The Bauhaus (1919-1933) and the digital agenda
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Paradoxes within the Bauhaus transition between artisanal variability to mechanical identicality: from the Modern Workshop to the contemporary Fab-Lab[1]

"The nature which speaks to the camera is a different nature from the one which speaks to the eye."

Walter Benjamin. A short History of Photography[2]

In his book "The Alphabet and the Algorithm"[3] Professor Mario Carpo points out the difference between handmade variability and digital `differentiality´[4] in the sequential chronology which can be established through three `technical ages: the age of hand making, mechanical making, and digital making. The Bauhaus was situated chronologically in the first break, in the transition from artisanal variability, which

characterizes several of its workshops, to mechanical variability. Although this transition depends mainly on the classes and types of objects and technologies one takes into account, the materials produced at the Bauhaus were able to illustrate both paradigms. While the artisanal variability was tested by several masters and students, others worked on the idea of mechanical variability. The tension established by these two manners of approaching the production –and reproduction– of the `work of art´ contributed to permanently enrich the debate on how architecture form should be studied and produced. On the one hand, workshops such as the Ceramic or the Carpentry were able to proof the validity of the artisanal hand-made product. On the other hand, workshops such as the Photography, or even, the Graphic Printing and the Printing and Advertising Workshop, experimented with new means of mechanical reproduction and representation, as well as with innovative paradigms associated with the rise of the society of information.

If the age of mass production –where standardized and mechanical reproduction is to be considered as an interlude or as a gap between the hand-making artisanal production and the digital age that has come to replace it since World War II–, can we understand the paradoxical statements headed by some members of the Bauhaus as premonitory of this non- linear evolution? Furthermore, if the digital turn and the pre-mechanical variability - exemplified at the Bauhaus– have many common points, is it possible to find within the Bauhaus the linkage between the digital agenda and the transition from artisanal variability to mechanical identicality? Thus how did the Bauhaus Masters react to the dialectic between craftsmanship and mechanical reproducibility? Did their discourses anticipate the digital shift, particularly rapidly triggered after the WWII, when some of the most influential Bauhaus leaders migrated to the United States?

The paradoxes of mechanical reproduction are explained through the different groups - and their affinities– working together at the school. On the one hand, the `sublime´ side including Klee, Feinenger, Itten and Kandinsky; on the other, the `geometricians´, with Moholy-Nagy at their head claiming objectivity (Neue Sachlichkeit) and finally, the `combatants´ led by Malevich, El Lissitzky, Mondrian or Van Doesburg. Moholy-Nagy´s collectivist ideology was truly committed with science, social systems and architecture, as he proclaimed in his first lecture at the Bauhaus in 1923. Amongst the Bauhaus masters that migrated to the US around WWII, the figure of Moholy-Nagy portrays a real continuity from the early works in Europe (pre and post-Bauhaus), to the North American theoretical and pedagogical endeavor. In this sense, Kepes takes on a decisive relevance, and links the mid-1920´s European Bauhaus context with the postwar 1940´s on to the 1970´s MIT `techno-social´ and `second modern´ environment. Was Moholy-Nagy claiming, through his studies of photography and motion –understood not only as new technical means of reproduction but of production– for a new design and self-consciousness methodologies?[5]

Bauhaus media: from the materiality of the printed object towards a New Materiality of architecture

"The Bauhaus workshops were really laboratories for working out practical new designs for present-day articles and improving models for mass-production. To create type-forms that would meet all technical, aesthetic and commercial demands required a picked staff. It needed a body of men of wide general culture as thoroughly versed in the practical and mechanical sides of design as in its theoretical and formal laws."

Walter Gropius. The New Architecture and the Bauhaus[6]

The Bauhaus printed material worked as an effective vehicle able to transmit the school´s modern ideal. It complied with three capital roles: It worked as an internal space for communication within the school, as a key advertising element for future students and also as a vehicle through which to disseminate theories of pedagogical approach. The printed material can be considered to be a space –a testing critical platform– for dissemination of theories raised within the school; a timely example of the emerging engagement between media and modern architectural ideology[7]. Specifically, Moholy-Nagy´s books were understood as experiments–test printed spaces not only capable to spread his ideas but to test them–, underlying a significant approach to graphic design. Books were able to be critical not only verbally, but also visually: One of the most enlightening aspects of Moholy-Nagy´s books was the ample selection of illustrations, a deliberate convergence between text and image. Malerei Fotografie Film is comparable to other similar manifestos published as books in the early 1920´s[8]. The Bauhaus printed material, aside from the Bauhausbücher, was completed with the regular publication of a magazine, from 1926 to 1931, and other smaller publications, such as advertising pamphlets, fanzines or exhibition posters.

The dissemination of ideas was produced in a sophisticated manner: Political and social issues were transformed into a mechanical graphic disseminate, individually developed through the different workshops of the school - Graphic Printing, Printing and Advertising, Photography or the Glass und Wall-Painting Workshop– and collectively put together within the different printed communication and information platforms of the school, the magazines, the book series, advertisement strategies, and obviously through their exhibitions[9]. The magazine, together with the books and other printed material, was the space where to test this new approach to representation, occasionally emphasizing a more pre-mechanical understanding and sometimes an approach aligned with the new systems for mechanical reproduction[10]. The Bauhaus vocabulary was fundamentally an advertising language employed even then, with some success, not only for immediate and direct printed material but also for the

Bauhausbücher, mainly designed by the Moholy-Nagy and Herbert Bayer[11].

Media becomes the `space´ where establish a profitable dialogue between materiality and abstraction, or the way from artisanal variability to mechanical identicality as portrayed in the cover and back-cover of 1928´s first issue of the Magazine[12] by featuring a photograph that included a non-exact copy of a previous edition[13]. On several laid-upon levels, some of the classical tools of the architect –pencil, square & triangle ruler–, together with several models of three dimensional basic geometric figures –the cone, the sphere and the cube– appear juxtaposed, maybe as an allegory of the basic Bauhaus figures –the square, the circle and the triangle–. It seems that the photomontage aims to reproduce the architect´s space of work, stirring up debate on how this canvas has been transformed or will be transformed by new mechanical means of representation and reproduction, thus not only through new means of representation - and material expression– but of new interfaces of production. Far from being abstract volumetric considerations, the cover magazine photomontage brings to light the break between handmade and machine-made production of standardized elements, a premonitory assumption revealed in Moholy-Nagy´s work: How could the advent of technology address this situation?

