

20/40/60. An Iconotextual Reflection on Photography as Art and Science

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Abstract

The 20s symbolise a period of optimism, with a confident look towards the future. The 40s are a stage of maturity, marked by the consolidation of the dreams imagined in the 20s. The 60s signify a stage of reflection, with the critical analysis of the impressions that the period of maturity has left and the memory of the dreams of the 20s that continue. 20/40/60 are approximate stages. They depend on each person's attitudes and learning abilities. This article is a subjective critical analysis from the perspectives of image management and visual communication, describing how these concepts have changed rapidly and exponentially over the past 40 years. Critical analysis and self-learning abilities, together with the predisposition to adapt to change, allow us to enjoy the professional and teaching periods and are valuable skills for approaching the work and post-work stages.

Keywords

art and science, visual communication, photography, image management, technological disruption

The discovery of the external and internal gaze

Childhood is the stage of discovering the environment through the eyes. Children watch and learn. Learning to look at and make images is one of the tools for development. Drawing, music, and later reading and writing will develop the ability to absorb knowledge, which will be the basis for coping with youth and maturity.

During Franco's educational era, childhood and adolescence were marked by limited exposure to outside perspectives. This absence of external viewpoints occasionally encouraged the development of an internal gaze, which, over time, promoted self-directed learning and fostered imagination as essential skills for discovering new ideas.

Visual education during the dictatorial period was largely limited to drawings that imposed the regime's icons, with few photographs in textbooks. In contrast, photography as a tool for visual communication was already being studied in other countries, such as the United States, Germany, and France.

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In 1971, Jean A. Keim, in his book *La photographie et l'homme*, reflected on photography from the perspectives of the sociology and psychology of the image. He explained how this photographic medium had been introduced into the different strata of society and how, since the evolution of photography, it would be difficult to understand society without images.

Fifty years later, some of his reflections have become obsolete. Photography is no longer the preserve of a specific group of professionals or amateur photographers. In the mid-twentieth century, photography was gradually being incorporated into society. The integration of cameras into mobile platforms, phones, and tablets has meant the definitive democratisation of photography and visual communication.

Keim's other reflections, such as the role of photography in communication, are still valid. In his book, he discussed how communication had become a hybrid of image and word, of image and sound.

There are many languages, making written language non-universal. Visual language is not universal either; not all cultures share the same iconic signs and values. However, the combination of iconic and linguistic signs enables the communication of ideas and the description of psychosocial facts. The text aids understanding of the image; according to Keim, it can adapt to variations in iconographic representation throughout history.

In *La Chambre Claire* (Barthes, 1980), Roland Barthes described two ways of understanding history, before and after photography. The photographic image is the evolution of realist painting. In a photograph based on optical-mechanical capture, the portraits and spaces of historical scenes are described with great visual detail.

At the beginning of the 20th century, the photographer Stieglitz (Frizot, 1998) was one of the pioneers in describing that photography was not only an optical-mechanical capture of subjects and spaces but that it had a visual language distinct from painting, both in the processes of creating the image and in the way the author's emotions were conveyed when capturing the photograph. Stieglitz spoke of the *Equivalent* to explain that in an image, there are equivalent visual components that transmit the photographer's emotions. He described photography not as a purely objective capture of reality but as the author's subjective view captured in the resulting image.

The photographer Minor White (Fontcuberta, 1984) went further on the term *equivalent*, describing that in a photograph, there are not only the author's equivalents but also the viewer's equivalents of the image, and these do not necessarily have to correspond.

The reflections of authors such as Keim, Barthes, Stieglitz, and White have helped to understand the discovery of the exterior and interior gaze during the educational process of children and adolescents. The teaching curricula established during the Franco era did not include these authors or similar reflections. The critical analysis of the discovery of the gaze could only be carried out from the present by reflecting on the past, investigating the emotions and memories that the visualisation of the photographs of childhood stages evoked.

I had no interest in photography as a child, nor any knowledge of its potential for scientific and artistic knowledge. My earliest memories of photography are a collection of pictures in a cardboard box and photographs of family events taken from time to time to remind us of what had happened. Figures 1 and 2 are part of that box of holiday entertainment.

Figure 1 is a photograph of my family, depicting a bygone era and a large family. I was the youngest of five siblings. There is no memory of the day it was captured nor of the place where it took place. The image itself does not convey any emotion. Instead, it conveys emotions and memories not reflected in the image and forms part of the educational and emotional process experienced in the family environment. They recall the parents' kindness, the two older sisters who were like two other mothers, and two brothers of whom there is no memory at all from this stage.

Figure 1: Family album picture. End of the 1950s. Family archives.



Figure 2: School group photograph. 1960s. Family archives.



Figure 2 is a photograph of the first year of boarding at the Valldemia School of the Marist Brothers in Mataró, a group photograph of the first year of high school. I was ten years old, and this image does not bring back any memory of the day it was taken, but it does bring back memories of some of my colleagues and the spaces I lived in. Nevertheless, as in the case of the family photograph above, this image of the school conveys other emotional memories not reflected in the photograph: discipline, order, strict silence, and a disciplinary policy regarding punishment. Paradoxically, it also suggests that some teachers' teaching quality did not conform to the strict rules of a religious boarding school.

Watching the TV series *The Handmaid's Tale*¹—with those uniformed young women silently descending the stairs to the courtyard, where they stood in an orderly fashion (left arm stretched to the side, right arm stretched forward, to create a human grid), awaiting the "captain's" orders before performing the maid's duties—bring to mind some of the moments experienced in a religious boarding school in the 1960s. Boys in uniform smocks quietly make their way down the stairs to the playground after breakfast and, standing in a strict grid, wait for the brother's orders before going to class. The line between fiction and reality is often very thin.

The inner gaze, together with the outer gaze, is a crucial element in developing imagination and generating new ideas during youth. This gaze allows foreseeing, from the present, the future activities in the maturity stage.

Photographs of lived stages, such as figures 1 and 2, help reflect on the inner gaze's discovery and self-learning. An inside look that can help a child survive in the adult world. When I was a child, I started asking myself questions about things I did not understand to survive in a familiar adult space that was often incomprehensible, and in a disciplinary space that was at odds with the intellectual and emotional values present in the classroom.

