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Enrico Cicalò *Editor*

Proceedings of the 2nd International and Interdisciplinary Conference on Image and Imagination

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Editor

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Preface

After the first edition hosted in Brixen by the Free University of Bozen, "IMMAGINI? International and Interdisciplinary Conference Image and Imagination between Representation, Communication Education and Psychology" has become a biennial and itinerant event that in 2019 arrived in Sardinia, in Alghero, hosted by the Department of Architecture, Design and Urban Planning of the University of Sassari. The event has preserved its international and interdisciplinary character, focusing in this new edition on graphic languages, on their being image and on their relationship with the imagination, on their use in the different fields of science and the arts, to explore the emerging fields of research and relevant experiments, the new interdisciplinary applications, highlighting their scientific relevance in relation to both their history and the contemporary context with its peculiarities, problems and potentialities.

Also, this edition of the conference was organized and supported by a network of researchers from different universities and disciplines. The event was sponsored by four Italian scientific societies: UID (Unione Italiana per il Disegno), SID (Società Italiana di Design), SIPED (Società Italiana di Pedagogia), AIP (Associazione Italiana di Psicologia) and AIAP (Associazione Italiana Design della Comunicazione Visiva).

The conference proposed the exploration of the *Graphic Sciences*, a name capable of synthesizing the variety of approaches and traditions with which the disciplines of graphic representation are declined in the international panorama of research and teaching.

The call for papers and for images was answered by 180 authors from 9 countries and 42 universities and research centres. About 70 contributions were presented in Alghero. The responses to the calls declined the proposed keyword in a plural way, outlining six major areas of interest of the hypothesized *Graphic Sciences*:

- graphic thinking and learning
- drawing, geometry and history of representation
- digital modelling, virtual and augmented relay, gaming

– graphic languages, writing and lettering
– graphic communication and digital media
– data and infographic visualization

These areas have made it possible to represent the complexity of genealogy and geography of what have been hypothesized to be the *Graphic Sciences* and that find different names and characterizations in the international research but that are united by their contents belonging to the sphere of production, analysis and interpretation of images in the most varied fields of application. This genealogy and geography of the *Graphic Sciences* has been represented in diagrammatic form through an image that has been used as a map and graphic index of the conference.

The IMG2019 conference was conceived not only as a collection of research presentations, but was itself a research experimentation aimed at verifying a hypothesis—i.e. the definition of a field of knowledge definable as *Graphic Sciences*—through a method—i.e. the collection and analysis of data from call submissions—to achieve a result—i.e. the verification of the possibility of defining and representing the hypothesized *Graphic Sciences* and its different fields of investigation—although not exhaustive and not definitive but that the next editions of IMG events will can deepen and further develop.

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Opening Lectures

Exploring *Graphic Sciences*

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Abstract. If we analyze the physiognomy of knowledge in the field of graphic representation, we have to face a sort of diaspora that throughout history has dispersed its contents in various disciplinary fields and that has prevented its coagulation within a unitary and universally recognizable disciplinary apparatus, which instead can only be found within particular national and cultural contexts. The disciplines that explore graphic representation are not always identifiable in the panorama of international research because they assume various denominations in the different cultural traditions. Starting from these premises, in this article we want to recompose the elements present in the international panorama of research in the field of studies focused on the production of images that can be expressed through the expression *Graphic Sciences*. According to this hypothesis, the *Graphic Sciences* would not be configured as a single discipline with monolithic methods and univocally and preventively determined objectives, but rather as a set of fields of study with a nonunitary repertoire of interests.

Keywords: *Graphic Sciences* · Visual Science · Image Science · Visualization · Representation · Drawing

1 The Conference as a Scientific Research Exploration

The IMG2019 conference was conceived not only as a collection of research presentations but was itself a research experiment aimed at verifying a hypothesis - i.e. the definition of a field of knowledge definable as *Graphic Sciences* - through a method - i.e. the collection and analysis of data from call responses - to achieve a result - i.e. the verification of the possibility of defining and representing the hypothesized *Graphic Sciences* and its different fields of investigation - although not exhaustive and not definitive but that the next editions of IMG events can deepen and develop.