In contrast, 1931´s issue[14] featured in the front cover just a series of large-scale photographs of different textile and other ornamental surfaces, bringing up to debate the idea of the internal structure of the material. Photography was indeed starting to be considered as a possible means of architectural representation and as a new interface capable to bring spatial, material and ornamental qualities yet unexplored, nevertheless able to become a mediator between materiality and abstraction. Similar to what would happen with computers later on, photography presented an emergent concern on perception, "perceptual entities and objects"[15]. They were significantly addressed by Moholy-Nagy and later on by Kepes, relating to the investigations developed at the Bauhaus. Over and above, 1931 edition brought up another important debate mainstream: The gap between representation and materiality. The two aforementioned editions represented various paradoxes triggered at the school: The early-modern hand making model of artisanal variability and the struggle of mechanical reproducibility to establish new means of identical representation and reproduction.

Hence, if the computer, and assisted-design software –from CAD (Computer Aided Design) to BIM (Building Information Modelling)– has been able to introduce additional layers of mediation that did not exist before, did Moholy-Nagy´s discourse denote an awareness of an emergent transformation affecting the way in which architecture is practiced and produced? If the computer is just another "vehicle that induces a new displacement of physical experience and materiality"[16], can we certainly assert that

new means of representation –photography and film, as described by Moholy-Nagy (he precisely used the word representation, together with the dialectic production-reproduction) – already stated a premonitory displacement of the physical experience of space and its materiality? His theories further expanded upon this idea: How can we represent this, or negotiate the relationship between the space and the observer, through architectural representation?

1925 Moholy-Nagy´s Bauhausbücher 8: Malerei Fotografie Film

"We may see that we see the world with entirely different eyes. Nevertheless, the total result to date amounts to little more than a visual encyclopedic achievement. This is not enough. We wish to produce systematically, since it is important for life that we create new relationships."
     László Moholy-Nagy. Painting, Photography and Film[17]

Malerei Fotografie Film was originally published in 1925[18]. The Bauhaus book series conveyed a deliberate balance between uniformity –to make the series identifiable as a unique collection of books[19]– and diversity; able to represent the different topics and therefore positions of their authors within each book. The book was divided into two related but consciously separated parts: In the first place, the text appears to be occupying approximately forty percent of the pages, while the other sixty percent consists of a collection of photographs, most of them produced by Moholy-Nagy´s students as part of their course work. At the end, the author included a manuscript sketch for a film – also typophoto– entitled "Dynamics of the Metropolis" which had been developed earlier on, in 1921-22.

Embedded in an advertising language and modern structural grid layouts[20] Moholy-Nagy´s first words are certainly quite revealing: "From painting with pigment to light displays projected with a reflector."[21] The shift had been announced. On the next page, occupying the entire layout, and making typography an element for graphic design itself, Moholy-Nagy stressed what he meant by the contemporary problem of optical creation and the difference between static and kinetic optical composition[22]. His words not only imply a shift in the way art, or architecture, was produced; but a shift in the relationship between the object and the subject, triggered by the appearance of mechanical means of representation, which had resulted in the emergence of new fields of creativity. Moholy-Nagy introduced photography and film as an alternative and mechanical means for spatial expression, able to fulfil representational purposes of a more complex society, transformed through the dialectic between production and reproduction. The mechanical reproduction meant something completely new and so photography and film could aim to fulfill the overlap of space and time in the work of art, as Benjamin will put it more than ten years later[23].

Moholy-Nagy argued that "new mechanical means of representation," using his own words, would replace the painting methods of representation, triggering a shift from representational arts –painting methods of representation–, to the non-objective and abstract painting/representation techniques[24]. This shift will entail and embrace a new representational optical creation, an unpredictable possibility of extension of the work of art, as experimented with students at the Bauhaus. Architecture and art found in photography a vehicle capable, like no other, not only to depict it but to map it in a sense that questioned many aspects and developments of its exercise[25]. Photography and film found a perfect positioning and accommodation in architecture, as the art capable of bringing together space and time - as it was understood in modernity–, in order to be able to continue dealing with everyday life understanding its more dynamic reality. Moholy - Nagy´s statements[26] illustrate the relationship between the artistic field, and architectural field as its main field of experimentation, and an emergent contemporary technological and pre-digital world in rapid evolution. Art and architecture started to be conceived differently.

The New [Bauhuas] Objectivity –"a `non-objective´ painter needs no special courage to embrace the art of creative presentation as provided today by photography and film[27]"– entailed crucial modern principles such as functionalism[28], but above all entailed a new way to conceive, observe and understand spatial practices, as happened after WWII and through the early 1950´s with the by then incipient irruption of digital culture and digital design techniques[29]. This explains the fact that the school was really a laboratory for Gestaltung –the production and construction of form–, rather than an amalgam from the Arts & Crafts School[30], just as Gropius emphasized in the school´s magazine second edition[31].

