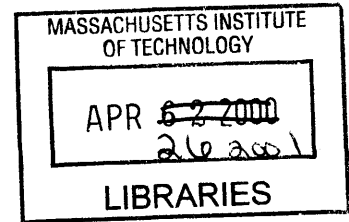


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behind the Screen

[on the perception of computer-generated architectural representations]

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Submitted to the Department of Architecture in partial fulfillment
of the requirements for the degree of

Master of Science in Architecture Studies

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[abstract]

Representations of an architectural space have a diversity of purposes and their implementation should be carefully evaluated in order to be coherent with those objectives. Some of them are analytical descriptions, where its components are easily identifiable but relations among them may appear distorted to enhance a particular attribute. Methods used to represent a space, however, are also capable of a more expressive nature, as in art. Those expressions need not be an attempt to evoke the experience of the space in consideration, but just ideas the architect wants to share with his reality.

The use of digital media allows incorporating time as another component to the spatial properties that static media has, expanding its possibilities both in terms of content as well as of form. This thesis suggests the use of diverse film theories as referential background for the creation of motion graphics, as a newly developed kind of architectural representations.

Film theory and practice should help understand the implications of adding this other dimension to static images, as it resembles a proportional similarity to motion graphics. This does not imply that these two channels are the same or incomparably different. Hypothetically, there is a common field that brings them together and from which we can learn similarities as well as differences.

A number of experiments were performed to test the validity of some of the notions expressed by several film theories in the realm of computer-generated motion graphics. A case study was selected to work with and a number of experiments would render several alternative representations of this particular architectural event, in this case, the church of Saint Pierre, in Firminy, France, designed by Le Corbusier in 1962. They represented the same object, but these representations would have a completely different character and, arguably, might evoke a different reading of the space. These studies are an attempt to understand how to synthesize visually different ideas and convey distinct meanings to provoke the reading of the building in divergent directions.

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[1.0] background

It is often claimed that meaningful knowledge of an architectural object can only be obtained through direct experience of the built artifact. Certainly, the validity of the readings that a physical manifestation of an architectural idea may be able to generate is not in discussion. However, this research is based on the assumption that they are not the only means capable of provoking interpretations that go beyond the notions of technology, functionality and morphology (the equivalents to the Vitruvian categories of firmness, commodity and delight).

A scientific analytical description of a particular situation is substantially different from our perception of it, but equally informative on other levels nonetheless. While descriptions of a particular event tend to be analytical, where chunks of reality are dismembered and reordered, the experience of that event is synthetic in nature. It becomes a re-construction of information gathered through our sensorial mechanisms in which scene components are completely integrated beyond their logical interconnections.

Norberg-Schulz suggests science and art are attempts to situate ourselves in the complexity of reality by means of symbols. Science, for instance, “through abstraction and generalization defines laws or objects which are ordered in logical systems”¹; and some of what those abstractions and generalizations fail to describe about the specificity of the situation is captured in some other symbol-systems, such as art: “Art does not give us descriptions but direct expressions of certain aspects of reality.”²

The possibility of multiple readings is one of the most interesting characteristics of art. Multiple interpretations are the result of either a recombination of the components in a new structure or a re-definition of the elements

involved. As Porter indicates, there is a “cycle of reading and conjecture which repeats itself until there is some degree of stability achieved in the mind”³, especially when the structure does not appear to be consistent enough. Divergent interpretations may arise when the structure relates in different manners to a larger frame of reference, when the relations among the scene nodes form new connections (recombination) or when the nodes themselves are understood differently (redefinition). In any case, the expression may be different and engage the reading of a previously undiscovered condition, revealing new meaning for man and his reality. Individuals, aiming for a better comprehension, are always trying to grasp the complexity of their environment, in a continuous process of re-arranging the parts and establishing connections between the parts according to some underlying order. Meaning becomes a structure to hold our perceptions. Porter further notes that reading requires “deep engagement of two sorts: engagement in the locale and engagement in the context”⁴, which also draws a distinction in the dimensions of meaning. In his paper “Re: Reading”, he selected Leonard Meyer’s terms to name some of these dimensions. Embodied meaning is the network created with the situational components and the relations among them; it is the consistency of the situation itself. On the other hand, designative meaning is the association derived from the extension of the internal structure into a larger frame of reference. Now the situation not only makes sense in itself, but it also is congruent with other situations. Of course, designative meaning is deeply conditioned by existing knowledge and previous experiences, and that is what allows for connections that go beyond the inner structure.