1.1 *Graphic Sciences*: A Hypothesis

The conference was aimed to recompose the elements present in the international panorama of research in the field of studies focused on the production of images that can be expressed through the expression *Graphic Sciences* (Cardone 2016, pp. 19–25). According to this hypothesis, the *Graphic Sciences* would not be configured as a single discipline with monolithic methods and univocally and preventively determined

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objectives, but rather as a set of fields of study with a non-unitary repertoire of interests (Eco 2016a, p. 10).

Within the landscape of knowledge recognized, investigated, systematized and transmitted in international literature, the *Graphic Sciences* are only partially recognizable through this name (used by Massironi 2002 and Suzuki 2002). The relative fields of investigation are often included within disciplines that assume different names on the international scale, such as, among the most frequent, the Visual Science (Bertoline 1998), or the Image Science (Mitchell 2018). Visual Science, Image Science and *Graphic Science* are just some of the different possible definitions that can be found in literature which, although representing different approaches and disciplinary traditions, are often used as synonyms. Visual Science, Image Science and *Graphic Science* are just some of the different possible definitions that can be found in literature to define the field of investigation on the production, perception, visualization, reading and interpretation, of images. Although they represent different approaches and disciplinary traditions, they are often used as synonyms. In this paper is discussed why terms so different in meaning are so interconnected and why it is impossible to investigate one of them without consider the others.

Visual Science, Image Science and *Graphic Science*, are often used as synonyms despite the fact that the words they are composed of have profoundly different meanings.

1.2 *Graphic Sciences*: The Literature Review

From the classical age to the present day there has been an uninterrupted need to investigate the roots of knowledge in order to understand the nature of the different fields of study (Foucault 1998, p. 88). If we analyze the physiognomy of knowledge in the field of graphic representation, we have to face a sort of diaspora that has dispersed its contents in various disciplinary fields (Bertoline 1998) and that has prevented its coagulation within a unitary and universally recognizable disciplinary apparatus, which instead can only be found within particular national and cultural contexts. Since ancient Greece, these skills have been considered related to manual activities, therefore of lower status than those related to thought, considered more noble. The disciplines connected to the graphic representation were not in fact considered to belong to the liberal arts, the only ones worthy of being practiced by people who were free, but were instead considered part of the Mechanical Arts, which required work and handcrafting work and skills (Arnheim 1974) rather than a theoretical and conceptual formalization. Also because of this inheritance, still today this kind of knowledge is dispersed in several disciplinary research areas, taught in different and multiple fields of study as fundamental knowledge to support the other forms of knowledge.

This field of investigation appears difficult to define, but two lines of research belonging to different disciplines, that of pedagogical matrix (Balchin and Coleman 1966; Bleed 2005) and that of cognitive psychology (Gardner 1983) and psychology of perception (Massironi 2002), can contribute significantly to their identification.

Starting from the studies from cognitive psychology and in particular from those of Howard Gardner, it is possible to identify within the continuum of intelligences the

graphic and visual intelligences that characterize the skills necessary for the production and reading of images and therefore to isolate the cognitive abilities that are the object of the graphic and Visual Sciences.

In the literature, such skills have been instead assimilated to other broader intellectual human abilities such as the spatial intelligence (Gardner 1983). Actually, they also are considered an amalgam of skills, to the point that in this area of research the word visual often comes to be used as a synonym of spatial, because spatial human's intelligence is closely related to the observation of the environment. Therefore, in this continuum of human intelligences, we can identify, confine and define the graphic intelligence (Cicalò 2016) as well as the visual intelligence (Ferguson 1978), which is certainly in close relation with other forms of intelligence and particularly with the spatial one. The spatial intelligence has been defined by Gardner (1983) as the composition of different skills connected among them. They work as a family and are able to support each other. The ability to recognize images of the same object, the ability to visually transform an object in another or to recognize this transformation, as well as the skill to make a graphic representation of the spatial information belong to this family. Thus, the graphic skills would be part of the spatial intelligence and it would be also the basis of the ability to represent in two or three dimensions the real world by using symbolic codes, as in the case of geographic and topographic representations, diagrams, and geometric figures. The graphic intelligence, or the skill to use the graphic abilities, and more in general the coordination of eyes, mind and hands—perception, cognition and representation—in order to solve problems or to create products.