Moholy-Nagy argued that the observer, or the user, in architectural terms, became an active part of a work of art[32]. There is, of course, a striking parallel between what he had described and the situation which occurred after the invention of the computer and its individual dimension. They have in common the transition between objects and informational events: architecture as form and architecture as politics. This shift will entail a new materiality; there is a progressive connection between the materiality of photography (and film) and the new digital materiality: one precedes the other and explains its validity[33]. Assuming that technology and its capacity for mass production had to a great extent levelled the niveau of humanity, Moholy-Nagy directly referred to the invention of printing and media as a democratic process that enabled everybody to acquire books. Reproduction became also a statement for democracy, the possibilities of reproducing pictures, even colored prints, socially available and reproducible in lithographs, collotypes and other means made him understand that contemporary technology was capable to

offer a wide circulation for `originals´ too[34]. The work of Futurist and Constructivist movements was used several times by Moholy-Nagy to address how the `new function´ had been covered in the traditional form. He described, for example, the work of the Futuristic Movement and techniques such as static painting, which stated the problem of simultaneity of movement. He considered the futuristic painting to be static, therefore stating the problem of simultaneity of movement, or as he put it, the representation of the time impulse. Photography and film were already known, but far from being understood not only as a means able to represent movement –the kinetic quality of space– but as a tool for creation (design) and transformation[35]. Furthermore, he insisted on the idea that the photographic camera –as a technological device– was capable of reproducing the purely optical image, enabling the subject to perceive optically true distortions, deformations and foreshortenings. On the other hand, the human eye, together with intellectual experience, was able to supplement perceived optical phenomena by means of dialogical association processes, able then to create both formally and spatially a conceptual image. How the creation of this conceptual image has changed since the appearance of this new mechanical means of representation and reproduction? Moholy-Nagy claimed the photographic camera as the first stage of objective vision and demanded for a juxtaposition of the human eye experience and the vision of the camera, in order to make the human inhabit both the ordinary and the technological simulated space, a dual perception formed by various interfaces, similar to what has been brought to light much later, in relation to the digital agenda, materiality and perception –disperse or not–[36] by theorists or architects such as Toyo Ito[37].

1929 Moholy-Nagy´s Bauhausbücher 14: Von Material zu Architektur

"Every action and expression of man is the sum of components founded mainly in biological structure" [...] "We are therefore much less interested today in the intensity and the quality of expressions of "art" than in the elements that determine, with the force of ruling law, our function as human beings and the forms it takes."

László Moholy-Nagy. The New Vision: From Material to Architecture[38]

Four years after the publication of his first book, Moholy-Nagy brought out another volume to the Bauhaus series. Entitled Von Material zu Architektur it was originally published in 1929[39], once he had already left the school to establish his studio in Berlin. This work, the origins of which dated from the Bauhaus period –many of the examples used in the book were taken from students work, workshops...– formed the basis of his later major work, Vision in Motion, written together with Sibyl Moholy-Nagy and published posthumously in 1947 with Paul Theobald in Chicago. The book was organized in four chapters: "The Educational Side", "Material", "Volume (Sculpture)"

and "Space (Architecture)"; each of them represented Moholy-Nagy´s main concerns, able to prove his strong commitment with the Bauhaus pedagogical purposes.

Within the first chapter, "The educational side", Moholy-Nagy paid special attention to educational issues developed at the Bauhaus[40]; placing them in the foreground of the school. The school attempted to address what he named as the injuries worked by a technical civilization. How could the new generations combat these injuries? And how to benefit from them in order to intensify art practices? Moholy-Nagy demanded a new attitude towards this dynamic context[41] emphasizing the way in which the school attempted to meet the shortcomings between hand-made production and mechanical reproduction in the context described by the irruption of technology as part of our daily lives. Moholy-Nagy vindicated, on the one hand, a manual training for the school –"This attitude, which looks toward wholeness, led in the Bauhaus to a manual training. Or at least to a hand work which along with its educational aim had also that of creating models for industry, taking into account the equipment and the processes of production of our technical age"[42]–. On the other hand, he claimed for a sensory training able to introduce experience to the study of matter and to materials science – "the synthetic approach to structure was introduced by experience with the material, the amassing of impressions often appearing unimportant at first"–.[43] Moholy- Nagy´s sensory training `experiences´ paralleled the emergence of the new digital tectonics in the early 1990s –where "multiple solutions could be envisaged in order to reach a perfect fit between form and technology"[44]–. The dialectic between form and technology addressed by Moholy-Nagy predicted the fact that, as it happens today, materials can be produced at any scale transforming the tectonic principles and assumptions that guided modern architecture[45] and reinventing architectural ornament.

The foregoing considerations bring us to the second chapter of the book ("Material") dedicated in fact not to materials –or the material, as an abstract entity, itself– rather than to materiality, understood not only as the physical, mechanical and chemical qualities of materials, but as a social and cultural construction. This chapter is perhaps the most important part of the book in terms of the variety and extension of the content and also with regards to its premonitory statements on materiality –from tectonics to ornament–, more engaged with the current design techniques –parametricism, thermodynamics, typology...– rather than with the tectonic assumption, which prevailed before the dawn of modernity[46]. Via the introduction of new experiments working on scale and material conditions, some of which had been practiced already by Johannes Itten[47] within the elementary courses, Moholy-Nagy addressed a new way of looking at materiality. He studied their physical conditions and mechanical characteristics incorporating sensory experience to design techniques yet avoiding any kind of phenomenological, poetic or metaphoric adjective of matter

or materiality, and preceding what could nowadays be described as a Thermodynamic Materialism. To this respect, the introduction of new means of representation and advanced technologies –photography and film– in these investigations transformed the assumptions on scale and ornament that had prevailed since the early modern times, envisaging a disruption between subject and object, or between human and the work of architecture.

These new mediation processes between the subject and the object –materials and their materiality– were tested through different experiments developed by students at the school. Such was the case, for example, of the `tactile exercises´[48], which had already been addressed by the Futurists –Marinetti, the leader of the Futurists, published in 1921 a manifesto on the creation process based on tactile values–.[49] The link between these sensory experiments with some of the principles that have arisen since the emergence of technology within design professions in the last 30 years is somehow or other related to the introduction of the diagram as part of the design process. In a sense, as it happened in film making –by filmmakers such as Eisenstein or Kubrick– the work of Moholy-Nagy was anticipating the diagrammatic basis of contemporary architecture, bypassing what he considered to be the misleading functional diagram, and proposing some means of representation and information capable to approach the incorporeal[50], and the interaction between space and movement. The Bauhaus used diagramming far more than for pure mental schemes. They used it as a research tool capable to guide architects and designers among the different flows of data and information that were already then affecting design processes[51].