The rigidity of the structure is a fundamental aspect when things are seen from this perspective. Stiny remarks the role of ambiguity as a property of visual objects to counteract the rigidity of a structure. When components are not clearly identifiable and the network of links is invisible, then the reader may seek to solve the indeterminacy with an imaginative response. In this case, the response is an original construction of meaning, which may be completely different from the idea that was originally intended to convey.

Architecture as an art shares this fundamental property. It generates meaning by expressing physically ideas that help man order reality. As Norberg-Schulz noted, it is only through that order, only by establishing those relationships, that meaning is constructed. The (partial) understanding of it is directly dependent on our ability to read and construct some meaningful knowledge.⁵

Representations of an architectural space have a diversity of purposes and their implementation should be carefully evaluated in order to be coherent with those objectives. Some of them are analytical descriptions, where components are easily identifiable but relations may appear distorted to enhance a particular attribute. However, methods used to represent a space are also capable of a more expressive nature, as in art. Those expressions need not be an attempt to evoke the experience of the space in consideration, but just ideas the architect wants to share with his reality.

Hence, the reading of an architectural representation of a space can also be seen as an active process of reconstruction of an idea. The idea that wants to be communicated, the meaning that wants to be shared by a group of individuals. For the idea to be generated in other minds, the author

deliberately defines a set of elements and arranges them in a particular manner, establishing relations among them. The elements and links become a structure, or possible meaning, which then may be incorporated into a larger frame when the object is interpreted. The term of reader or observer supposes certain passivity in the role, when, in fact, interpretation is an active process of identifying the nodes re-creating the linkage between them. If the elements are clearly visible and the relationships very well defined, the process of understanding becomes an easy task for the reader, and vice-versa. However, clarity on the structure is not the only requirement for communication to be possible. If the reader does not have the ability to distinguish the components or to reconstruct the relations among those components, the understanding may be partial or even impossible.

The use of digital media gives a more accessible approach to explore another component in representations. The production of images is accomplished through a mathematical procedure with a high degree of automatation, and by using the paradigm of filmmaking, we can create a large number of images, which played back at a certain speed, create the optical illusion of movement. This allows incorporating time as another dimension to the spatial properties that static media has, expanding its possibilities both in terms of content as well as of form. Based on the spatial paradigm of current computer technology³, which enables the

³ The current user interface developed for personal computers is based on the analogy of the physical spatial properties applied to a two-dimensional screen: the desktop. Originally based on an idea developed at Xerox Park and later implemented in almost all operating systems, it gives an analogous graphical representation –which depends on a Cartesian space on the screen- to every digital ‘object’. Thus, the computer is represented on the screen and ‘everything inside it’ has a physical appearance on this digital ‘virtual’ space, and where processes can be started by a graphical display of some sort.

process of architectural design in a non-traditional manner, “virtual space” is understood as an analogy of the physical space known by experience. In some sense, this project is an attempt to further translate some of the concepts elaborated in for the physical world to its parallel ‘virtual’ dimension; in order to better understand its similarities and differences, and consciously take advantage of its intrinsic possibilities. This thesis suggests the use of diverse film theories as referential background for the creation of motion graphics, as a newly developed kind of architectural representations.

Film theory and practice should help understand the implications of adding this other dimension to static images, as it resembles a proportional similarity to motion graphics. In other words, if computer-generated images have a connection with photography –or even painting, if you prefer- then we are exploring the relation of film with computer-generated motion graphics. This does not imply that we think that these two channels are the same or incomparably different. Hypothetically, there is a common field that brings them together and from which we can learn similarities as well as differences.

Three aspects seem to be most relevant for this discussion. One of them is the study on the relationship motion pictures have with reality. The encyclopedic entry for the term *representations* immediately alludes to the notion of ‘images’ that stand as other objects, and not the object themselves, creating a parallelism between their own dimension and the one of the real thing.

Another relevant aspect found in film theory is the level of expressiveness they can hold as independent objects, not only implying the connections to another reality but also within their own particular physical existence. Working with time as “artistic material” is essential for the expressive

potential of film. Perez-Gomez explains that the moving image in film generated new possibilities of introducing a completely different temporality into visual experience. In the early stages of filmmaking, it was realized that “this medium assumes the non-neutrality of its means of representation, as well as the explicit subjectivity of the phenomena of perception. Film offered a possibility of transcending the limitations of the technological, framed vision through the juxtaposition of different realities.”⁶

Even more interesting, film theory provides another paradigm in the study on the properties for architectural representations to hold signification. One of the latest film theories, with its origins in the early 70s and still in development, understands motion pictures as a system of communication, thus a medium for the creator to convey meaning to an audience.