Another important contribution to the definition of the graphic and Visual Sciences comes from the pedagogical field in which many scholars are involved in defining what should be the necessary skills within the different educational curricula. Learning the languages based on signs, both verbal and non-verbal, concerns not only the decoding processes of the signs perceived but also the complex process of coding of the same signs. So, also the learning of images-based languages requires the development of the coding and decoding the visual information. Therefore, it makes sense to speak of graphic communications to refer to the coding of the message that will be then decoded through the perceptive processes usually associated with the expression of visual communication.

Generally by visual education, or image education, we mean both the understanding and the production of images (Bleed 2005) but also in this case the definitions are not always shared (Brumberger 2011) and the productive component is always relegated to marginal roles if not completely absent, as demonstrated by the diagram that Avgerinou and Ericson (1997) have built on the basis of the analysis of literature on the subject. The diagram represents the sphere of visual literacy as a family of competences concerning: visual perception, visual communication, visual languages, visual thought, visual learning. On the other hand, there are different competences in literature that are included in the graphic sphere (Delahunty et al. 2012), such as skills in the fields of manual drawing, geometry, modelling, spatial thinking, visualization, problem solving and design. Although there are also in this list of overlapping with the sphere of visual and spatial intelligence, there emerges a strong connection but also a different connotation between graphicacy (Balchin and Coleman 1966) - understood as the ability to communicate through visual messages such as images, maps, diagrams,

graphics, symbols and drawings-, and visual literacy, which focused on visual perception, visual communication, visual languages, visual thought, visual learning (Cicalò 2017a, b).

Pedagogy and Psychology are precisely the areas that can be most useful in defining the areas of investigation of graphic representation and visual communication; the areas of investigation of what can be defined as graphic and Visual Sciences, in which the adjectives graphic and visual refer to the double relationship that can be established between the individual and the image: the individual as a producer of images and as a reader of images. Knowledge of the processes of perception makes it possible to define the strategies of graphic representation. The awareness of the perceptual mechanisms of decoding the image is the key to the design of encoding visual messages (Massironi 1989). Knowing the cognitive paths of decoding, it is possible to define those of codification of graphic signs aimed at the transmission of messages through the visual channel. The study of graphic representation cannot therefore ignore that of visual perception. Therefore, the graphic dimension and the visual dimension are the two complementary dimensions of the images.

Graphic and visual actually identify two different faces of the same medal (Massironi 1989) where the term graphic is linked to the coding of signs that is the basis of the production of images while visual is instead linked to the process of decoding the act of perception. Graphic representation and visual perception are two closely linked processes because in order to code the signs correctly it is necessary to know the mechanisms by which they will be decoded. However, in the literature also the terms representation and visualization are often used as synonyms if not as equivalents. Visualization is defined as a rigorous and systematic graphic representation of data, information and knowledge aimed at communicating and understanding what could not be communicated in an alternative way (Lengler and Eppler 2007; Yoon 2017).

The sciences that aspire to investigate images have to be developed according to this double identity. For this reason, very often in international literature expressions such as Image Science, Visual Science and *Graphic Science* are used in an alternative way.

Visual Science (Bertoline 1998), Image Science (Mitchell 2018) and *Graphic Science* (Suzuki 2002) are just some of the different possible definitions that can be found in literature which, although representing different approaches and disciplinary traditions, are often used as synonyms.

In addition to being linked to different disciplinary traditions, the use of these expressions is also linked to linguistic considerations. The search for an expression that is universally recognized and identifying a particular field of study can be problematic due to the difficulties of translation. Translators select the most suitable words to express concepts, always making an approximation and a compromise (Eco 2016a, b).