Photography for example, addressed by Moholy-Nagy in the third chapter, was able to introduce new layers of mediation in the sense that a new optical approach through the camera assisted the tactile training; similar to what has later been demonstrated in the computer age, dealing with concepts such as memory, time, physicality, ornament, thermodynamics; and ultimately, towards a different materiality.[52] Moholy-Nagy seemed to be especially concerned on materiality and its scales; his interest in the texture, surface aspect, or other physical experiences, underlined a more profound focus on the structure of the material and its processes of obtainment –naturally and artificially–, fabrication and transformation. His observations on the structure of materials, propitiated by the use of photography, magnifying glasses and other tools dealt with the aforementioned taxonomies of space. The different projects and investigations developed with his students, some of which were published in the book, denote a fascination for the Nano and micro scale structures of different natural materials, such as wood or different textiles. This fact is associated with the current approach to the concept of materiality, intensely addressed in architecture schools, as well as with the fabrication of materials. The fabrication laboratory (Fab-lab) ideology has transformed the modern

workshop into a new space for action and algorithmic or differential reproducibility.[53]

Ornament is also present in his work. He for example defined concepts such as the mass arrangement of the material ("massing"), which was precisely described not as the classical or modern conception of `surface treatment´, or the surface itself as architecture. Without doubt these statements were an enabling starting point for Moholy-Nagy to introduce the function of ornament: "the correct and creative application for the material clarifies the question of functional and ornament form."[54] Although he stated the modern assumption on ornamentation arguing that where a complete fulfilment of the functional need has been found, there is nothing left for ornamentation; he probed the linkage between mechanical reproduction –introducing the idea of repetition – and the debate functionalism and ornament.[55] Was Moholy-Nagy venturing the future consequences of the suspension of traditional tectonic assumptions? Can we find a correlation, and if so, in what terms, between the ongoing debate on digital tectonics and what he experienced during that period at the Bauhaus?[56]

The last pages of Von Material zu Architektur are dedicated to space and to the movement of the body in space. In contrast to the static, hierarchic dimension of earlier periods, Moholy-Nagy claimed for a kinetic and dynamic understanding of architectural space. He asserted that space is meant to be as the magical box produced by the relative location of bodies in continuous motion, thus "spatial creation is the creation of a relationship between the positions of bodies".[57] The study of motion within architectural space –intensified through photography and film– became a touchstone for his definition of space, advocating the use of the term kinetic space instead of static space, or in other words, the recognition of spatial conditions –which are not the result of the positions or relationships within a rigid volume– but rather consist of visible and invisible flows of movement together with the phenomena triggered by this movement[58].

Anticipating the digital: Translating knowledge from Europe to the United States. From the Bauhaus modern ideal to the `techno-social´ MIT second modernism, László Moholy-Nagy and Geörgy Kepes

"...The education of the architects must, therefore, include the education of the eye."
    György Kepes.[handwriteen undated note]
    Kepes papers, Reel 5312, frame 446. MIT.[59]

Moholy-Nagy left the Bauhaus in 1928 and he was replaced by Josef Albers. He then established his own studio of typography, exhibition design, photomontage and photo collage in Berlin and participated, in 1933, in the 4th CIAM Congress in Athens. A year later, he emigrated to Amsterdam and London, where he stayed until 1937 before moving to the United States. On Walter Gropius's recommendation he was named director

of the planned New Bauhaus in Chicago in 1937. However, the school was forced to close as early as 1938 for financial reasons and in 1939 Moholy-Nagy founded the successor to the School of Design in Chicago, which was restructured in 1944 as the Institute of Design, currently part of the Illinois Institute of Technology. Moholy-Nagy also worked as a freelance artist and designer until his death in Chicago in 1946, the same year Kepes, his former collaborator, started teaching at MIT[60].

It has already been addressed by several scholars, how the Bauhaus influenced Canadian and North American art school´s institutional program instruction.[61] Many professors and leaders moved from Europe to Canada and the United States before or during the WWII.[62] In the case of Moholy-Nagy, a continuity of his legacy was translated to Kepes investigations at MIT, which did not happen in such an influential manner as the other members of the Bauhaus that came to the United States. The venture between Moholy-Nagy and Kepes allows us to easily trace a line between the European avant-garde context –after the Great War– and those conditions performed in the United States after the WWII; this is to say, from the creation of the Bauhaus to the creation of the MIT Center for Advanced Visual Studies in 1968.[63] In this sense, Kepes´ legacy at MIT can be understood as one of the most pivotal proponents of the Bauhaus tradition; after WWII, the institute was transforming its educational curriculum from an established engineering school into a science-based research institution, elaborating a new meaning for scientific knowledge as deferred agency[64]. MIT was for Kepes a fertile ground on which to implement and translate his long-term –together with Moholy-Nagy– investigations on visual perception of space, and specially his reflections on art and architecture as a form of instrumental and applied knowledge.[65]

Kepes´ Language of Vision[66] (1944) advanced a philosophy of the image as both index and instrument of a visual technology of knowledge. His theories addressed several important influences from the Gestalt perceptual psychology.[67] This approach to vision had already been explored by Moholy-Nagy through photography and the sensory training experiences developed at the Bauhaus, claiming for a combination between the human real vision and the artificial vision, and hybridization between nature and artifice -machine, technology–. In this respect, and in order to illustrate an emerging techno-social commitment, it seems appropriate to note their collaborations with the US Army; they developed several collaborations with the `apparatus of war´ that emphasized the perfect combination, triggered since WWII, between war and technology. For example, Kepes worked in 1942[68] under the auspices of the United States Army in the study of civilian camouflage[69]. This newly certified arm of civil defense gave him the opportunity to work with larger agencies and test new ideas. By flying over Chicago at night, Kepes transformed his ideas about environmental art and large-scale mapping. His proposal was to string together a large network of cables

and lights and float them on Lake Michigan in order to fool night raiders into thinking the city extended further into the lake, thus providing a false target for bombing raids[70]. It is not casual that the MIT received after the WWII the influx of defense funding in Campus –"the largest share of any US university in the postwar period"–.[71] Indeed, the question to be addressed is clear: the correlation between the Bauhaus approaches to perception, concept and reality, triggered in some points with little self- consciousness, through the employment of new technological means of representations and production; the subsequent translation to the United States, in this case through Moholy-Nagy and Kepes; and the ongoing debate on digital principles for design. Thus how to map the common ground between the Bauhaus gestaltung spirit, the MIT `techno- social´ moment and the ongoing digital and liquid scenario?