The learning and self-learning of the exterior and interior gaze in childhood and adolescence are tools for rational and emotional knowledge that have served me and can serve others in understanding cultural and visual communication.

The 20s, a process of transition towards the gaze's rational learning

The 20s represent the stage of illusion and the search for ideas. Illusions and ideas that accompany you throughout life. The transition from childhood to youth is a path marked by difficulties that vary for each individual and each social, family, and political environment.

Being part of the last generation of the "pre-university" course, the last promotion of the Bachelor of Arts in "Philosophy and Letters", and the end of a totalitarian regime in the middle of university studies influenced my transition to maturity.

Several authors influenced the first searches in philosophy at the university. In my case, I highlight Russell and Ortega y Gasset with their theories on perspectivism.

Nietzsche and Schopenhauer seduced me with their critical vision. They encouraged my interest in nihilism through different, sometimes contradictory, visions of understanding thought and the theory of knowledge.

An accumulation of paths and ways of understanding life, an aporia in the face of some teachers or social environments that sought to control pupils and young people, while others encouraged each pupil or young person to choose their own path. The illusions of the 20s,

1 Miller, B., Wilson, D., Sears, F., & Littlefield, W. (Executive Producers). (2017–Present). *The Handmaid's Tale* [TV series]. Daniel Wilson Productions, The Littlefield Company, White Oak Pictures, Toluca Pictures, MGM Television, HBO Entertainment.

the learning processes of this stage, and the management of frustrations when these were not fulfilled were tools for moving towards the future.

The 20s look at a biography yet to be written, at many things to be discovered, from different views than one's experience, and it is the time for the fall of the first myths.

From university teaching, from the 40s or 60s, one should remember the daydreams of the 20s and analyse and share the views of young people who have just left secondary school. Young people who arrive at university are usually excited, sometimes clueless, and often lost. A good time to spread the word that the essential part of learning is not the information they are given, but the management of this information towards their personal interests. It must be shown in daily classroom activities that teachers also learn from their discoveries.

Only some people agree with critically analysing teachers' and students' needs for discovery. A few years ago, while working on the creativity of images, a student claimed that fashion should be followed when making images. The class discussion turned to the concept of fashion and who should decide what fashion was. The debate drifted towards more conceptual issues, and the resolution of questions such as: should we be hostages to the guidelines of those who decide to captain fashion? Where does freedom stand in relation to creativity? Why can't it be a student who decides what fashion is? Questions that are sometimes difficult to solve (or not because they are more evident than they seem). Sometimes these questions are more useful to other students than to the students who prompted the discussion.

With the evolution of information technology, new search tools and an abundance of information about what one wants to learn have emerged. This has meant that students can find out more information about their dreams more quickly, individually and in groups, in front of a computer. This information is only sometimes related to what is explained in the classroom, and understanding their motivations should be considered when teaching and preparing classes, encouraging self-learning and critical debate.

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One day, a critical student questioned the dissemination of knowledge in the classroom. He argued that *Google* was everything. The debate moved towards innovation and the search for new ideas based on self-learning, and that networks such as *Google* lacked the most essential thing, the knowledge and reflections they could provide to the networks.

The question of the search for knowledge no longer depends on the quantity of information to which one has access, but on the quality and reliability of this information, knowing how to choose and contrast it in the shortest time possible.

Perspectivist theories have facilitated reflection on how knowledge can be examined from diverse viewpoints. This can involve individual or group perspectives, combining various insights to achieve a broader understanding. However, reaching complete objectivity remains unattainable, even when considering multiple perspectives. Additionally, as Ortega y Gasset noted, it is important to consider the different viewpoints arising from various historical stages.

Learning in the classroom, self-learning outside the classroom, and the dreams of youth should all serve to focus on specific topics, resolve the questions that arise, and guide the transition to maturity without losing the illusions of the 20s.

My interests in mathematics and philosophy in secondary education developed into an interest in the semiotics of the image during higher education. Discovering photography at 20 allowed me to enter an unknown field of knowledge and, at times, verify that it could have been more

appreciated in the academic world. Semiotics used to be a field of study mainly in linguistics. Still, it has since been incorporated into and related to other areas of knowledge, for example, the field of images. Extending my studies at the University of Paris VIII enabled me to take the Semiotics of Photography course, which was not offered at the University of Barcelona.

In the 1930s, French photographer Henri Cartier-Bresson described the concept of the *decisive moment* as the instant in which, when pressing the camera button, the elements of the image are aesthetically ordered within the photograph's composition.

A few years later, in the USA, photographer Robert Frank went beyond the *decisive moment* to uncover the *meaningful moment*, in which, when pressing the camera button, the elements of the image are distributed to convey a meaning, a concept, or a metaphor.

It was in the 1970s in the United States of America that a group of photographers—some of whom represented philosophical photography—wanted to break the limits of the concepts of decisive or meaningful moments. Photographer Ralph Gibson, for example, supported the idea that images had no more value than the author or the viewers of the photographs wanted to give them.

At this stage of reflection as a student, and with the desire to learn photography and visual semiotics, I made figures 3 and 4, which are given as examples.

Figure 3: From the street. Toni Bover. 1970s.



Figure 4: From home. Toni Bover. 1980s.



I started studying photography because of my interest in an exhibition about philosophical photography at the now-defunct *Spectrum* gallery in Barcelona in 1975. At that time, I had neither a camera nor any knowledge of photography. Figure 3 is a photograph taken at the end of Franco's regime, one of the first images I took as a student; it helped me understand the concept of the iconic sign and the relationship between signifier and signified as elements of visual language. A photograph with a visual metaphor shows the contradictions of information and obligations. The cathedral and museum signs are cultural elements, whereas the mandatory traffic sign points towards the opposite direction. Above these signals, a text explicitly prohibits fixing posters. This image conveyed the contradictions to which young people were—and still are—subjected: between the dreams of emerging youth and the eagerness for the future, and the feeling of being in front of a world of adults who seem to have forgotten the importance of illusions.

The image of clouds has accompanied me throughout my life; it is the image of a real, changing, and random element. A different visual form that escapes reiteration. Figure 4 is a photographic image made to convey a visual metaphor, the need to search for something new, to think that, behind the comfort and security of learned knowledge, there is also the desire to discover what is not yet known.