In the Japanese disciplinary tradition, for example, the expression *Graphic Sciences* is used as a translation of the expression 図学研究 in which the ideogram 図 is translated as graphic/graphical but could also have the meaning of drawing; image, diagram, figure, illustration. This conception of *Graphic Sciences* includes three areas: the theoretical one of geometry, the technical one related to representation and the

cognitive and psychological one (Suzuki 2002); an articulation very close to that used by Bertoline to connote the Visual Sciences, based on geometry, representation and spatial thought. It can therefore be said that often in literature the expressions *Graphic Sciences* and Visual Sciences are used to connote the same field of study. To further underline how ambiguous the distinction between these expressions can be, it is sufficient to think of how Bertoline (1998) began his discussion in defining the Visual Sciences using the expression graphic or Visual Sciences, then preferring the expression Visual Sciences to that of the *Graphic Sciences* because, in his opinion, the latter would be limiting because it is linked only to texts and images, while the adjective visual would be able to understand everything that the eye can perceive. This broadening of perspective that characterizes the use of the adjective visual is then highlighted in what in international literature are defined as visual studies that identify a field of study even wider that reaches to embrace art, aesthetics, anthropology, sociology, history, communication, design, photography and film (Barnhurst et al. 2004), i.e. all those fields of knowledge based more on the production of the image on its perception and interpretation.

1.3 Graphics: The Method

The verification of the hypothesis was made by analysing the submissions sent in response to the call for paper and for images and by creating a knowledge taxonomy linked to the contents of the *Graphic Sciences*, also through the use of a diagrammatic representation mode that is able to visualise the complexity of the results thus obtained.

Each edition of the IMG conferences explores the world of images through a unique look, and the IMG2019 does so by proposing the keyword - graphics with the following meanings:

- graphics is a linguistic suffix that adjectives what comes from the sphere of -graphia, that is, description, study, writing, drawing. What is graphical uses signs on different supports and means. What is graphical consists of a weave of significant signs, concerns the drawing, is expressed in an image.
- graphics is also the suffix that distinguishes the arts and sciences that have as their object the description of a subject also through images.
- graphics is a suffix that can be combined with several roots to create neologisms and new images, experimental and alternative forms for the description of subjects, even unusual.
- graphics therefore refers to a plural vision of the modes, techniques, sciences and arts of description and representation drawn through images.
- graphics can be the scientific visualizations, design images, communication techniques, modes of expression, works, forms of narration, strategies of learning and construction of thought.
- graphics are the bodily or mental elaborations that the individual produces through his perceptive, cognitive and executive functions.
- graphics are the encodings through which the representations of invisible, intangible, ephemeral or immaterial phenomena and subjects are experienced.

– graphics can be defined the sciences involved in the study of methods and techniques for the production of visual artefacts, images and their uses in the most varied fields of knowledge and society
– graphics is the extension that IMG2019 imagines to use to indicate the nature of the subjects on which it intends to focus attention and the domain to which the themes that the conference intends to study and deepen belong.

1.4 The Fields of Interest of *Graphic Sciences*: The Results

According to the hypothesis, the *Graphic Sciences* would not be configured as a single discipline with monolithic methods and univocally and preventively determined objectives, but rather as a set of fields of study with a non-unitary repertoire of interests (Eco 2016a, p. 10).

The conference proposed the exploration of the *Graphic Sciences*, a name capable of synthesizing the variety of approaches and traditions with which the disciplines of graphic representation are declined in the international panorama of research and teaching. However, the responses to the calls have declined the proposed keyword in a plural way outlining six major fields of interest of the *Graphic Sciences* hypothesized:

- graphic thinking and learning
- drawing, geometry and history of representation
- digital modeling, virtual and augmented reality, gaming
- graphic languages, writing and lettering
- graphic communication and digital media
- data visualization and infographic

These areas have made it possible to represent the complexity of genealogy and geography of what have been hypothesized to be the *Graphic Sciences* that find different names and characterizations in the international arena but that are united by their contents, belonging to the sphere of production, analysis and interpretation of images in the most varied fields of application.

This genealogy and geography of the *Graphic Sciences* has been represented in diagrammatic form through an image that has been taken as a map and graphic index of the conference.