It seems worthy to investigate, especially today, when the digital has invaded the discipline –theoretical stances, universities and practice–, how it is possible to correlate historically and theoretically this digital turn, and the way in which it has affected architecture and urban landscape –design processes and production (built) paradigms–. The assumptions here described find theoretical and historical conditions to justify how, when and why the aforementioned turn was early rooted within the Bauhaus pedagogical and experimental experience –the transition from artisanal variability to mechanical identicality–, thereafter at MIT. In a bigger context, these conditions also struggle to overcome Benjamin´s debate on reproducibility and hand making variability. This is to say, the difference nature of the mechanical and the digital copy being the latter in constant change and transformation. The dialectical between the mechanical and the digital copy has its architectural parallelism: from anthropocentric vision of space to the break of the space of the Cartesian order[72], and definitely between the Beaux Arts model to the aforementioned `techno-social´ model, going through the European Arts & Crafts Bauhaus structure and the Modern Movement. Moholy-Nagy´s (and Kepes´) figure appears to be a condition of possibility that certifies this assumption, this is to say, their work –which in a sense can be taken as pre-digital technological manifestos– represents in part what made the digital conditions. Thus, which are for example the convergences between the theoretical conditions of materiality that both Moholy-Nagy and Kepes were striving towards, and the digital, soft conditions in which we currently inhabit? Having already addressed the importance of the social value in the training of the designer[73] how should designers tackle today the question of digital design within the educational environment? If the mechanical and technological age needed –as it was proofed by Moholy - Nagy at first, and then by Kepes– a new visual practice, what should be necessary nowadays? What does the digital paradigm require to embrace a non-linear architecture after the age of printing? and finally, how is this achievable in the different schools of architecture and design?

1. An early version of this paper was developed in the seminar "Digital Culture, Architecture and the City", taught by Professor Antoine Picon at Harvard University Graduate School of Design (Spring 2015 semester). I am grateful to Professor Picon for his orientation and suggestions in and after the seminar. Professor Eduardo Prieto (ETSAM, Universidad Politécnica de Madrid; and visiting scholar at the Harvard GSD 2016) was also very helpful as a second reader. The initial scholarly research dates from a study trip to the Bauhaus at Dessau in Germany in April 2015, as part of the seminar "Translating Architecture: Walter Gropius and the Legacy of the Bauhaus" taught by Professor Neil Leach at Harvard University Graduate School of Design. The vast majority of the materials included and reproduced within the paper where examined at the Harvard University Graduate School of Design Frances Loeb Library thanks to the help of Ines Zalduendo, Special Collections Archivist & Reference Librarian. Other contents were examined at the Massachusetts Institute of Technology Rotch Library in Cambridge, MA, and at the Bauhaus Archives in Berlin.

2. Benjamin, Walter, A Short History of Photography. Cambridge, MA: Belknap Press, 1966 [Benjamin, Walter. Kleine Geschichte der Photographie, originally published in The Literarische Welt of 18.9., 25.9. and 2.10.1931.

3. Carpo, Mario, The Alphabet and the Algorithm, Cambridge, MA, MIT Press, 2011.

4. "Digital "differentiality" was a term introduced by Greg Lynn to describe the new forms of serial variations in the digital age". Carpo, The Alphabet and the Algorithm, Cambridge, MA, MIT Press, 2011.

5. "Men discover new instruments, new methods of work, which revolutionize their familiar habits of work. Often, however, it is a long time before the innovation is properly utilized; it is hampered by the old; the new function is shrouded in the traditional form". Moholy-Nagy, L. (1925). Malerei, Fotografie, Film. Bauhausbücher 8, Albert Langen, Munich, 1925. English edition: Painting, Photography Film. The MIT Press, Cambridge, MA, 1967, pp. 27.

6. Gropius, Walter, The New Architecture and the Bauhaus, London: Faber and Faber, 1935, pp. 53.

7. Ockman, Joan (Colomina, Beatriz: Guest Editor), Architectureproduction. Revision-papers on Architectural Theory and Criticism. Princeton Architectural Press, New York, 1988.

8. E.g., Le Corbusier's 1923 Vers une architecture. The book contains seven essays, all but one of which was published in the magazine L'Esprit Nouveau beginning in 1921. Although many of the original essays were co-signed by Le Corbusier and the painter Amédée Ozanfant, with whom he directed the magazine, the book was finally signed only by Le Corbusier. The book was translated into English in 1927 as Toward and Architecture. See: Colomina, Beatriz. Privacy and Publicity, Modern Architecture as Mass Media, Cambridge, MA and London, MIT Press, 1996.

9. Bergdoll, Barry; Dickerman, Leah (Ed.), Bauhaus 1919-1933, Workshops for Modernity, Museum of Modern Art, New York, 2010.

10. "An impulse to record, categorize, and historicize avant-garde artistic production in the 1920's emerged alongside that production itself, and often among its practitioners". Sudhalter, Adrian, "Walter Gropius and László Moholy-Nagy". Ibídem, pp. 196-199.

11. Herbert Bayer (1900-1985) was an architect, painter, photographer and graphic designer who studied typography at the Bauhaus and later taught it there. He was responsible for the entwurf für eine universalschrift – design for the universal alphabet –. In 1926 the alphabet became the `official' Bauhaus typography and produced part of the graphic content together with Moholy-Nagy. In this sense, it is not coincidental, and paradoxical, that Herbert Bayer's typography design was named as the "new universal alphabet", paradigm of the early-modern perspectival vision and artisanal variability.

