Visualizing Intangible Realities in Design
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This paper explores an enormous potential of digital media in the area of morphology in industrial design, which goes beyond its extended and widespread possibilities of visualization and materialization. The visualization of the concepts that sustain the identity of our projects, even though they are invisible in finished products, can be explained and made evident through digital media. Intelligible aspects acquire perceptual shapes in order to make its apprehension easier. In this sense, we understand that virtual simulation is an important tool of cognitive mediation.
1. Material and cultural reality

We believe our senses let us recognize what is real and tangible. The problem is to determine what we understand as “real.” We deceive ourselves in our simplifications, thinking that it is only physical, including everything that can be touched and seen. We are also wrong when we think of perception as a natural process, because reality is unreachable in a direct way for human beings.

Every apprehension of the world is artificial because it is produced inside a particular culture. Paul Watzlawick explains that “…the presumed external reality, objective and established, is always founded on certain fundamental suppositions that we take as “objective” aspects of reality, when truly they are only the consequences of our way of looking for reality.” [1]

In the same line of thought Judah Schwartz states:

“While we apprehend nature through our perceptions, we understand it through the concepts and explicative models we build with them.” [2]

The representations of reality we construct are grounded on socially validated codes that make communication possible. We learn to read according to them and to the values they carry, and we qualify them as “natural” to the point that we find its recognition difficult. A natural landscape looks like a painting, and a painting seems a landscape. A photo looks like a painting, and the painting a photograph. In these similarities, in the game of “looking like” something else there is always a reduction that implies a selection and a hierarchy that allows us to recognize the underlying values of a definite culture. Tomás Maldonado confirms this when he states that every media for creating images has been “a faithful interpreter of the particular way that each society had of dealing with – or rather of compelling men to deal with – the relation with reality.” [3]

Throughout the history of graphic media: at first through drawings, later with photography and finally using digitally produced images, people stubbornly tried to simulate reality. To erase the boundary between a representation and what it represented, to the point that today we can find websites that offer the creation of realistic oil paintings from photos. So the image of the “real” model is captured in a photo that is turned into an oil painting that is digitized into the website in an endless chain of representations. What was already represented is persistently re-presented again and again.
2. Representations in design practices

The first applications of digital media in design were instrumental, in an operational sense, concerning their drawings; to the point that in its origin CAD meant: Computer Aided Drafting that in time turned into the current D of Design. So, many of the drawing and visual constraints were eliminated. Digital drawing media make possible what was conceived as unachievable, not because the knowledge to produce these images was inaccessible but for the labour, dedication and time they required. However, digital drawing media in three dimensions produced a relevant change that exceeds this first consideration. What is built in a three dimensional CAD system is not a drawing, such as a perspective, but an electronic model. It is an information object, in a simulated three dimensional space, which is produced through the different drawing systems that are used as building languages. In these circumstances drawing is no longer an end but a medium; it becomes the interface between the will of action and the machine. Beyond this significant change that introduced a set of complex shapes that were unavailable beforehand to the design practice, CAM linked in a closer way drawing and manufacturing. Different visual analysis tools allowed interaction between the images of the objects and its physical information. So, drawing increased its attributes of design instrument.

However this has not meant a loss in the merely descriptive capabilities of CAD because there have been remarkable advances in the simulation of the existence of what is drawn, using more sophisticated technologies for the representation of materials and lighting situations. The intention of mimics persists in these representations but, as the project does not have concrete existence yet, they can only reproduce with greater or less fidelity the foreseen attributes of its materials. It is a paradox that the interface of some of the software to produce realistic renders, such as 3D studio, is a virtual photographic studio, where users metaphorically handle cameras and lights. However this particular insubstantial studio has features that are unavailable in its physical equivalent. Among the most interesting differences we consider the possibility of working with something as contradictory as choosing lights that do not throw shadows, and with the possibility of excluding only some objects of the scene from the effects of a light source, clearly breaking the physical laws of the “real” world.

Facing the advance of the photorealistic digital images Jean Baudrillard states that the difference between model and reality has been lost, that:

“something has disappeared: the sovereign difference between one and other, which constituted the charm of abstraction. Because it is the difference that constitutes the poetry of the map and the charm of the territory, the magic of the concept and the charm of the real”.

