable space, a place inhabited, lived in, traversed and configured by different types of ‘living beings’ and ‘substances’ that are ‘inspired’ by Whirlwind I, as materialised in the Barta building, is not just any building on the MIT campus; it is itself an architectural technological device, a computer, which has a scale and dimensions that are both editorial and instructional. Its external façades and the networks it deploys are, in any case, the computer’s casing. Its uses distributed in rooms, its corridors, its roof, its basement, are all its hardware. And some of these ‘living beings’ that inhabit it constitute the software that puts it into operation. This is how this earliest example of computer architecture can be described as an architectural technological device.

1. One of the more archaic anecdotes in the history of computing about which much has been written is the moth (a moth) in English and the German Harke in the Harke Mark II of Allen B. Caldecott, a 16-bit electromechanical computer, a non-human agent, as they say, who did trapped itself in a relay, triggering a programming error in the device. The moth’s inhabiting this computing space gave rise to a new meaning of the term ‘bug’ as error of multilocation in a device. Grace M. Hopper, “The First Bug.” IEEE Annals of the History of Computing 3, no. 3 (1981): 283-286. doi:10.1109/MAHCH.1981.10002.
2. During the project, Randell, Wilkes, and Ceruzzi spent a month at La Fyla and La Fyla y el Viento (Barcelona: Anagrama, 2015), 15.
4. The project started up during the Second World War (1942). MIT and Lincoln Laboratory worked using in 1940, when it was moved to Concord, Massachusetts (US). (Wolf Research & Development Corp.) and it was used until 1974. Allan C. Doug. ‘Whirlwind: Twenty Years of Computing History’ in: ASCC, 1974. April 19, 1949, https://doi.org/10.1109/MAHC.1974.10042.
11. Southern Peters of Perry and Bellied Architects in Cambridge carried out the refurbishment of the Barta container in 1986 for 152. It was acquired in the original context of the enclosure, very early in the 20th century.
17. ibid., 560.
20. He compared the spaces of Whirlwind I to the scale-in classes is the home of the well-built, where once can walk into and inside the most complex and the most significant of the owner’s clothes hanging in the room. Forrester, Op. Cit., 604.
21. One of the technologies on which the first First Generation (1950-1960) computer technology devices were based.
23. The SAGE programme was the largest network of connected radars in the United States, a precursor to ARPANET and what is currently known as the Internet. John C. Ackley, ‘Whirlwind’ in Encyclopedia of Computer Science (Chichester: John Wiley and Sons Ltd., 2003), 1948.
26. Whirlwind I was designed as a closed system in which the human element or object to give scale and to be able to compare the size of the whole of both elements with each other, but it was not another component of the technology deployed for its proper functioning. At Loosmore, Modular reached 2.00 m with its own structure and the cabinets and racks of Whirlwind I was designed by Forrester not to exceed that of 1.50 m for a revolutionary architecture to reach all its components. The racks were designed to be similar to refrigerator cabinets in any home, using many references to domestic architectures, to a point that even vacuum tubes had to use clay bricks to build these computer architectures. Redmond, Op. Cit., 142.
27. Some of its hardware was damaged during its lifetime: from a laundry (from the early 20th century to the mid-1940s), computer architecture (1946 to 1950), graphic design workshop (1960 to 1990), multimedia center with a large library (1995 to 2005), to MIT’s Information Systems Department (2010 to 2018); and to the Institute for Artificial Research (2018 to 2020). Some of the structures (some are currently broken) of the project The World Game, by R. Buckminster Fuller, Op. Cit., 604.
28. An interdisciplinary team of more than 30 people worked at Whirlwind I, and this was one of its strengths, owing to the presence of the Englishman, Von Neumann. Op. Cit., 604.
29. This emerges thanks to the heroic action of the architect (mainly black, white, Caucasian, Western, male, serious, etc.) Colomina, Op. Cit., 12.
30. In 1963 the Strawbale was the first American feminist group to appear and work with a computer space. African-American women were not allowed to work until 1953, when a black computing machine was purchased for the project’s use. Whirlwind I” Joe Thompson, 2018, https://medium.com/.
31. The strawbale was a computer space that was then that what was then “of Boston, Massachusetts” and what is now the Computer History Museum (San Jose, California). O’Regan, Op. Cit., 26.
32. These architectural spaces are not neutral, unaffected by their location, their scale, their architectural and technological devices such as Whirlwind I, a non-human agent to work and develop a computer space. African-American women and women of color were not allowed to vote until 1965. David C. Brock, “Meet Whirlwind” Joe Thompson, 2018, https://medium.com/.
33. Architecture Computing Device: 1st Generation Whirlwind I

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