[2.0] [purpose]

This experiment was part of a larger research project, directed by Takehiko Nagakura, Associate Professor of Design and Computation at the School of Architecture at MIT, entitled The Unbuilt Monuments. The project seeks to explore some of the visual qualities of celebrated architectural works that –for diverse reasons- were never materialized as buildings. Using digital media, the intention is to help gain a better understanding of them, by exploiting the possibilities of computers to simulate the behavior of surfaces under light and to render these graphics into a sequence that –in a similar fashion as cinema does- generates the illusion of motion to the eyes of the spectator.

This particular piece of study relies on the hypothesis that representations of a space are an instrument for people to construct the concept of a space, or at least a fragment of that concept, and not an absolute and objective description. When the artist chooses to represent the object of her creation, she is manipulating a collection of nodes and links to form a meaningful –at least from her perspective- structure and communicate with others.

At the same time, the representation of an architectural space is also the representation of an idea; and the creation of a representation becomes an active process of communication between the architect and the world; a process that is often minimized or eclipsed by the exploration of the idea, or even disregarded. The representation (descriptive or not) of an architectural event should not be considered as a minor task but as a primary means of sharing meaningful concepts to other people.

The purpose of the research is to gain a better understanding about the ways that concepts of a spatial idea are constructed through representations of an

architectural event, and thus reflect on the implications of our actions in such representations.

[3.0] [case study]

There are two dimensions in the case I selected to study. One deals with the architectural event in particular, namely the project itself. The second dimension is related to the kind of architectural representations I will be concentrating on in this research.

[3.1] [eglise st. pierre, firminy, france. 1962]

Le Corbusier, arguably the most influential architect of the modern movement, accepted in 1962 the commission for designing a church in the town of Firminy, in France, where he already had a number of other projects going on. Le Corbusier died three years later, and the construction of the church had not yet started, although its design had been completed for the most part.

The project came into his office by request of a personal friend of Le Corbusier, Eugène Claudius-Petit, the mayor of Firminy, and despite some reluctance of the architect in the beginning, it finally became one of his (last) projects. From the initial stages, the design of the building was done in collaboration with Jose Oubrierie, who had started working in Le Corbusier's studio about three years before. After Le Corbusier's death, Oubrierie became in charge of the project and the design was further developed until 1970, when construction began. In 1975, the work was interrupted indefinitely, leaving the spaces without materialization.

[3.1.1] [le corbusier]

At that time, Le Corbusier was still working on the construction of a capital for the new government of East Punjab. The work in Chandigarh had started about ten years before and the Assembly Hall, part of the new Capitol, had been finished already. On top of a cuboid base that serves for

auxiliary spaces, a great hyperbolic drum and a pyramid, contain both legislative chambers, which are dramatically illuminated with shafts of light coming from openings on the roof.

About three years before he started working on the church for Firminy, Le Corbusier had also finished building a new monastery for the provincial chapter of the Dominicans of Lyon. Sainte-Marie-de-la-Tourette was his second religious building –after the church in Ronchamp- that offered him the possibility to “fully express his mastery of light and space while complying to requirements not only material but also spiritual and respectful of the monastic tradition”⁷, as the text in *Œuvre Complète* narrates. The square plan with a central courtyard is largely based on the traditional layout of a Dominican convent. Three of the wings contain the living cells while the north wing of the convent is the church, a large dark prismatic space which displays a total poverty but articulated by light coming from a skylight and a number of openings strategically placed on the side walls. A number of lateral chapels with independent skylights are connected to the main space but at the same time retaining different spatial qualities.

[3.1.2] [firminy, france]

Firminy is an industrial town of approximately 20,000 inhabitants in the proximities of St. Etienne, about 60 km west of Lyon. Eugène Claudius-Petit, Professor of Design, close friend of Le Corbusier and Mayor of Firminy from 1953 to 1971, offered him the opportunity to work on a master plan for the town and avoid the “disorganized results of accidental initiatives”. The commissions included first a stadium, then a swimming pool and a youth and cultural center –presently known as Espace Le Corbusier. Later, only one Unité d’habitation was designed and

built, although it was part of an extension to the original master plan, in a housing project that accounted for the construction of 3,500 dwellings.