[4]

However, it is possible to work this difference in the photorealistic
representation of what is incorporeal in its nature: intangible designs and fantastic worlds; so that project, illusion and imagination gets closer to reality. Animated pictures – especially those created by Pixar Studio – and special effects in fiction movies are a clear evidence of this pursuit to gain credibility for imaginary worlds. On the other hand, dreams, memories and fantasy permanently nourish human creations. Even though these inspiring images do not have physical existence they are present in our lives; they compose a part of the insubstantial aspects of our reality and, in particular, of our design projects. Digital media provide a powerful resource so that these images can be shared, broadening our scope of knowledge and communication.

Because there is more, we understand that what is real surpasses what is visible and tangible. Objects cannot be considered only in their material aspects. The concepts and ideas that gave them shape have the same presence as the traces of the tools that manufactured them. What is real, for a human beings, needs to be built, it is linked to history, culture and social practices.

In this line of thought Pierre Lévy explains:

"...even goods that are described as “material goods” get their worth mainly from their shape, their structure, their proprieties in a context, finally, from their “immaterial” dimension. Rigorously speaking, raw materials are the only goods that are only material."[5]

We can agree with Lévy if we add the condition that raw materials should be considered “in” nature, because once they have undergone any industrial process, they have incorporated technology and information.

2.1. The visual shape of information

We think digital media has a great potential beyond mimetic representations that has not been developed yet. Several authors have been concerned with this issue. Among them Arlindo Machado defines it as

"its power to make sensitive what is formal". [6]

Roman Gubern states that the new generation of digital images has produced

"an important breaking point in the history of representation techniques, because for the first time what is visible is created." [7]

In the same line of thought Philippe Quéau explains that the synthetic images

"emerge from symbolic languages, freed from the material condition of light. They are essentially abstract even if they display a material and visible aspect." He sustains that "Images give us the sensitive perception of intelligible models (...) They provide the way of exploring, in a perceptively manner, these conceptual universes." [8]
Much has been said about the loss of representation of the referents in images. However, we may say that the loss is not of the referent in itself but of its substance, because an incorporeal human made algorithm is still represented. The problem is to define which shape they will assume, because any shape is possible since no faithful or proper correspondence exists. When everything is equally possible, the development of criteria of selection and discrimination of alternatives becomes fundamental. A clear and relevant example is the Project Cyberprint, directed by Julio Bermúdez [9]. Different shapes in transformation represent the variations of the corporeal activities of a dancer who interacts with his changing representations. Each kind of activity — of the breathing, circulatory, and nervous system — has a shape assigned. Its selection is not a given data, and cannot be declared “true” or “natural”. It is created considering the communicational purposes of the project.

Even though everything that exists in digital mode is – in its last instance of analysis – a mathematical algorithm, it can hardly be acknowledged as such. In the same way we do not recognize the inner organs of a living body, nor the wave longitudes of colours or sounds. Although we know they exist we do not visualize them in normal conditions. The images describe only a fragment of reality. We understand them because we have learned to distinguish them, without considering their origin or way of emission; even though this information enables a better and deeper understanding. The relevant question that is left unanswered is: what fragment are we perceiving when we see? Or better, what are we missing in what we see?

In design, we reach the algorithms through spatial operations that use drawing systems as a language, as an interface – more or less friendly – between designers and computers. As in the instances we referred previously, what is represented – the model in three dimensions – does not have material existence, even though it is foreseen that it will. This is a reason why this type of representations adopts a stronger resemblance of “real” materials, even though they are built in something intangible. The substance of their construction is data.

In these different cases, the original character of the term cyberspace is recovered, coined by the writer William Gibson in his novel Neuromancer (1984), who defined it as “an accepted hallucination”; adding that it is “not really a place. It is not really a space. It is a conceptual space.” So, it becomes a place to conceive new alternatives.

3. Visualization and manipulation of intangibles in industrial design

Jean Baudrillard states that:

“in the relations between things there is always a gap, a distortion, a breach that prevents any reduction of the same to the same.” [10]
Representation cannot escape to this difference. It is evident that reduction takes place in any image through the selection of some attributes of what is traditionally understood as “real”. However there can be an expansion as well because drawings in both, material and cyberspace, can include information that exceeds its material condition and that is not offered as data but must be built. The resulting images do not depend only on the available techniques, but they are ruled basically by intention. In particular, in the design area images do not refer only to their appearance, they are conditioned by different communicational purposes. Therefore it is fundamental to determine them clearly and to choose the more adequate media to perform them.