1.5 Graphics on Graphics: The Results Visualization

After having analyzed and classified the conference submissions, it has been analyzed and compared the graphic representations that can visualize the taxonomies of the fields and subjects of study of the *Graphic Sciences*. If there is a field of studies that can be labelled ad *Graphic Sciences*, it must in fact look at images and graphic productions by groupings, families, classes, connected by similarity to other things in the world and between them (Mitchell 2018, p. 37). Although analyzing this type of taxonomy numerous case studies are available in the literature, many of them do not make use of graphic representations (such as that of Fry 1981 and Schenk 2007). This study focuses instead on the studies that graphize these taxonomies and that allow through visualization to compare both the graphic devices used to govern the complexity of a

disciplinary taxonomy and the contents included in them - that is, the research areas and the subjects investigated that are isolated and classified within a continuum of objects observed (Foucault 1998, p. 89) - and the relationships between the same contents placed in the representation according to consistent internal rules.

This information is not always easy to compare as it is conceived through different disciplinary views, aims and graphic capabilities. However, reading them makes it possible to highlight and extract interesting and useful information both on the method by which to govern the complexity of the information through a graphical representation, and on the choice of content considered belonging to different traditions and different disciplinary views.

The study of *Graphic Sciences* taxonomies has already been discussed by several scholars from different disciplines including, in addition to engineering and architecture, cognitive psychology and pedagogy. Often, these studies consider the visual and graphic fields as a whole (Bertoline 1998), or discuss this subject only in the field of certain disciplines such as design (Schenk 1989, 2007; Pei et al. 2011) or economics (Lengler and Eppler 2007), or have been created in a technological context that is now obsolete, as in the case of Fry's taxonomy (1981).

The taxonomic classification and visualization of graphic products must in fact be continuously updated as these fields evolve constantly in relation to technological, cultural and professional changes. There may be dormant fields that can reappear, others that instead temporarily switch off and then re-emerge in the future (Massironi 2002, p. 3). Studies on these updates are also recurrent in literature, such as Danos and Normans's (2009), which updates Fry's diagrams in the light of professional and technological changes, and Gorska's (2015), which updates Bertoline's (1998), including pedagogical aspects.

Therefore, in literature there are numerous studies about graphics on graphics, graphic models for the representation of the fields of study of the graphic-visual disciplines (Cicalò 2019). Some of them are characterized by a distinctly static and hierarchical profile that finds in the tree diagram an ideal representation. Among those that can be classified as non-hierarchical, some borrowed taxonomic patterns from other fields of knowledge include the periodic table by Lengler and Eppler (2007), the rhizomatic diagram by Moriarty and Barbatis and the river branching diagram by Massironi.

In the academic tradition, the taxonomic representation of knowledge often refers to the metaphor of the tree, which provides a central body of knowledge from which branches of discipline ramify. This structure corresponds to a hierarchical, linear and rigid logic, inappropriate however to describe more complex and dynamic structures (Moriarty and Barbatis 2005, pp. xi, xii) for which other metaphors seem more effective. The rhizome, for example, differs from the tree because it is a self-reproductive, multiple, dynamic structure, without any center of hierarchical control but with the nodes that connect with other nodes in a non-hierarchical structure capable of extending in all directions (Deleuze and Guattari 1987).

Of greater interest for the objectives of this research is instead the graphic representation of Massironi (2002, p. 3) who selects the most relevant uses of drawing in human communication in different eras, for different objectives, without claiming to create an exhaustive taxonomy. Its diagram is drawn as a river ramification in which

the different branches can intersect, disappear or originate other branches. According to this approach the model is continuously subject to transformation, deformation, expansion, reduction. The flow of knowledge is sometimes rapid and vigorous, others slow and stagnant. The springs become extinct and then reappear. The flow is continuously directed towards the sea but the two main tributaries, that of representational and non-representational images, remain constantly active (Massironi 2002, pp. 2–4).

Starting from Massironi's diagram, and in line with his internal rules, an update of the graphic production has been hypothesized in the light of the new graphic representations today elaborated with and for the new digital technologies. The diagram drawn takes into account not only the technological innovations, but completes the taxonomy of Massironi with the elements missing in it but present in the other taxonomies analyzed and already mentioned above (Fig. 1).