A cloud is an aesthetic form, real and abstract at the same time, which only has meaning if the viewer of the cloud or its image wants to give it meaning. Moreover, if desired, it can convey the emotions from the inner gaze (the *Equivalentes* that Stieglitz spoke of) or the beauty of the forms captured by the outside gaze.

Becoming familiar with photography allowed me to learn how to look, to communicate ideas through iconic signs, and to order the elements of an image, thereby understanding the basics of aesthetics and visual communication.

The 40s, a process of transition to maturity. Looking to the future from the present

The 40s open the stage of maturity and continuous progress. You become aware of what you love and consolidate the ideas of your 20s. This stage helped me to understand and consolidate my knowledge of photography and its relationship with visual communication.

The concern to understand photography through the semiotics of the image was interrupted, as the concepts of semiotics, applied primarily to linguistics, did not help in studying photography. One of the main objectives was to understand photography as an element of reflection beyond professional or artistic sectors, which often have partial visions of the subject and are generally only interested in the specific photographic themes of their speciality. With little information on the pursuit of knowledge through photography in education, many questions were to be answered, and still, not all of them have been resolved in my lifelong learning.

Why has photography been considered for many years as a mechanical or merely technical element if it can also convey emotions both from the author and from the image viewers?

French poet Baudelaire (Sougez, 1981) was one of the detractors of photography at the beginning of the 19th century. For him, photography meant the death of art since it was a mechanical capture of reality. Baudelaire is a universal poet. His book *Les Fleurs du Mal* has been and remains a bedside book for many, but his view of photography stemmed from a need for a deeper understanding of the medium. Baudelaire was photographed by one of the pioneers of portrait photography in France, Gaspard-Félix Tournachon, better known as Nadar. Some of his photographs can be seen on the covers of Baudelaire's books, in the editions of *Les Flors del Mal* (Baudelaire, 1990) and *Els Petits poemes en prosa* (Baudelaire, 1991), from the collection Edhasa Clàssics Moderns. These two photographs, two portraits of the poet, are an example of subjectivism in the capture of photographic images, both in the composition and in the photographer's point of view about the position of the character and the instant of the capture of the poet's gaze. These images show that, behind a photomechanical capture and a photochemical process, an author conveys a human point of view in the resulting image. The painter Delacroix thought the opposite of Baudelaire, since many of the pioneers of photography came from the field of drawing and painting.

In England, William Fox Talbot, one of the discoverers of photography in parallel to Daguerre in France, described in one of his writings how fascinated he was by the first photographs when he saw how the lines of the composition of the image all came out at the same instant and did not have to be drawn one after the other as in the drawing (Fontcuberta, 1984). Talbot was well acquainted with drawing, as he travelled around classical Europe, sketching with his camera lucida urban landscapes and historical heritage sites, as one of the participants in the *Le Grand Tour* (Zannier, 1987).

The history of photography in the 19th century primarily shows progress in photochemical processes and improvements in camera and optical quality. From the 20th century onwards, photography evolved as a communication tool from a psychosocial perspective.

Lewis Hine (Lemagny i Rouillé, 1986), for example, in the early 20th century in the United States, used images to raise social awareness of one of the most severe problems of the Industrial Revolution: the exploitation of children. Hine photographed different industries where one could see boys working in mines and girls in textile factories. The emotional impact of his photographs contributed to laws related to occupational safety and child exploitation.

In the 1930s, the photographers of the *Farm Security Administration* (F.S.A.)² toured areas more affected by the *Crash* of 1929 in the United States, visualising the impoverished spaces and

2 Centre National de la Photographie (Ed.). (1983). *Amérique. Les années noires: F.S.A 1935-1942*. Paris, Collection Photo Poche.

the sadness in their inhabitants' gazes. Some of these photographs have remained mythical in the field of photography and visual communication.

In the 1960s, the American photographer Diane Arbus travelled around New York to select the people she wanted to portray. The bitterness conveyed by her images reflects the inner self that led her to end her life.

In one of his short prose poems, *L'étranger*, Baudelaire talked about a man who loved the clouds. If he had lived longer, he would have seen that photography, too, allows the visual metaphor to be captured through the gaze on the small clouds.

Why did photography take so many years to be considered an artistic genre when cinema, based on the principles of photography, was considered the seventh art from the very beginning?

The main difference between photography and film is the incorporation of the time dimension, as in framing a two-dimensional image (three dimensions, with the arrangement of the perspective image components within the composition). The control of time in visualising images captured in a *camera obscura* enabled the manipulation of spectators' emotions from the earliest films. The film by the Lumière brothers from 1895, *L'Arrivé d'un train en gare de La Ciotat*, is considered one of the pioneering films in the language of cinema. The film shows a train in perspective, moving towards the camera from a distance. The image of the train's arrival moving towards the spectator was a totally unknown way of visualising reality. It seems that some of the film's first viewers suddenly got up from their seats, feeling as if the train were bearing down on them.

Photography and cinema are products of the Industrial Revolution. They were born in the city and, as with most contributions of the industrial revolution, aroused more interest from the outset among engineers and businesspeople than among professionals in the human sciences. Cinema will be a case apart from photography because of the economic impact of controlling emotions by turning the viewing of cinematic images into a spectacle and a lucrative business.

Photography and film are products of scientific research. Cinema was born out of studies on retinal persistence, which explains that images displayed to the human visual organs are retained for fractions of a second after the stimulus has disappeared. The application of this knowledge to the photographic camera enabled the representation of movement and the control of time in visual communication.

The concepts of movement and time control in photography were not limited to cinema. Some processes, such as chronophotography or multi-exposure in a single image, as in Marey's photographs, contributed to new ways of understanding the relationship between movement and time in visual communication. Later, painters such as Duchamp and Giacomo Balla used these visual searches in their pictorial works (Scharf, 1994). One of the paradoxes of art history is to see how, from photography, painting drifted towards impressionism (for a quick image capture) and towards abstraction (influenced by the vision of the world provided by photomacrographs and aerial views). In contrast, some photographers pretended to be considered artists and modified their images with chemical processes to imitate impressionist painting, while others sought abstraction by capturing decontextualised fragments of reality.

This conceptual-art/technical duality in photography still needs to be fully resolved. However, it is evident that nowadays, photographic processes are tools used both for artistic expression and for the visual dissemination of social and scientific themes.

Why has photography not been considered an element of interest in education, while textbooks are full of images to illustrate texts and communication-related content is part of school curricula?