Industrial Design objects can be understood in two basic levels. One is composed by their visual aspects: their material, physical disposition and tangible qualities. The other one is as important as the former because it supports and justifies it. It involves what cannot be seen directly in our projects, referred to both, to its configuration – proportions, axis, generative systems, structures – and to the concepts and ideas that silently determine their identity in the profuse universe of objects that surround us. This work explores this potential faculty of computer science, of unveiling the concepts that underlie our projects in a visual and explicit way, in particular in the area of Morphology of Industrial Design. These aspects sustain and configure the material condition of products. So virtual representations attain a purpose far more relevant than the simple representation of appearance. From an educational point of view Eliot Eisner states:

“Human beings have created many instruments to represent and study the world in which we live. Maps present earth masses that we cannot see; histograms, dispersion graphics and bar charts enable us to see quantitative relations that numbers would only darken. (...) In brief, these devices carry out important epistemic functions, not only because they make the display and attainment of information easier, but also because they favour enquiries on the received information.” [11]

The possibility digital media have to extract these concepts of their silence, exceeds the representational capabilities of photography and even of a three dimensional prototype. As Pierre Lévy affirms, virtuality “digs holes full of sense under the superficiality of immediate physical presence.” [5]

It allows us to go beyond substance, to breach the skin of appearance. John Berger recognizes that this possibility exists in graphic systems since their most remote origins when he states:

“Since the time of Palaeolithic painting, the main function of painting has been to contradict the laws that rule what is visible: they let us "see" what is not present.” [12]
For instance, in the image of a designed product its abstract elements can be revealed in order to describe them in the classroom. This lets us explain the shape and its morphological attributes, bringing to sight elements that are invisible in the finished product. Surpassing the superficiality of appearance and including a more dense and complex way of looking.

However digital media surpass drawing systems in their explicative capacity to expose these concepts as processes throughout time, making abstraction and cognition processes easier. They go beyond the production of “realistic” images because digital media includes interactivity: the possibility to “manipulate” forms, even in a virtual way, to explore and study their different visions.

These terms appear as contradictory, because these media open the possibility of virtually seeing and handling – rotating, sectioning and transforming – what we could call the virtual aspects of reality that even though they are not evident in physical objects, they are present and determine their identity.

4. **Three significant cases**

Some of these concepts will be illustrated in their transference to three simple but relevant cases. They are the way in which the previously
developed ideas assume a visible shape, where representations go beyond iconic representations. They are animations created and used as fragments of the instructional material of our courses of Morphology for Industrial Design, in the Faculty of Architecture, Design and Urban Studies, University of Buenos Aires, Argentina.

4.1. Case 1 – Showing beyond what is actually there: the experiment of the Exploratorium in San Francisco, USA

At the Exploratorium there is an experiment referred to hyperboles: the visitor turns a straight rod that goes through a curve slot in the shape of a hyperbole.

The digital animation we made had to optimize the use of time in order to achieve an adequate relation between information and weight of the final product. So we decided to determine a minimum cycle that would be repeated continuously. As it happens with other digital productions, the course of time allows comprehension through the repetition of an event. The aim was to show to the observer the spatial event in first place: a straight line goes through a curve slot. After this is attained, an attentive sight looks for comprehension because what is seen seems impossible. Finally, the way in which the lines penetrates and goes through the slot is understood. The surface that is described by the line can be visualized. Even if the action of looking at a straight line that goes through a double curvature surface is actually impossible in the material world, it is not unsettling because it completes the comprehension of the first event.

Figure 3. Images of different captures of the animation of the experiment. [13]
The regulation of time in the animation was an issue. There was no use in simulating the “natural” movement, so we decided to alter it, working with variable speeds that would favour comprehension. The line moves slowly when it goes through the slot, to enable a better visualization, and quickly gets to its original position. This rotation presents a contradictory aspect because the speed of turn is intentionally altered in cycles. The “realistic” representation of movement was avoided in order to facilitate the comprehension.

Only two turns of the rod were built that were recursively repeated. The first one presented the experiment and the second one included the surface that appeared and vanished in order to get a continuous loop. So we got an animation of eight seconds and 1.28Mb in 320 × 240 pixels using standard codecs of compression, in order to favour accessibility even if the size of the file was larger.