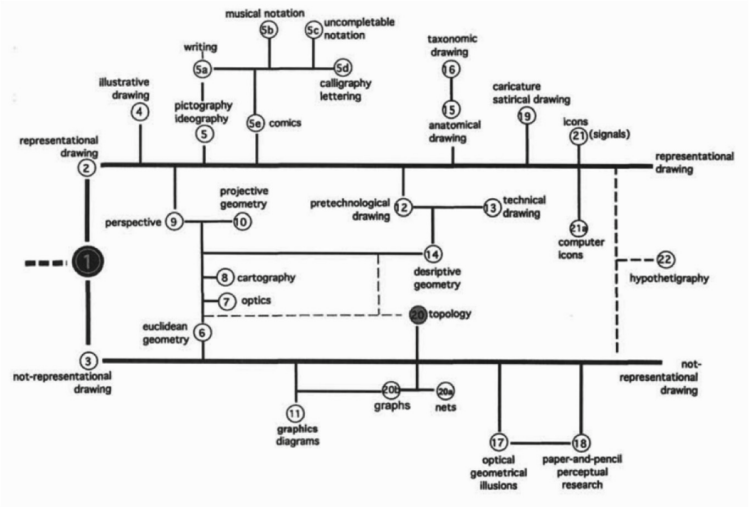

Fig. 1. Diagram of graphic productions by Massironi (2002)

The new graphic representation of the subjects of study of the *Graphic Sciences* thus obtained, even if without any ambition of exhaustiveness and objectivity, allows to highlight the genealogy, the geography and the taxonomy of these knowledge to start a discussion on the different fields of their study and on their mutual relations.

This experimentation also makes it possible to highlight some limitations. Even this representation, like the others analyzed, is not objective but strongly influenced - both in the choice of the nodes within the continuum of graphic production as well as their relationships and their positions - by the context in which it has been elaborated, by the objectives it has given itself, by the disciplinary field of origin of the author and by his personal gaze. The connections between the nodes are to be understood as genealogical relationships and not as possible connections in relation to potential applications, which would be much more dense, dynamic and changeable. Each of the nodes can, and has

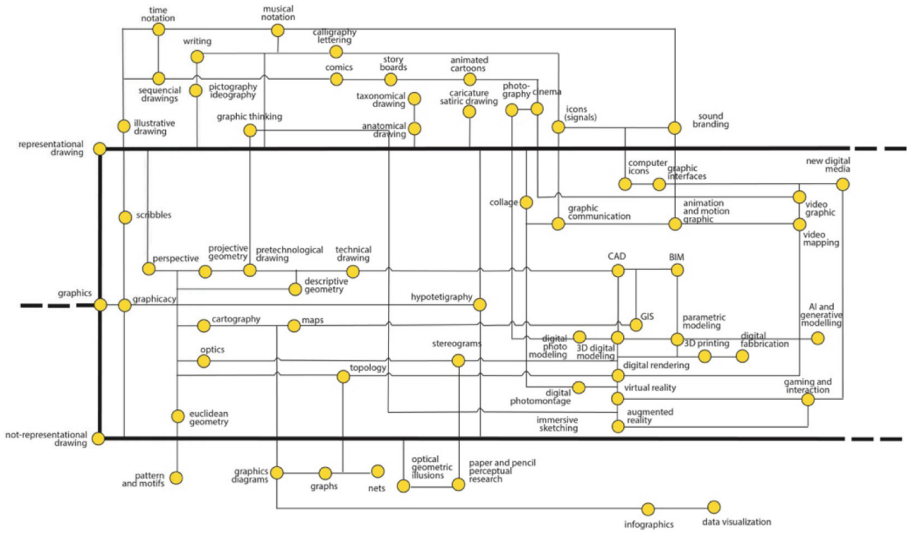

Fig. 2. Diagram of the fields of interest of *Graphic Sciences* by Cicalò (2019), made updating the Massironi diagram of graphic production.