Regarding the teaching of photography, not all countries and cultural institutions have shown the same level of interest. The teaching of photography entered the United States' universities at the beginning of the 20th century. In the 1930s, from the German Bauhaus, teacher and

artist Moholy-Nagy predicted that the "illiterates" of the future would be those who neither read nor write, nor make or understand photographic images.

In Spain, it would not be until 1994 that the Polytechnic University of Catalonia (UPC) would offer the first Degree in Photography as its own degree. This degree would not become official until the beginning of the 21st century. Since 2015, this degree has been discontinued at the UPC due to changes in the field of photography. It has been replaced by the Degree in Design, Animation and Digital Art, which is more related to *Image Management*.³

One of the paradoxes in education has been the exponential increase in the use of photographic images as visual support for the subjects taught in master classes and their use in textbooks. In contrast, the study of the photographic image is reduced to extracurricular activities.

During the period of photochemical photography and in the early days of electronic imaging, specific equipment (collection equipment and laboratory processes) had a financial cost that not all schools could afford. However, lack of financial resources would not have been the only reason for not providing more knowledge of photography in the teaching curricula. The consideration of photography as a purely optical-mechanical capture of reality, for some, and the lack of knowledge about the emotional implications of photographing, for others, are among the reasons why photography has not been used as a subject of knowledge in the majority of schools.

One of the most exciting goals for teaching staff is to research and improve their knowledge of the subjects they teach. Having taught photography-related subjects to students of different ages and in different educational settings since the 1980s, I have found that visual learning was more agile and effective the younger the students were. In photography learning activities for children and adults, the images resulting from similar exercises in class were better—both from the point of view of semiotics, aesthetics or technique—in the younger students than in the older ones.

The interest in and faster learning among young people compared to older people have persisted throughout the evolution of image-capturing processes and their applications in visual communication. The more vertiginous and exponential this evolution has been, the greater this generational learning distance, or self-learning, has grown.

Historically, photography, from both social and artistic perspectives, was more widely accepted and evolved more rapidly in the United States than in most European countries. The cultural conservatism of old Europe had less influence on a young country like the United States.

The ability to live with uncertainty and adapt to the evolution of technology and its social applications was, for me, one of the great challenges of maturity.

From the present, one must look to the future, and the more one can narrow down the questions that arise, the more likely one will be to resolve doubts in the future.

The period of the 40s helped me understand the basis of photography, seeing that it could only be explained by the relationship between art and science, between the still and the moving image, between the exterior and the interior gaze, and between an intergenerational and an intercultural vision. The 40s helped me understand that photography should be applied more in education.

Learning photography involves understanding semiotics and visual communication, which can be applied across different fields of knowledge. To understand photography, you need knowledge related to the humanities, physics to understand the characteristics of light and its

3 "Puedo aventurar que en el futuro no habrá estos compartimentos de 'fotógrafo', 'videasta', etc., sino que hablaremos de *image managers*, es decir, comunicadores y creadores de imágenes; en el futuro daremos cursos de *image management*" (Fragment of the interview to Nathan Lyons) (Fontcuberta, 1990, p. 15).

impact on objects, technology to understand the control of the devices and the processes of image formation, geometry to understand the laws of perspective and mathematical calculations to understand the numerical structures of the processes involved.

If linguistic structures are necessary for writing to make the content of a sentence comprehensible, photography requires knowledge of physical-mathematical structures to make the content of the image comprehensible.

To understand visual communication, it is necessary to grasp the space-time relationship, the image-word binomial, and how to interrelate different image-creation techniques or processes.

In his book *Entender el Cómic* (2014), Scott McCloud defines the comic as juxtaposed illustrations and other images in deliberate sequence to convey information and elicit an aesthetic response from the reader. The comic is a genre of visual communication that works with the dimension of time and visual narrative, with historical precedents in both Egyptian and Mayan art.

In photography, reference authors use narrative and visual sequences, such as the American photographer Duane Michals (Centre National de la Photographie, 1983b). Since the 70s, Michals has produced a series of sequential photographs within the so-called philosophic photography—visual metaphorical sequences related to photographic aesthetics and time dimension.

The series of images in Figure 5 is part of the beginning of my maturity stage, with the search for the essential elements in the creation of a photographic image, with the sum of the icon-communicative bases of the visual metaphor, and with the physical-numerical bases of illumination, to visually show the content of an idea.

The tree transformed into a door, and the leaf, as a residual element of that tree, will disappear over time, leaving only its memory in the photograph. A photograph that will also degrade, starting with the degradation of the colours. *Tempus Fugit*, where only memories remain and in time these too fade away.

The direction and quality of light describe shapes, volumes and colours. Intensity values and colour tones that are numerically measured for a correct capture on a photochemical support.

The sequence of images becomes a visual reflection on the space-time dimensions. This flat two-dimensional image is three-dimensional from the geometry of perspective and the distribution of light and shadow in the composition. The serial sequence brings the fourth dimension, the dimension of time, with the reading of the images one after the other.

Figure 5: Sequential image. Toni Bover. 1990s.



Personal growth is not only the acquisition of greater knowledge, but it is also the ability to adapt to change. The evolution of technology, with the advent of information technology, has brought other tools for the acquisition and delivery of teaching materials.

The computer and digital evolution, or revolution, connotes a rapid pace of learning in acquiring new technological knowledge. Younger people adapt more easily to change than later age groups.

These intergenerational skill differences were common in the field of sport but rare in other areas. This technological disruption has raised new questions.

Why is there still this separation between science and technology, and humanistic knowledge and art?

Research in science and technology has always been carried out by a group of women and men who have studied nature, its laws and evolutionary processes, using mathematical abstraction and examining its usefulness to society. Some areas of so-called humanism and artistic activities have sought to distance themselves from the rationality of science and engineering, as if these were not part of humanism. These separations of knowledge have too often led to psychosocial and psycho-pedagogical reflections that are far removed from technological developments. The separation of science and literature in education for many years would be an example.

The exponential evolution of technology has made the humanities more dependent than ever on technological tools for acquiring and disseminating knowledge. It has made hybrids of image and word, image and sound, necessary tools for classroom learning and individual self-learning.