As we have previously described, the animation is not the equivalent to the actual experience. The spectator of the virtual experiment observes what can be seen in the actual experiment, even if the event is distorted in its speed; but in addition he sees information that would be impossible in our material world, that allows him to understand better the creation of a surface of double curvature -the hyperboloid- by means of a straight line. What appears as inconceivable to common sense can be visualized through these new media.

4.2. Case 2 – Showing what you know of what you see, not what you actually see. Morphology of spatial surfaces: the conoid case

The presentation we will describe is part of our educational material used to explain spatial surfaces in our courses of Morphology in Industrial Design studies, at the University of Buenos Aires, Argentina. We will describe the part of it that deals with the conoid surface, combining different sources of information: CAD drawings, animations, digitized images of three dimensional models and from handmade sketches. Each kind of image was selected according to its suitability for our educational purposes. CAD drawings were used to present the different sets of curves that constitute the shape because of its precision and visual appeal. Animations were used to explain its classic generative method and to infer the process of transformation undergone by a conoid when it turned into a concrete product: a coffee filter. Three dimensional models were built to provide a better spatial comprehension of the shape. Handmade sketches were included to reveal the concept that determines each set of curves.

The presentation begins with the geometric concepts, which define the group of spatial surfaces that includes the conoid. Following that, an animation illustrates the classic process of generation of the shape in real time. This sequence allows students to understand how a surface of double...
curvature is generated by the movement of a line with variable speed. So, they can visualize what could only be explained through schemes in addition to their imagination.

The construction process of the animation revealed some morphological information that we had not considered. An important issue was that what we understood as a conoid, limited by two ellipses, was only a fragment of the surface. If we did not alter the size of the generative line, the edges of the surface were spatial curves. We also realized that the generating line had variable speed in its process of creating the surface. So, producing the digital simulation of what we knew allowed us, not only to make it visible but to increase our knowledge on that topic as well.

After this, the photograph of different physical models of the conoid is included. These models were built from CAD drawings, using a laser cutting machine. So, a view of the range of different sets of curves that can constitute the shape – that will be explained later – can be anticipated. Then, it is presented a hand made sketch displaying the slopes of the cutting planes that determine the different notable sections.
Each of the sections is then presented in an image that includes the systematic constitution of the conoid by the curve, in perspective and projections, and a small sketch that shows the original cutting plane. An image of different views of the three dimensional model is also included. In some cases other drawings are added to illustrate special attributes of the form.

The presentation ends with an animation that displays the transformation undergone by a conoid to become the shape of a coffee filter. The narration goes from the product to the geometrical shape. It begins with the photograph of the product where the main lines of the shape appear. The texture of the object is smoothed, filtered by a translucent area, in order to appreciate the conoid better. Other point of view gives more information of the shape. Then the object fades, leaving behind its main lines that transform into the original conoid. Therefore, the notable points of the surface are presented. There is a change in the point of view that is carried out only through the main lines of the surface and afterwards the shell reappears.

Even though there is plenty of surface morphological information in this presentation, it represents just a relevant fragment for industrial designers. Each part of the shape presentation is purposely included, choosing and disclosing only some of its attributes, revealing its intensional and restricted character.
4.3. Case 3 – Showing what is there but cannot be seen: abstract schemes and proportions in Industrial Design products

The shapes of many objects are organized according to lines and generative systems, which are not evident in the manufactured object. These concepts can be revealed through digital media, inverting the relation between what is visible and what is underlying in a continuous process. The dissolution of material, leaving the structure and revealing the immaterial, contributes to achieve comprehension and abstraction. We consider it is important to present the proportions of objects in space, not only in flat drawings, as it traditionally occurs.

In this particular case we organized the animation in different moments, according to the direction of the narration we decided, based on our educational aims. The object to be analyzed, the coffee pot “La conica” designed by Aldo Rossi, has a simple and easily understood shape but has interesting geometrical relations in its functional components: lid, spout, handle and container. We chose to have a rather static camera, and to introduce movements only to present these relations better.

We decided to begin from the context to the object, starting with a digitized image of a “real” kitchen. The object of study was only an insignificant part of the scene. In order to focus attention to it, two black angles moved into the scene, framing the object and blocking the visualization of the background. Once the coffee pot is isolated the observer is drawn towards it through a virtual camera approach, providing a full view.