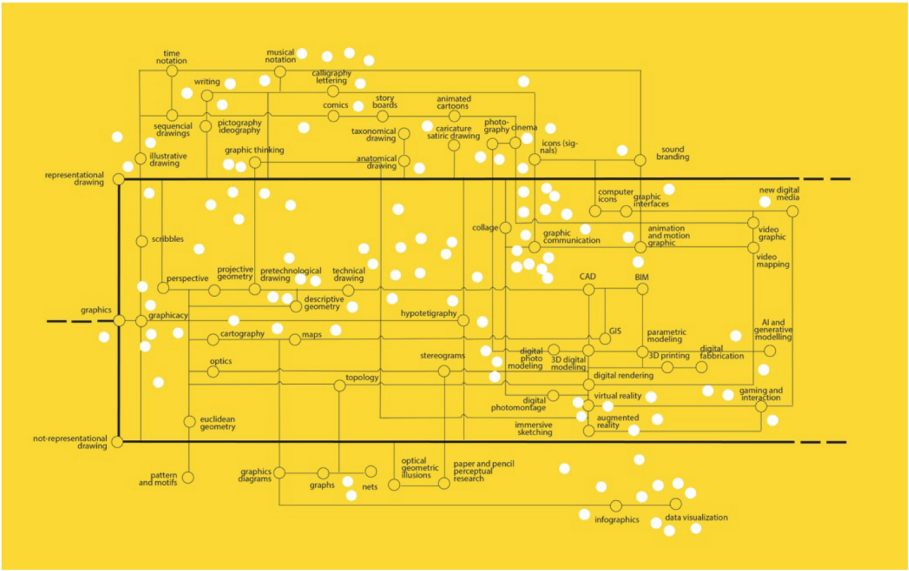

Fig. 3. Visualization of the papers and images submitted in reply to the IMG2019 call for papers and for images, placed in the diagram of the fields of interest of *Graphic Sciences* by Cicalò (2019), made updating the Massironi diagram of graphic production.

to, be interpreted as indicative also of other different declinations, without this affecting the general structure of the graphic model.

In conclusion, Massironi's graphic model inspired by a river network continues to highlight the possibilities of movement, exchange, contributions, confluences and ramifications within a liquid network and therefore in a continuous transformation in which the knowledge produced in one node passes through the various ramifications reaching all the others, almost following the principle of communicating vessels that restores unity to a system of apparently non-communicating nodes that are actually strongly connected (Figs. 2 and 3).

1.6 Conclusions

The IMG2019 conference was an opportunity to explore the fields of interest of the *Graphic Sciences* and to represent them in a taxonomic way.

At the base of this exploration there were some assumptions:

- The disciplines indicated in literature with the names of *Graphic Science*, Image Science and Visual Science are often considered as equivalent and overlapping. They all have images as their subject but have different objectives linked on the one hand to the process of codification of signs and on the other hand to the decoding and interpretation of the same.
- Graphic and visual spheres are complementary but not overlapping and equivalent fields of study in which one represents an essential cognitive basis for the study of the other.
- The graphic sphere is the one to which the processes of image production refer, for any purpose and in the different fields of application, while the processes of reading and interpretation refer to the visual sphere.
- The exploration of the graphic sphere must therefore be addressed to the techniques, methods and tools of image production, but also needs to know what will be the life of images, which implies knowledge from other fields of study such as psychology, sociology, pedagogy, anthropology, art and other humanistic disciplines.
- The graphic sphere is therefore by definition a technical-scientific field but with indissoluble and unavoidable relations with the humanistic one.

In the light of the distinction between the graphic approach and the visual one, which characterize the more general field of study of images, and having highlighted how the term graphic distinguishes in particular the field of production of images, the diagram of graphic products of Massironi was taken as the basis for representing the fields of interest of the *Graphic Sciences*. This has been updated in the light of the possible declinations of the term proposed at the conference img2019, including all new fields of interest related to the innovations introduced by digital technologies, and beyond. These entries were made in accordance with the internal rules of the diagram of Massironi, so that each new update could be placed consistently with the previous structure.

In this new display, the positions of the contributions sent to the conference have been inserted, highlighting an almost uniform distribution of points and thus confirming

how the term graphic lends itself to identifying the most diverse fields of knowledge related to the production of images.

In conclusion, the conference allowed to represent taxonomically and graphically a visualization of the fields of interest of the *Graphic Sciences*, able to keep together very different and apparently distant traditions and approaches, but belonging to the same geography and genealogy, thus verifying and demonstrating the hypothesis initially assumed.

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Writing Is Image

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One of the crucial issues of the so-called visual culture, which is so frequently presented as pervasive and characterizing the current era, is the relationship between images and writing.

This relationship is usually poorly understood, misunderstood or even distorted. The approach of this conference itself shows a typical flaw of critical review with regard to this question.