The misunderstanding of considering humanism and science as separate concepts is described by John Brockman in his book *La tercera cultura* (Brockman, 1996), when he referred to C.P. Snow's 1959 lecture in which he explained the error of separating the "two cultures" and the incredulity of not applying the term humanist to scientific or technological texts.

Why not incorporate more of the learning skills of the 20s and admit to younger people that the limitations of the 40s are not a problem?

Nowadays, maturity means recognising that a young person may sometimes have better knowledge and learning skills than an adult. This should not be a problem; on the contrary, the teacher should not always be the only element of knowledge delivery in the classroom. A teacher's humility will always bring greater acceptance with students than arrogance. This attitude will mean that the knowledge that teachers can bring from maturity will reach the pupils more effectively.

The excess of knowledge, the ease of access to it, and the need for specialisation in specific subjects underscore the importance of interprofessional teams by linking other specialities of knowledge with those that are not their own.

The capacity for rapid acquisition of technological knowledge leads to the consolidation of intergenerational teams. The addition of interprofessional and intergenerational teams to project management improves project outcomes.

If a student is faster than the teacher at certain skills necessary for project development, the teacher should not compete with them but work together to improve and enrich the results intellectually. *Project-based learning* is another approach to consolidating knowledge in classrooms.

Why, in the face of the definitive democratisation of photography, are the foundations of this communication tool in education still underdeveloped?

Photography is the evolution of the perspective devices that were developed and improved from the Renaissance onwards. In 1550, the physicist Girolamo Cardano (Gernsheim, 1967)

incorporated a biconvex lens into the *camera obscura*. In 1568, Danielle Barbaro (Gernsheim, 1967) described the incorporation of diaphragms of different sizes, in conjunction with optics, to obtain a sharper image inside the *camera obscura* used for drawing.

The evolution of chemical studies on the blackening of light-sensitive materials from the 17th century onwards, together with the social changes of the 18th century, led to the birth of photography in the 19th century. Various entrepreneurs, such as Niepce, Daguerre, Talbot, and Bayard, discovered the use of light-sensitive materials in the *camera obscura* for drawing. With the birth of photography, they created a new visual communication tool for the future.

Photography is a unique subject which is related to different contents of the school curriculum: learning to look (mainly topics related to artistic creativity), history and social science content (use of images to support the text), the contents of chemistry (analogue photographic processes) and physics (mainly topics related to light), technology content (optics and mechanics), mathematics content (topics such as perspective geometry and numerical proportions) and communication (senders and receivers of information).

The evolution from photochemical photography to digital imaging is an important change in terms of innovation and the search for new applications of photographic knowledge in education.

The electronic capture of the image of the real, transformed into numerical values, means that from numerical values, realistic images of elements that do not exist can be created on a computer. The incorporation of mathematics into image creation enables the creation of iconographic simulations of realistic aesthetics, both to represent the past and the future.

CGI (Computer Generated Image) is the creation of computer-generated images, virtual photographs taken with cameras and light sources, from numerical values in computer software. The computer-generated image of a realistic type is based on the same principles that are necessary to capture an image of a real space in a photographic camera. Numerical values related to optics, to the mechanical components of a camera, to light and lighting parameters, or to image post-production processes, can be accurately simulated by means of software and computer tools.

The fusion of images of the real and the virtual also allows the virtual image to be illuminated by the numerical values of an image, using a cylindrical perspective generated from photographs, a process called *Image-Based Lighting (IBL)* or illumination through photographs (Bover, 2011).

The set of the two images in Figure 6 marks the end of the maturity stage, with the search for the essential elements between the real and the virtual. Classroom exercises were conducted with an intergenerational team, leveraging the knowledge mix of the 40 and the workflow speed of the 20.

The virtual balls, as part of the Polytechnic University of Catalonia's logo, would be of large dimensions in reality; virtual elements created and captured on a computer, illuminated using real numerical values derived from photographs.

An exercise in visual communication in which the history of modernist heritage, the characteristics of natural light and artificial lighting, the reproduction of a three-dimensional space based on the geometry of perspective and the fourth dimension of time in the passage from day to night are reflected. The use of mathematical algorithms has allowed the fusion of real and virtual images in a computer—a fusion of humanism and technology, art and science in a classroom project in the educational field.

The 60, a process of transition towards reflection. Looking from the present to the past

The 60 means the stage of reflection and a continuation of the illusions of the 20s. A stage for sorting and archiving what has been useful, and eliminating what has contributed little or nothing to the consolidation of the illusions of the 20s or the maturity of the 40s.

The adaptability of the 60, together with the students in their 20s, is a key element in consolidating lifelong learning processes.

In recent years, students arrive at university with learning acquired through the education system and self-learning acquired outside the education system. Understanding this duality of learning sources has been a key element in organising classroom teaching and consolidating their illusions.

In 2014, Howard Gardner, in collaboration with Katie Davies, published the book *Generación APP* (Gardner & Davies, 2014), in which he reflects on how three generations relate to technology. Gardner, born in 1950, belongs to the generation that grew up with analogue technologies, while Katie, 30 years younger, began to see computers introduced into her education. Katie's younger sister, 10 years her junior, is already fully part of the digital natives generation: three generations, three different behaviours in the face of digital disruption.

Since the 60s, the need to slow the vertiginous pace of the search for knowledge associated with technology has been evident. The look from the present to the future must be left progressively, for those who still have a long-term professional or teaching future. The 60s are a good time to take another look at the past from the present, with a renewed vision, thanks to the 20s and 40s and the year-after-year contributions of younger generations.

Looking at the past from the present is a reflection on the visual communication of 2D, 3D, and 4D images, real and virtual, still, moving, and/or interactive. A reflection on how the transition from analogue to digital, from photochemical to digital image, in the case of photography, has been experienced. This reflection from the 60s does not mean looking to the future either. There are still many illusions of the 20th century to overcome and many aspects to reflect on in the face of a technological evolution that is not going to stop. Although it is difficult to predict the future, it always begins with the present. "The future is in the present and in our minds as a projection of the scientific and social moment we live in." (Carbonell, 2007, p. 169).

Visual communication will evolve with advances in photonics and quantum computing (Centre de Cultura Contemporània de Barcelona, 2019), affecting both digital natives and transdigitals. All these new developments will bring with them old and new questions to be answered.

What are the contributions and reflections to be taken into account in the face of the exponential growth of technology in the field of education?