12. Bauhaus 1 (1928): Die Zeitschrift erscheint vierteljährlich (directed by Gropius and Moholy-Nagy).

13. Although the graphics correspond to 1927's second issue, Bauhaus 2- 1927: Die Zeitschrift erscheint vierteljährlich, the date `1928' instead of `1927' appears in the dateline right next to the masthead.

14. Bauhaus zeitschrift für gestaltung 2 (July, 1931). (Directed by Josef Albers).

15. "Architectural representation negotiates these contrary tendencies: the quest for verisimilitude and the desire to preserve margins of indeterminacy. Actually, the necessity to balance between these two conflicting ideal might very well account for an inherent paradox of architectural drawings: the more specific the physical effect intended, the more abstract the representation, as if this fundamental tension translated into equilibrium between materiality and abstraction". Picon, Antoine. "Architecture and the Virtual: Towards a New Materiality", 2004. In Krista Sykes, A., Constructing a New Agenda: architectural Theory 1993-2009, New York, Princeton Architectural Press, 2010, pp. 268-289.

16. "Vehicle that induces a new displacement of physical experience and materiality." Ibídem.

17. Moholy-Nagy, László, Painting, Photography Film, Cambridge, MA, MIT Press, 1967, pp. 29. [Moholy-Nagy, László, Malerei, Fotografie, Film. Bauhausbücher 8, Albert Langen, Munich, 1925].

18. Bauhausbücher 8. Second German edition of 1927. The author noted in the first edition that he had been gathering the materials for his book in the summer in 1924, and due to technical problems, the edition came out a year later, in 1925. Moholy-Nagy's book was part of the series of books that were published by the school between 1925 and 1930. Moholy-Nagy was responsible for the format, layout and external design. Moholy-Nagy, László, Painting, Photography Film, Cambridge, MA, MIT Press, 1967, pp. 29. [Moholy-Nagy, László, Malerei, Fotografie, Film. Bauhausbücher 8, Albert Langen, Munich, 1925].

19. Moholy-Nagy designed almost all the covers except for book Bauhausbücher 1, designed by Farkas Molnár. Bauhausbücher 3, probably designed by Adolf Meyer; Bauhausbücher 4, probably designed by Oskar Schlemmer; Bauhausbücher 5, designed by Theo Van Doesburg; and Bauhausbücher 9, designed by Herbert Bayer.

20. The structural `functionalist and rationalist' grid layout characterized most of the Bauhaus' printed material.

21. "From painting with pigment to light displays projected with a reflector". Moholy-Nagy, Painting, Photography Film, op. cit., pp. 32.

22. "In the interests of better understanding we need to grapple with the whole contemporary problem of optical creation: with objective and non-objective painting, easel painting and color composition in architectonic context, which is linked with the problem of the `Gesamtkunstwerk'; with static and kinetic optical composition, with the material pigment and the material light", Moholy-Nagy, Painting, Photography Film, op. cit., pp. 12.

23. "Even the most perfect reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be", Benjamin, Walter, "The Work of Art in the Age of Mechanical Reproduction", in Illuminations:

24. "Development in every field of creation has led man to concentrate upon establishing means exclusively appropriate to the work. Extreme mastery and extreme inventiveness have been displayed in bringing out what is essential and elementary, in discovering basic constellations and organizing them. Thus painting too comes to recognize its elementary means: colour and plane. This recognition has been aided by the invention of the mechanical process of representation: photography. People have discovered on the one hand the possibility of representing, in an objective, mechanical manner, the effortless crystallizing out of a law stated in its own medium; on the other hand it has become clear that colour composition carries its `subject' within itself, in its colour", Moholy-Nagy, Painting, Photography Film, op. cit., pp. 14.

25. "Photography not only as a means of reproduction reality and relieving the painter to its function, but as a powerful apparatus of discovering reality", Stelzer, Otto. "Moholy-Nagy and his vision". Postsctipt to the English edition of Painting, Photography and Film, Cambridge, MA, MIT Press, 1967.

26. "A continuous and progressive development of photography and the film will soon show that these techniques enable us to fulfil representational purposes incomparably more completely than painting as it has been known hitherto could ever do". Moholy-Nagy, Painting, Photography Film, op.cit., pp. 15.

27. Ibídem.

28. E.g. The social housing and the minimum dwelling, the industrial city and the `New Building' European ideal. See: De Zurko, Edward R., Origins of the Functional Theory, Columbia University Press, New York, 1957, pp. 15-27.

29. In this sense, it is important to point out the context in which the work of the Bauhaus was developed, between the Great War (1914-1918) and WWII (1939-1945). Both episodes limit the life of the institution, which was founded in Weimar 1919 and ceased its activity in 1934, closed by mandate of the German Nazi Government. While the First World War was characterized as the last pre-industrial global event, an important shift was produced in the Second World War, with the implementation of mechanical technology and the invention of the computer on the one hand and with the emergence of the Society of Information on the other. Nevertheless, the emergence of the society of information, rooted in the Second Industrial Revolution – data processing, organization and management of work... –in the later half of the Nineteenth-century, was transformed into a matter for propaganda and social interaction. From 1919 to the end of the Second World War in 1945, European industry would hardly be conceivable without its engagement with war and with its social and economic implications – armament, data or information record, or mapping–. This fact will also propitiate a `war aesthetic' or a technological aesthetic. We can find parallelism between what happened in Europe after the Second World to what happened in the late 1980's and early 1990's with the Gulf War, the first war to be live broadcasted.

30. "The Bauhaus had become an institute for design, a laboratory for Gestaltung ("form giving"), rather than an amalgam of an arts School and a crafts school." Bergdoll, Barry. "The Paradoxes of Mechanical Reproduction", Bergdoll, B.; Dickerman, L. (Ed.), Bauhaus 1919-1933, Workshops for Modernity, op. cit., pp. 41-61.

31. "The time for manifestos for das neue Bauen is past and that it was time to enter into the study of practical reckoning and exact evaluation of practical experiments", Bauhaus 2, Verlag und geschäftsstelle, Dessau, 1927, pp. 1.