Writing and images are often in opposition, unless they are the works of street writers, and current writing is almost heard more than seen, one no longer notices that the letters of a text, both on paper and on screen, are nothing more than small graphic signs, images placed one after the other that slide on the support or that form a larger one, the page.

But let's summarily see how things have gone.

The first forms of actual writing, i.e. the *tokens*, the signs studied by the Franco-American archaeologist Denise Schmandt-Besserat, or the first cuneiformes on clay, or the antecedents of Chinese characters engraved on turtle shells, had commercial, bureaucratic-institutional or religious functions.

They did not have the objective of transcribing the spoken language: they absolved, we can suppose with full effectiveness, their own communicative aims by means of specific signs, developed within specific fields.

When the needs of communication increased, starting from the need to give people names, the graphic signs began to represent also those of the language, and syllabic and consonant systems were developed.

This process, as far as the antecedents of our alphabetical system are concerned, takes place mainly in the presence of languages, such as Semitic languages, in which recognition passes primarily through consonant sounds: these are therefore writings in which the representation of vowels is not essential for the understanding of a text.

But in Greek and in the Italian languages it is: it is necessary that all the vowels are present, to avoid that the words "pigna" and "pegno" can be confused, to make a trivial example in Italian.

And it is here, with this illusory program of transcription of all sounds, that things start to get bad.

It is in Greek, in fact, the first known formulation of the absolute and invasive paradigm that still determines our vision of these issues.

I use here the term "paradigm" in the meaning so brilliantly proposed and argued by the American science historian Thomas Kuhn in the fundamental *The structure of scientific revolutions* (1962), published in Italian in 1969 as *La struttura delle rivoluzioni scientifiche*.

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Knowledge, according to Kuhn, proceeds by paradigms, by general schemes which, once developed and accepted, impose themselves on research processes as "normal science", which is then systematically difficult, long and laborious, in spite of observations and reasoning even if impeccable and innovative, to disassemble in order to proceed further towards more advanced and complex forms of knowledge.

An exemplary case is that of the Ptolemaic system, a true and proper absolute paradigm: after having been assumed as an explanation of the relationship between the Earth and the solar system, questioning it, albeit with very clear and simplifying arguments, as in the case of Galileo, even leads to the risk of sending to the stake.

In our case the paradigm, which we can call "alphabetical" or "Aristotelian", is that declared by Aristotle in his *De interpretatione*: "Those that are in the voice are symbols of the motions that are in the soul, and the written signs of those that are in the voice".

More than twenty-two centuries later, Ferdinand de Saussure, in his *Cours de linguistique générale* (1916), gave an even more categorical formulation: "Language and writing are two distinct systems of signs: the only reason for being of the second is the representation of the first".

Similarly, Leonard Bloomfield, decane of twentieth-century American linguistics, in his *Language* (1933): "Writing is not language, but merely a way of recording language by means of visible marks".

Aristotle then enunciated a hierarchical structure that from the soul (the thought, the consciousness, or the langue of Saussure) leads to spoken language, and from this, down below, to writing.

That is, it is taken for granted that thought is linguistic and sequential; but let's see how Einstein thought about it.

The French mathematician Jacques Hadamard, finding himself blocked in the United States at the outburst of World War II, took the opportunity to conduct a research on what today, alas!, would be called "creativity" in science, making a series of interviews with physicists and mathematicians, then published in 1945 by Princeton University Press under the title *An essay on the psychology of invention in the mathematical field*.

Albert Einstein's answer: "The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be "voluntarily" reproduced and combined.

There is, of course, a certain connection between those elements and relevant logical concepts, It is also clear that the desire to arrive finally at logically connected concepts is the emotional basis of this rather vague play with the above mentioned elements. But taken from a psychological viewpoint, this combinatory play seems to be the essential feature in productive thought – before there is any connection with logical construction in words or other kinds of signs which can be communicated to others". It is difficult to bring this suggestive exposure back to the Aristotelian-Saussurian hierarchy.

The Aristotelian paradigm is well established, deeply implanted in all the literacy of Western countries, and not only, by the traditional teaching techniques of the primary school corroborated by subsequent reaffirmations, such as the reduction of the complex