The disruptions brought about by this technological growth are increasingly visible. There have been new forms of illiteracy, new uncertainties amid information overload, and new forms of social polarisation.

All changes throughout history have had both advantages and disadvantages for society. New knowledge has always meant that some individuals adapt to it, while others are unable or unwilling to, creating new "illiterates" or new maladaptations to change. Some psychologists have retrained to deal with the new problems brought about by the advent of mobile telephony and the difficulties of adapting to it.

Mobile platforms, mainly tablets and smartphones, have provided people with external memory. Quick access to many contents, processes and mathematical formulas. This quick access also leads to information overload, which can be harmful and lead to misinformation. New learning

skills must be practised in the formative stages to arrive at contrasting information as quickly as possible.

New additions have emerged, for example, in certain video games. But the problem, or at least the main problem, is not in electronic games, but in the predisposition of certain psychological profiles to obsess over a certain subject, and in the lack of critical analysis that regulates certain video game designs. On the other hand, *Serious Games* bring improvements to society, for example, video games to improve mobility for certain handicaps.

Every change brings with it a polarisation between supporters and opponents; not everyone sees situations from the same perspective. Gardner already discussed the APP generation in his book, written in collaboration with Katie Davies (Gardner & Davis, 2014), in terms of the two ways of understanding digital evolution. Those he calls *Cyberutopians*, who see the new digital paradigm as a strength and an opportunity to improve society, and those he calls *sceptical theorists*, who focus more on the weaknesses and dangers of this endless technological evolution.

Merging diverse points of view and considering multiple perspectives to reach the broadest possible consensus is the method for advancing the management of new projects. The solution usually involves anticipating and minimising negative reactions, and not over-supporting positive reactions.

It is not in the interest of the education system to be polarised for or against technological developments, but rather to reflect on and undertake projects with and without ICT. This technological evolution consolidates lifelong learning; it is necessary to work on learning skills and methods that help students and teachers adapt to continuous change and learn to live and coexist with uncertainty.

Teaching philosophy involves raising and resolving doubts. Science also asks questions and develops methods for resolving doubts through human reflection. Why not interlink art and science projects and subjects in the education system?

Geometry, perspective drawing, and the camera are products of the evolution of visual communication from a monocular point of view (Kemp, 2000). Cinematographic and video cameras intrinsically incorporate the dimension of time into the creation of images from a monocular point of view.

Studies on the functioning of the human eye and stereoscopic vision in the organs of vision have allowed, since the origins of photography, a whole series of cameras and binocular viewers to reconstruct or simulate a three-dimensional view of images.

*Figure 6: Sequential image with photographic image fusion and CGI.
Toni Bover and Miquel Bigas. 2009.*



All these processes of image creation are based on the interrelation of artistic and scientific foundations, from their beginnings and their subsequent evolution.

Reflections such as these have made it possible to create experiences of interrelation between art and science in the educational field, such as, for example, the activities "from drawing to digital art" of La Farinera, Centre d'Art Visuals de Vic (La Farinera, Centre d'Arts Visuals de Vic, online). These activities allow children and young people to observe and experience the evolution of perspective devices from the Renaissance to Dutch Painting in the 17th century, and to see how these instruments lay the foundations for the camera in the 19th century. These activities provide an understanding of changes in imaging devices, the evolution of analogue industrial processes towards digital imaging, the incorporation of cameras into smartphones, and the beginnings of *Augmented Reality*. A space that allows us to understand and experience the creation of images as a historical, social and cultural process, as well as the evolution of science, technology and the applications of mathematics in all these processes. Art and science, in their purest essence, are about understanding that science and technology have evolved from a human perspective, and that this evolution can serve emotional creativity and communication between people.

Creativity and the possibilities of *Augmented Reality* are another technological element that fosters the relationship between art and science. Generated from a numerical image, the interrelation between real and virtual images through a smartphone opens infinite possibilities, both for its applications in the social or cultural spheres and for its use in educational projects. The "Invisible Cities" project of La Farinera, Centre d'Art Visuals de Vic (La Farinera, Centre d'Arts Visuals de Vic, *Ciutats Invisibles*, online) is an example of the application of *Augmented Reality* to the dissemination of cultural heritage and history in educational environments. In one of the activities of this project, the footprints of historical photographers are marked on the ground, and from these points, you can see the images they took. With *Augmented Reality*, they can be contrasted with the real image. The incorporation of CGI images allows for the realistic simulation of historical architectural constructions that no longer exist, or of social or political events in the same physical space where they occurred.

Augmented Reality projects make visible, through mobile platforms, the visions of the city that Italo Calvino narrates in *Las ciudades invisibles* (Calvino, 2011), when he describes that, walking through a historic city, one can imagine and feel what has happened in those streets in the past. The possibilities of visual communication provided by *Augmented Reality* bring, and will bring, new methodologies for understanding and disseminating history.

The set of two images in Figure 7 is part of the end of the reflection stage of the 60, with applications of the sum of knowledge of art and science and an intergenerational interrelationship inside and outside the classroom. These are the photographs of a class session with the students of Visual Culture of the degrees of the Image and Multimedia Technology Centre of the UPC,

Figure 7: Exhibition "A través del Mirall" VICCC 2016. Pictures by Miquel Bigas



on the occasion of the exhibition "A través del mirall" (*Through the mirror*), during the activities of the Vic Capital of Catalan Culture of the year 2016. The exhibition showed the evolution of perspective devices from the Renaissance to *Virtual Reality* devices and visualisations, passing through the different stages of photography, cinematography and electronic imaging.

This exhibition activity allowed students to see learning tools and devices that had been used by students of similar degrees in previous years and were now museum pieces. It was possible to reflect on how some image-capture and visual communication tools had become obsolete in a few years, and how cameras embedded in mobile devices, together with the software on those devices, could produce similar images. The students could see how *Augmented Reality* was used as a teaching tool to visually and interactively explain, within the exhibition, the functioning of some of the historical devices on display.

All this experience and historical evolution experienced by the older ones made it possible to foresee an even more rapid and profound evolution for the younger ones.

Their gaze, the discovery of their hopes and dreams

The illusions of the 20s are usually related to the future of work, about what they want to do and the skills and attitudes they have to carry it out.

Learning to look outside and to look inside connotes the mastery of critical analysis to understand the facts of the past and to visualise what the future might be like.