[3.1.3] [eglise st. Pierre]

The project for a church in Firminy was not an easy decision for Le Corbusier as he claimed to be an architect and not a church builder, but it was finally accepted because he understood it was a church for the “working people”.⁸

The first design intentions for the church in Firminy show a single vertical volume; very similar to a project he had done for a church in Le Tremblay that never materialized. Soon, the shape evolved to a conical drum that mutates from a square base to a smaller circular top. The drum was truncated at the top in a sloping plane, displaying a shape that bears a strong resemblance to the outline of the Assembly Hall in Chandigarh. In a similar fashion but in a much smaller scale, a number of strategic openings on the roof would bring light onto the seating area in the space inside the conical dome. These tubular perforations on the skin of the building were aligned with the position of the sun at “magical hours”^b, as described by Le Corbusier on one of his earliest sketches.

Even though the connection to these other projects is obvious, not so evident is the origin of these shapes. Le Corbusier himself narrated how the cooling towers of a power station in Ahmedabad largely influenced the design for Assembly Hall in Chandigarh -and its connection with the church in Firminy is undeniable-; however, a study by Allen Brooks shows a sketch of a farmhouse in Switzerland where he spent some time during his

^b There is a sketch done in 1929 by Le Corbusier named “Sunrays at a Cosmic Hour”. It is an abstract depiction of the sunlight coming in through the openings on the dome of Hagia Sophia in the summer solstice.

youth that might indicate a more subtle relationship with those figures. The mentioned sketch clearly displays the shape of a pyramidal chimney, truncated at the top by a sloping plane, rather common for that type of farmhouse. It was dated in 1959, which suggests that those memories were still fresh in his mind by the time he designed the church.

Another feature adopted in the early stages of this project was a spiral path of circulation, also a recurrent theme in many of his projects. There are sketches of the Assembly Hall drum as well, with a continuous band wrapping around the cone. In addition, in some sense more close to the church in La Tourette, he thought of openings on the sidewalls that would bring indirect light by a process of reflection on the surfaces of an abstract brise-soleil. At a later stage in the project, these two ideas were combined to result in a horizontal ribbon of openings wrapping around the shell of the dome in a spiral path, in some sort of continuation of the procession described by the circulatory trail.

The square base of the drum was the main floor for the church, and a cube underneath it would hold the living spaces for the priest and some areas for educational purposes as well.

One year later, the project was almost complete and showing all the features of its final appearance. In 1965, Le Corbusier passed away without having seen the beginning of the construction. It took another five years and a strong decision from Petit to initiate the process of building the church for the town of Firminy, only to be later abandoned when the shell of the church was beginning to appear. Today, the site shows the remains of an uncompleted building process deteriorated by time: the concrete work of the double-story square base up to the main floor of the church without the shell, thus open to the sky.

The design process to date has had several stages, even after the construction was stopped; and mainly carried out by Jose Oubrierie, who was working at Le Corbusier's atelier when the project had started. It may be impossible to determine how much of Oubrierie's ideas are part of the final scheme, but that discussion exceeds the limits of this research, in any case.

[3.2] [architecture in motion graphics]

The lack of materialization of this project poses an interesting opportunity to concentrate on the representational issues of a project, since representations of the space are the only remains we have in order to gain an understanding of the architectural creation. Unlike an existing building, which gives the opportunity of capturing meanings in an experiential manner, an unbuilt project encloses immaterial dimensions that can be only explored through representations of it.

The development of digital technologies has found a quick way into architectural practice and academic environments through representational tasks. Most of these tasks, however, are being directly emulated from more traditional kinds of representations, often times resulting in a worthless comparative discussion over the supremacy of one or the other. The fact is that paper-based representations have some intrinsic qualities that define them as well suited for some purposes as much as computer-generated representations are for others.

In addition, for the purpose of this research, computer-generated representations offer a substantial advantage over other types of representations. Because of the nature of the study, which will be based on comparative studies, it is essential to have control over most of the variables involved in the experiments. The importance of computers for this research reside in the possibility of generating a virtual environment in which those variables

can remain unchanged over time, be repeated in precisely the same way, or be precisely altered in a number of other ways. In this way, a more rigorous method of testing is possible, with a strong reminiscence of the traditional scientific methods, even if the final conclusions remain in the field of subjective knowledge.