32. "The development of new technical means has resulted in the emergence of new fields of creativity; and this it is that contemporary technical products, optical apparatus: the spotlight, the reflector, the electric sign, have created new forms and fields not only of representation but also of color composition", Moholy-Nagy, Painting, Photography Film, op. cit., pp. 19.

33. Moholy-Nagy points out that the same problem of justification crops up between printed literature and radio or talking-film and theatre: "The newly emergent impulse of time and its ever expanding articulation here produce a state of increased activity in the observer, who – instead of mediating upon a static image and instead of immersing himself in it and only then becoming active – is forced almost to double his efforts immediately in order to be able simultaneously to comprehend and to participate in the optical events. Kinetic composition so to speak enables the observer's desire to participate to seize instantly upon new moments of vital insight, whereas the static image generates these reactions slowly", Moholy-Nagy, Painting, Photography Film, op. cit., pp. 23-24.

34. Ibídem, pp. 25.

35. "When photography gains full recognition of its own true laws, representational composition will reach a peak and a perfection which could never be achieved by craft (manual) means". Ibídem, pp. 34.

36. An approach to visual and tactile perception since the avant-garde, together with an analysis of several contemporary works has been developed by Professor Eugenio Pandolfini. See: Pandolfini, Eugenio. Percepción Dispersa: Arquitectura y tactilidad en la sociedad de la comunicación. Ph.D. Dissertation. Universidad Politécnica, Madrid, 2014.

37. Some works by Toyo Ito (1941) have addressed these questions on materiality, perception, data and informal architecture, as for example the Tower of Winds, built in Yokohama in 1986. See: Ito, Toyo. "Tarzans in the Media Forest". 2G Magazine n. 2, Gustavo Gili, Barcelona, 1997, pp. 121-144 and Ito, Toyo. Escritos. Colección de Arquilectura n. 41. Colegio Oficial de Aparejadores y Arquitectos Técnicos de Murcia, Librería Yerba, Caja Murcia, 2000. Other recent projects that have contributed to the discourse on tactile, haptic perception and materiality are the New York-based architects Elizabeth Diller's and Ricardo Scofidio's Blur Building in Yverdon-les-bains, 2002; or the Bangkok's Dustyrelief/B.mu not built project designed by Françoise Roche, R&Sie(n) architects (Pandolfini, op. cit., pp. 245-283).

38. Moholy-Nagy, László, The New Vision; From Material to Architecture, New York, Brewer, Warren & Putman Inc, 1936 [Von Material zu Architektur, Bauhausbücher 14, Albert Langen, Munich, 1929].

39. Moholy-Nagy, Von Material zu Architektur, Bauhausbücher 14, Albert Langen, Munich, 1929.

40. "Our specialized training cannot be abandoned as yet at this time when all production is being put on a scientific basis, but it should not be carried so far that the individual becomes stunted – in spite of all his highly prized professional knowledge", Moholy-Nagy, The New Vision and Abstract of an Artist, op. cit., pp. 11.

41. "In conclusion we may say that the injuries worked by a technical civilization can be combatted on two fronts: First, by the purposive observation and the rational safeguarding of the organic, biologically conditioned functions (science, education, politics), later he adds: "Second, by means of the constructive carrying forward of our scientific culture – since there is no turning backward. In practice the two approaches interlock closely, though theoretically the first step must prepare for second step." Ibídem, pp. 15.

42. Ibídem, pp. 16-17.

43. Ibídem, pp. 18.

44. Picon, Antoine. Digital Culture in Architecture. An Introduction of the design professions, Birkhäuser, Basel, 2010, pp. 127.

45. "Systematic work toward "standardized production" did not, however, form the first step in Bauhaus instruction. The synthetic approach to structure was introduced by experience with the material, the massing of impressions often appearing unimportant at first", Moholy-Nagy, The New Vision and Abstract of an Artist, op. cit., Introduction second chapter.

46. Picon, Antoine. Digital Culture in Architecture, op. cit., pp. 127.

47. Johannes Itten (1888-1967). Painter, designer and Swiss writer, Itten was appointed as one of the first masters at the Bauhaus in Weimar 1919. Until 1922-23, he was both director of the preliminary course and master of form of all the workshops except for the ceramic, bookbinding and printing workshops. He left the Bauhaus in 1923. One of his major works was the book Kunst der Fabe originally published in 1961 (English version: The art of color; the subjective experience and objective rationale of color). See also: Bothe, Rolf et al. Das frühe Bauhaus und Johannes Itten, Ostfildern-Ruit, 1994 and https://www.bauhaus100.de/en/past/people/masters/johannes-itten/index.html

48. "Since tactile experiments are registered purely subjectively, it appeared desirable to introduce a sort of check of individual perceptions in ´touch diagrams´", Moholy-Nagy, The New Vision and Abstract of an Artist, op. cit., pp. 11.

49. Filippo Tommaso Marinetti (1876-1944) was an Italian theorist, poet and editor, founder of the Futurist Movement. Well known as the author of the first Futurist Manifesto (Il Manifesto del futurismo, Milan, 1909); he also wrote The Manifesto of Tactilism (Il manifesto del tattilismo, Milan, 1921).

50. "Approaching the incorporeal is one of the major challenges of contemporary design practice. There were times – more innocent times to be sure – when this was done with very few self-consciousness and with sweeping brilliance; one thinks the work of Moholy-Magy, the Constructivists, certain filmmakers from Eisenstein to Kubrick, Buckminster Fuller, Robert Smithson, the aesthetic-philosophical urbanist movements of the late 1950s and 1960s, etc., Kwinter, Sanford, "The Hammer and the Song", ANY n. 23, Diagram Works, New York, 1998.

51. "Besides de use of scenarios, diagrams may orient the designer among the various paths of evolution made possible by digital media. Because of their proximity to concept, and the suppression of unnecessary concrete details to which they proceed, diagrams are often perceived as pure mental schemes. This approach is inconsistent with the true nature of diagrams, namely the fact that they are inseparable from courses of action". Picon, Antoine. "Architecture and the Virtual: Towards a New Materiality", Op. cit., pp. 268-289.