Where is the look to the future after the 60s? If we were to look at it purely from a biological point of view, the answer would be obvious. If we look at it from the perspective of the illusions of the 20 that continue and from the reflection of thought, the answer is also obvious, it must be reflected on the looks of them, of the youngest, and how they face the discovery of their illusions.

This reflection on the gaze of the 20s is among the most interesting at the end of the teaching stage. The main advantage of the 60s is the benefit of more than 40 years of professional and reflective experience, while the 20s are facing more than 40 years of the future.

The intuitive attitude is one of the strengths of young people, an important element for innovation and the search for new ideas. It is one that, as a general rule, is lost over time and drifts towards a more deductive attitude, towards the search for or attempt to approach perfection. Experience is one of the advantages of maturity, but it is not indispensable in times of disruptive change.

Technological innovation implies learning skills that digital natives have acquired since childhood, skills that transdigital natives will find difficult to acquire due to the intellectual effort required to transition from analogue to digital. Analogue learning involves living with more random components, and digital learning is based on more structured components.

The evolution towards more project-based professional structures and teaching-learning processes means and entails more flexible activities, the need to archive obsolete technological and management processes, and the creation of interprofessional and intergenerational working groups.

Interprofessional groups allow for broader processes of reflection and work, accessibility and better control of information overload. Intergenerational groups allow the more intuitive attitudes of younger people to be combined with the more deductive attitudes of older people. Interprofessional and intergenerational groups could be a good model for breaking down barriers in education between art and science.

All this evolution towards professional structures and project-based teaching structures will entail resolving other types of doubts and questions.

Developments in photonics and quantum computing will lead to changes in the applications of physics and mathematics in visual communication. What role will these innovations play in the education system?

Developments in quantum computing and photonics make it possible to envisage nD workspaces that go beyond the interactive 4D spaces of today's *image management*. (Centre de Cultura Contemporània de Barcelona, 2019). nD spaces that are still difficult to understand from the physical sciences but perfectly described by algebra in mathematics.

The most obvious improvement will be the speed of computer algorithms, with the advantage that this will represent for certain subjects and with the disadvantages that this speed may entail for the control of individual freedom.

The advantages and disadvantages of all evolutionary processes throughout history could serve as a basis for understanding, from a sociological and psychological perspective, the impact of future changes.

Visual communication enables the creation of new visual resources, aesthetic and social possibilities, and teaching applications. Some future applications of *Augmented Reality* can be seen, for example, in *Pokémon Go* for smartphones. This game shows possibilities that go beyond the purely business and playful components associated with mass gaming.

The gamification of *Pokémon Go* enables outdoor activities beyond the computer room, opening up new uses that may have applications in social work and health. (Infermera Virtual: *Pokemon Go: saludable o perillós?*, online). In the field of education, for example, it makes it easier for digital natives to explain the use of the camera obscura used by Vermeer in the 17th century by photographing Pokémon at the beginning of the lesson, and from there to critically analyse the evolution of the camera built into the mobile phone into the historical past.

The evolution of computer technology will allow the restitution of captured images in three-dimensional space, without the need to display them on a screen or print them. Holographic products have been known since the 80s. (Musée d'Art Moderne de la Ville de Paris, 1983), and departments from different Universities are working to find new social applications and technological improvements in the processes of image creation and visualisation. For example, the ViRVIG (ViRVIG: *Visualització, Realitat Virtual i Interacció Gràfica*, online), formed by members of the UPC's Computer Science and Mathematics departments, researches into modelling, visualisation and advanced graphical interaction and their application to virtual reality.

The processes of light capture in camera modules integrated into smartphones make it possible to capture more information at each point in the image (light and dark tones, and colour spaces) than was possible in the photographic processes of the mid-20th century. Current technologies and computer algorithms make it possible to obtain information from each point in the image and the distance between the object and the camera, and to digitally reconstruct a 3D image with all the information on tones, colours, and distances, so that it can be displayed on a 2D screen.

With the visualisation of 3D images without the need for screens, the visual breakthrough will go beyond a change in perception and the visualisation of images; it will mean the evolution of hundreds of years of monocular image capture towards true visualisation and visual communication with three-dimensional images.

From the perspective of visual communication in education and in subjects related to visual culture, it is already possible to examine the vision of the holographic image by tracing the evolution of the sculptural image throughout the history of art. From an engineering perspective, the evolution of holographic imaging will continue as technological processes improve. From the humanistic perspectives of sociology and psychology, the changes that

these innovations in the visualisation of three-dimensional images will bring about should be reflected upon in greater depth.

The evolution of artificial intelligence is moving towards hybrid models with the incorporation of technological elements into the human body. What should humanistic reflections have to say in the face of the forecasts that transhumanism is beginning to bring?

One question to reflect on for the future is the evolution of transhumanism and its implications. Developments in nanotechnology and biochemistry mean that technology will no longer just be external to the human body.

This hybrid vision, with technological elements incorporated into the human body, has been explored mainly in science fiction for years. Some television series raise the issue of transhumanism, for example, *Black Mirror* (Netflix: *Black Mirror*, online) from a more aesthetic and fictional point of view and *Years and Years* (HBO: *Years and Years*, online) from a more realistic fiction and an approach to the humanistic doubts on which these technologies can have an impact.

One should not wait for these technological innovations to be in use before reflecting on the negative and positive aspects that transhumanism will or would entail.

If we look at it from a photographic perspective, it was an evolutionary process spanning more than 2,000 years. Plato was already thinking about the darkroom, and it was not until the Industrial Revolution that a series of scientific experiments in physics and chemistry, together with the evolution of realistic aesthetics, would bring about a change in visual communication.

Reflecting on the present, we can see that, for years, an intraocular lens has replaced the natural lens of the eye in cataract surgery. It is becoming common to place chips in the retina to improve vision. This is the case for young people who want to have myopia surgery and have a very thin crystalline lens that cannot be reduced much with the laser. In these cases, to improve vision without glasses, they propose incorporating a chip to avoid excessive cutting of the crystalline lens. In the early days of photography, studies of the eye were incorporated into the design of optics; today, research in optics and digital imaging is beginning to incorporate the human eye.