[4.0] [relevance]

Computer-generated representations are becoming commonplace in architectural practice, but the profound implications of these technologies have yet to be carefully studied. Probably it is too early to understand completely those connotations, but this research is also an attempt to understand better the nature of these representations.

Nevertheless, the most interesting aspect of this research lies on the importance of being more self-conscious when creating representations of our ideas intended to be spatially materialized. The creation of representations of an architectural object is a fundamental portion of the design process, in which ideas and intentions are in a different kind of materialization.

Much of the discussion about what design is remains focused between the product and the process. Some of them claim that the *real* design is only comprehensible in the built artifact (i.e. the physical construction) while some others insist that the authentic design can be better understood through the knowledge of the creative process involved. Mitchell, however, argues that architectural design -if it had to be isolated- is not either in the final product nor in the process of design, but it is the structure of components and relations among them. Using the paradigm of computers, he says that the design itself could be referred to as the file that stores all the bits (data) arranged in a composition, which will be later interpreted by software to display it on the screen, to print it on paper, or eventually to construct it using some electronically-controlled manufacturing process⁹. In a similar way, but more concerned about the formal properties of the architectural object, Stiny describes design as a group of relations among descriptions of an object.¹⁰

If design is understood as an arrangement of elements and relations forming a structure, then representation is a visual manifestation of those elements

and relations. Consequently, it is fundamental for the architect to understand the implications of his decisions in the moment of representing the architectural event. Then the architect can act in a conscious way towards expressing an idea and establishing meaningful communication with the world. If this process is unconscious and involuntary, then the representations of the object may not be faithful to the ideas held in architecture. Descriptions of the object –that are intended to be objective- may develop into incongruent paraphernalia.

Nonetheless, representations are not only a means of sharing meaning with other people. They are also a catalyst of the creator's intentions and consequently they generate feedback on his own intentions.

Constantly, results seen from different courses in architectural education show a great discrepancy between the verbal explanation of a specific design project and the representational devices chosen to communicate the same idea. A most recurrent comment in the reviewing sessions of architectural design studios is the incongruence among different pieces of representational material (in the form of abstract graphics, figurative drawings and models, and so on) or even between them and the design intention behind them. This is even more evident in the case of animated sequences of computer-generated graphics, a place that seems very likely to jeopardize the integrity of the project. Generally, the conclusion seems to be that the design ideas are well understood and coherent but the expressiveness of the non-verbal communication devices is not entirely successful. Excellent design responses are frequently underrated because of a misrepresentation or a careless process in the selection of information.

[5.0] [methodology]**[5.1] [replication]**

Experimenting on the representations of this architectural event (i.e. the church designed by Le Corbusier) required an exercise of replication on the original design. For that matter, the unfinished project itself was thoroughly examined, both in analytic and synthetic processes. There were a number of different sources that led this domain of the research:

- i. Existing representations of the building: there were several sets of architectural drawing (plans, sections, elevations, details) corresponding to different stages of the design process. They described in more or less accurate fashion the geometrical properties of the space and the physical boundaries. Oubrierie drew most of these documents. There were also available some photographic records of a few models.
- ii. Sketches: there were a series of conceptual drawings from the initial stages of the design as well as others from a much later period. Some of them probably enclosed much of the ideas and intentions for the architectural object. Both Le Corbusier and Oubrierie were the authors.
- iii. A brief verbal reference by Le Corbusier in *Œuvre complète*. Using his distinctive telegraphic style he mentioned the project in one short paragraph.
- iv. Remnants of an uncompleted materialization.
- v. Literature on the project: although not as well documented as other projects, the church of Saint Pierre was subject of previous studies.
- vi. Interviews.

Through the authorization of Foundation Le Corbusier in Paris, we had access to two different sets of architectural drawings: one of them done in 1970

and the other in 1974. After some discussion, it was decided to re-construct the building in digital media as the most recent scheme showed. The decision was made after a careful evaluation of all the information available at that point, and based on the concepts of higher accuracy in the data (i.e. more information) and less inconsistency among the sources.

Thus, we built a priority scheme that would help solve the problems derived from the sources of information. Everything would be modeled according to the drawings dated in 1974, and in the case of missing information it would be taken from the other set of drawings. Wherever there was a discrepancy in the data, it would be tried to solve by the same procedure or –in the third case- by information available in publications. For the unfortunate situations in which no information was available, a design intervention was mandatory for the sake of coherence in the visual output. Design interventions^c were largely based on the relationship with other buildings and some other historical reasons.