In a second moment the “real” image fades into a digital perspective of the coffee pot that reproduced the point of view of the photograph. The digital drawing simulates the image it substitutes with a selective...
photorealistic rendering. The object is presented in a similar material but less glossy, in order to illustrate better the attributes of the three dimensional shape and not of the appearance of its surface. The background is left out but for the cooking plate that is attenuated by drawing only its main lines and by colouring it with a dark hue. When the abstract elements are introduced this horizontal plane is turned into a black area.

Then, the image turns in order to show better the more representative profile of the object, and its only symmetry plane appears. Its square shape exposes the main proportions of the object in height and width. In this instance we did not draw the complete cube because the depth can be deduced to be the same from the cone, and it would just be too explicit and unnecessary.

In order to make evident that the slope of the spout is coincident to the slope of the cone a contrasting parallelogram enters the scene. The coffee pot is made translucent to illustrate this better and a central axis is materialized to complete the set of relations to be presented. A small turn is introduced to get a better spatial understanding; the coffee pot recovers its opacity as the coloured parallelogram vanishes.

The coffee pot is turned back to its former position and another relation is revealed. The proportion in height of the lid, to the top of the spout and the end of the handle, to the base is 1:1:1:1; so four square horizontal planes appear, first through their edges and then in their surface.
They also expose how these planes cut the coffee pot in circular sections. The object is turned to the back and the horizontal planes disappear. So, in this short animation we were able to mix tangible and intangible aspects that are present in product design. Even if they are not evident to an ingenuous observer it is fundamental that our students recognize them because they sustain and organize the shape of our design projects.

5. Towards a visible reality of its intangible aspects

As we have discussed and illustrated in the three cases exposed we understand that simulation should not be simulated, though it frequently happens. The main value of simulation and representation is when they split up from concrete matters, when they do not aim to copy but build new spatial possibilities and even oppose what is taken as “real”. Better saying, when it exhibits its artificial character, allowing the comprehension of the ideas and values it carries. Breaking up with the idea of concealment and deception and allowing the understanding of these new possibilities as tentative and partial approaches.

If we can acknowledge the artificial, fragmentary and intentional character of simulation we can also produce images that will not only represent what it is there, but what underlies it as well. These images present a different character as they surpass the ideas of “mimesis” and “phantasia”. The relation of concealment and disclosure that is present in them strengthens our desire to understand them, in their vanishing nature. We learn from discovery. In this sense Angela S. Monger [14] explains that:

“The teaching and narration exist, last, and work by means of the continuously renewed postponement of satisfaction (...) Once that it has been acquired, the object of desire looses its desirable condition. And sense is to narration as satisfaction to desire: possession is equal to death. Stories work with the promise of information they never give. A story has to be pursued, if there is no enigma, if there is no space to go through, there is no story.”

The pursuit of comprehension of our complex reality can be found in the base of all research. We live in a dense world, in spaces that are built and dreamt of, structured by objects that are configured not only by their materiality, but by the tools and concepts that enabled their construction as well. In these concepts we include not only the technologies but the possibilities of thinking and representing forms and its attributes. As we have already explained, reality – for human beings- is a construction that reflects the multiple and diverse ideas and dreams of the people who live in it and relentlessly question it, in order to understand and inhabit it better.

We are humans in all that exceeds mere materiality, in the symbolic and significant additions that transform a given reality into a new cultural construction. In a space where basic survival needs are not merely satisfied,
but are included and transformed into social practices. Adding the values that “picture” us as society – for good or for bad. Unveiling the secrets of the shapes of the objects that compose our environment does not make them less attractive but it enables a better comprehension. Not necessarily to promote acceptance but to create a space for critics that makes change possible. Digital media, used in this sense are a strong and relevant tool for design education. This capacity of digital media allows us to detach “real” from “natural”, from given data, from the unalterable. It goes beyond representational aspects of reality and includes disciplinary knowledge, contributing to dream and design other possible realities. Product design will not change the world, but it can – through responsible decisions and correct evaluation of the conceptual bases that sustain it, make evident the values we promote, so we can provide alternatives to make our disciplines possible in this complex “artificial nature” we have chosen to live in. Jorge Dubauti sustains too that “Culture should create worlds; it should be capable of founding another reality, to extend the limits of reality”. [15]

To conclude, we would like to mention once more that beyond the extended and generalized uses of computer science there is an enormous potential in the differentiated use we have described, that allows the visualization of the concepts that sustain the identity of the project, even though they are invisible in the final product. What is intelligible adopts sensitive shapes so as to be apprehended. Therefore, virtual simulation becomes an important tool of cognitive mediation.

References


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