In parallel with studies on the human eye, the transmission of data from the brain to the computer has been studied for some time now, using an experimental helmet. (Centre de Cultura Contemporània de Barcelona, 2019). Today, it seems very primitive research, and its success is unclear, but what will happen as quantum computing evolves and its data-processing speeds increase?

If we look at it from a historical perspective, in the 17th century, chemistry studies on the blackening of silver and the evolution of the camera obscura were separate. No one imagined that, in the 19th century, the two research would merge and change visual communication and the way we understand history.

There is no prediction today that improvements in vision in the eye and computer movement through thought can be merged. But some young people are beginning to show interest in aspects of transhumanism, researching and proposing options and ideas for visual culture based on hybrids incorporating computer elements into the human body.

From the reflections of the 60s, we can influence reflections on the present and the study of history. We can reflect on the historical stages in which science and art were united. We can reflect on the historical stages in which art and science have been separated and observe that this has led to exponential technological growth, with humanistic and ethical reflection that has gone behind, not alongside, science. But where are these reflections in the face of the illusions of the 20th century, with long-term thinking about the future?

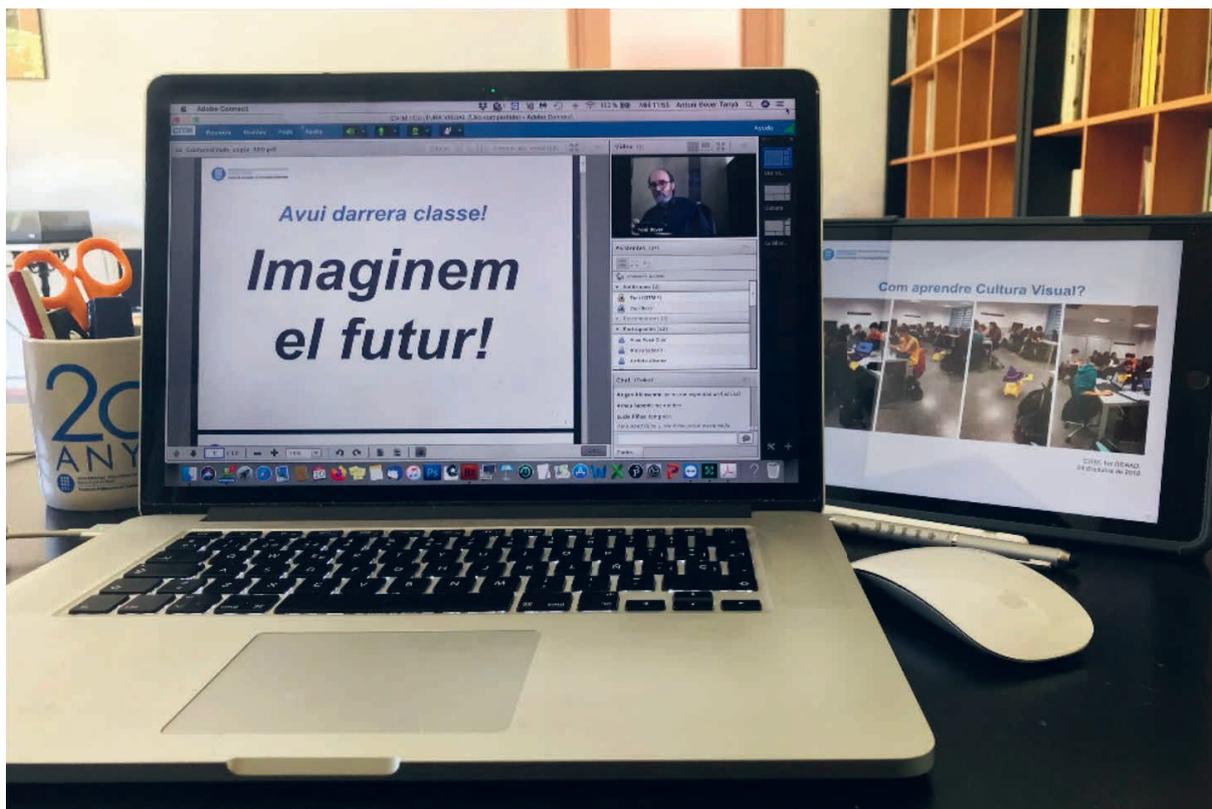
The end of the work phase coincided with the pandemic and home confinement, so the end of the teaching phase was through online face-to-face teaching. For years now, online face-to-face teaching has been one of the great innovations in education.

Some online teaching platforms, such as Adobe Connect, allow students to have and share a virtual classroom with almost all the advantages of a face-to-face classroom: virtual blackboard, visualisation of teaching materials, interaction between the students' computers and the teacher's computer, creation of chat rooms or work groups connected, or not, between them. The teaching structure in a live online classroom can be very similar to that of a face-to-face class.

*Figure 8: Pokémon at home.
Iphone picture, Toni Bover. 2020*



Figure 9: Last class session from home. Iphone picture, Toni Bover, 2020



This type of teaching also involves new questions and a new way of resolving doubts, with both strong and weak points, which must be addressed and new solutions sought. Has this not always been the key to reflection on the theory of knowledge throughout history?

Figure 8 is an image taken with the mobile phone camera from the *Pokémon Go* application. The image was created to prepare a visual culture exercise on art and fantasy from home, featuring a fusion of real and virtual elements and an aesthetic rooted in realism. It is one of the examples prepared from elements close to home to interact with students in a face-to-face online class during the confinement.

The game's Augmented Reality features a virtual element (images of *Pokémon*) that moves continuously within a real space, to be hunted based on the player's skills. In this case, the image was used to reflect on the evolution of the concept of the *Decisive Moment* ninety years after Cartier Bresson's reflections; all the elements of the image had to be ordered within the frame, taking into account the search for a change in the point of view, in the face of real and virtual elements in continuous movement.

Figure 9 is an image captured with a mobile phone camera from the last online classroom lesson on visual culture. The last slide was not only the end of the class, but it was for me, the end of the working period.

In this last class session, we talked about visual culture and how they imagined their professional future. They freely presented their personal interests, some of which were related to *Virtual Reality*, video games, *Augmented Reality*, the possibilities of holography, or transhumanism.

In this last class, we reflected on the importance of technological innovations not being disconnected from humanistic reflections. And if we are to imagine that the next disruptive changes that they will experience professionally will always be at the service of and for the benefit of people.

Vic, December 2020

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