52. "Documentarily exact photographs of material (tactile) values, the magnification of their forms of appearance, scarcely noticed before, inspire almost every observer – not only the handworker– to experiment with the tactile function", Moholy-Nagy, The New Vision and Abstract of an Artist, op. cit., pp. 26.

53. "In the universe of mechanical Reproduzierbarkeit, the identification and, in turn, the meaning of forms depended on their identicality. In the new world of algorithmic, or differential, reproducibility, visual sameness is replaced by similarity. Similarity and resemblance, however, are not scientific notions, and are notoriously difficult to assess and measure. The classical tradition, which was based on imitation, tried to nail down a workable notion of similarity almost from the beginnings of Western thought. Computers engineers and cognitive scientists today are trying to do the same –for the time being with less acumen than their classical and humanists predecessors. Indeed, there is an understandable, albeit ironic, vindication in the fact that some of our contemporaries, baffled by the apparently infinite range of variations generated by algorithmic reproduction, now attribute to mass produced, identical copies some of the same nostalgic and `auratic' value that Walter Benjamin famously conferred upon premechanical, handmade originals early in the last century, when art theory first came to terms with the logic of identical copies", Carpo, Mario, The Alphabet and the Algorithm, op. cit., pp.101.

54. "The correct and creative application for the material clarifies the question of functional and ornament form". Moholy-Nagy, The New Vision and Abstract of an Artist, op. cit., pp. 57-58.

55. "The fancied increase in value was mostly mere imitation of a once original arrangement (thereby losing its functional relationship); often mechanical repetition of one and the same form, by which an apparent – because purely external – arrangement was simulated." Ibídem.

56. "Space creation does not consist on putting together heavy building masses, or in the formation of hollow bodies, nor in the relative positions of well-arranged volumes. Nor in arranging alongside of one another single cells of the same or different volume content. Space creation is today much more an interweaving of parts of space, which are anchored for the most part in invisible, but clearly traceable relations, moving in all dimensional directions, and in the fluctuating play of forces". Ibidem, pp. 169

57. Ibídem, pp. 165.

58. "This interpretation of `relative positions of bodies´ – like space – for the creation of new space relations is fully expressed at the present stage of our scientific knowledge as `material according to strength'. Its significance for actual architecture: relation instead of mass will in probability is left to the coming generation to work out". Ibídem, pp. 163

59. Vallye, Anna. "The Middleman. Kepe's Instruments", in DUTTA. Arindam (Ed). A Second Modernism: MIT, Architecture and the `Techno-Social Moment'. SA+P Press-Department of Architecture MIT, Cambridge, MA and London, MIT Press, 2014, pp. 144-185.

60. Kepes also moved to the United States in 1937; a year after moving from Germany to London, where Moholy-Nagy had relocated his studio. They worked together until Moholy-Nagy passed away.

61. See: Alofsin, Anthony. "American Modernism´s Challenge to the Beaux-Arts" and Ockman, Joan; Sachs, Avigail. "Modernism Takes Command". In Ockman, Joan (Ed). Architecture School. Three Centuries of Educating Architects in North America, Cambridge, MA and London, MIT Press, 2012.

62. Walter Gropius, as aforementioned, became Chair of the Department of Architecture at Harvard University Graduate School of Design in 1938, where he taught with Marcel Breuer. After working together for a period of time, Gropius stablished his practice between New York and Boston. Ludwig Mies Van der Rohe did the same in Chicago and became chair of the Department of Architecture at the Illinois Institute of Technology for twenty years. Other examples of this Bauhaus exile which test the extensive influence the Bauhaus has had on the cultural production in North America since the beginning of the Second World War in Europe can be found in other Bauhaus members or connected figures as Hans Hoffmann, who worked as a teacher and researcher in California and New York; Annie and Josef Albers, who did the same in North Carolina; and Werner Drewes in St. Louis, or Rudolf Arnheim in New York.

63. "Where design and the professional education of architects were also articulated as a discipline of intellectual research, analysis and invention". Vallye, A., "The Middleman. Kepe's Instruments", op. cit., pp. 146.

64. "Rejecting a focus on immediate industrial productions, MIT assimilated the liberal arts educational model at the undergraduate level and promoted basic science in graduate and post-graduate research. No longer a practical servant to industry, the Institute would dedicate itself to the broader and more abstract purpose of service to the nation. The transition involved a development of a new logic of instrumentality capable of articulating relationships between knowledge production and citizenship." Ibídem.

65. Kepes worked at MIT for thirty one years, from 1946 to 1977. "The educational program Kepes was invited to establish at MIT under the placeholder of `drawing´ was developed during his years of teaching at the New Bauhaus in Chicago as a course of Visual Fundamentals, and it was encapsulated in his Language of Vision, published in 1944." Ibídem, pp. 154.

66. Kepes, György, The Language of Vision, Chicago, Pual Theobald and Company, 1944.

67. "Gestalt psychology logy activated vision a creative process, rather than a static reflection of physical reality."Ibídem, pp. 154.

68. Kepes, Geörgy, The MIT Years, 1945-1977, Cambridge, MA, MIT Press, 1978.

69. Leach, Neil. The Anaesthetics of Architecture, Cambridge, MA and London, MIT Press, 1999. See also: Leach, Neil. Camouflage, Cambridge, MA and London, MIT Press, 2006.

70. Kepes, Geörgy, The MIT Years, 1945-1977, op. cit.

71. Vallye, A., "The Middleman. Kepe's Instruments", op. cit., pp. 162.

72. Eisenman, Peter, "Visions Unfolding: Architecture in the Age of Electronic Media", Domus 734 (January 1992), pp. 17-24.

73. "The correspondence between the physical and the physic-cognitive environment that Kepes focused on articulating at the MIT was essential to the translation of professional skill into social value in the training of the citizen-architect." Ibídem, pp. 156.

Bauhaus
Digital turn
Lásló Moholy-Nagy
György Kepes
Photography
Film
Materiality