As mentioned before, the set of architectural representations describe a conical building about 35 meters high, transforming gradually from a square base of 25.5 meters on the side to a circular top of 12 meters in diameter. There are four flat planes defined by corner points of the square and quadrant points on the circle, and in between them there are triangular warped surfaces defined by two lines and a quarter of the circle. The cone is truncated by an inclined plane on which there are a square and a circular perforation that serve as the main daylight sources for the interior space.

^c For a list of design interventions, refer to the Appendix A.

The main entrance to the building is through an opening on the west plane of the shell accessible by a ramp –formally the ramp is detached from the main cone. On that side as well, there is a third perforation to allow more daylight inside the building. Also present, a number of smaller openings on all the sides of the shell, arranged in a spiral-like ribbon that accompanies the changes in the floor level.

Inside, the main seating area is arranged in a sloping plane that gradually becomes a tray on top of the entrance level, which also creates the space for a side chapel. Underneath the main level, there are a number of intermediate floors –technically speaking, there are four different levels- that provide space for the sacristy, offices, religious education and house for the priest.

We know from the remnants on the construction site and from textual indication on the drawings that the structural parts of the building (i.e. the shell, roof, floor slabs, some pillars and columns and many walls) would be made out of exposed reinforced concrete; a consistent vocabulary in his last works. The other elements, most of them removable furniture, were intended to be wooden. And that accounts for most of the information available at the time of modeling. There are no indications of colored surfaces, although a recent photograph of a model exhibited in Paris shows the tubular openings on the roof in yellow and orange, comparable to the skylights in the side chapels of La Tourette.

This led to the production of a digital model of the church using current CAD (Computer Aided Design) software. The actual modeling of the building in a computer became itself a method of construction, in which the intrinsic features of the modeling software imposed other limitations different -yet comparable- to the physical ones. Although much of this

process was possible in AutoCAD, it was also necessary to employ more advanced software packages to precisely define in geometric terms, the exact shape that Le Corbusier had intended for this building. NURBS modeling software was needed for several stages of the replication as well as some other technologies, such as rapid prototyping, for auxiliary purposes.

As in any construction process, the creation of a digital model of the building required the intervention in some design aspects that needed to be revised and adjusted. Furthermore, due to the unfinished nature of this project, many design aspects of the building were not taken into account, at least not until the stage where the construction was abandoned. In an architectural enterprise, many decisions are made upon the actual construction; when new problems arise that require new interventions of the creative mind. Some new decisions are made; some others are changed. The documentations pose yet another problem that needs to be addressed. The architectural representations mentioned above are not absolute and ultimate descriptions of the building. On the contrary, much of the information is missing. For instance, some of the openings do not show any kind of glazing system, although it is suggested that a window is desirable, particularly because of climatic requirements. Yet more complicated, some of the information displayed is inconsistent with other sources, such as some elements that are present in a drawing of a plan view but they are not found in any of the section drawings.

Naturally, this leads to an impossible path if we want to stick to the pure creation of Le Corbusier. There are no means to have a definite truth on many of those issues, and this kind of speculation could easily delay the interests of this investigation considerably. Even though this project does not concentrate on the discussion of the fidelity of the represented object

with the purest idea that Le Corbusier had, all those issues are unavoidable and they require an immediate intervention to fill in the missing information and to solve the inconsistencies in an acceptable manner. The 'acceptable' quality shall always be under discussion, but the intention is to render a complete and coherent idea that might be with more or less accuracy correspondent with the information present in the sources of information that are available at this point.

For those reasons, the present replication is not and does not claim to be Le Corbusier's design for the church in Firminy. Rather, it is a new interpretation of it and a *re*-presentation in the format of computer-generated motion graphics.

[5.2] [motion graphics]

The second dimension of this research project addressed the problems regarding representation; and relying on the precedence of filmmaking, it involved a number of small and very controlled experiments addressing one particular issue. In these small-scale experiments, a single component of the event considered in the representation was variable –and transformed– whereas the rest of the elements remained unchanged. Consequently, it was possible to understand how that particular component affects the reading of the situation. For this sort of experimentation, it was necessary to rely on the capability of computer-generated representations to control the number of variables and to allow for specific alterations while keeping at the same time a number of constants.

This was the procedure for the comparative studies: once the digital model was completed, and a specific set of conditions determined –say, for instance, a particular lighting condition, a specific color palette for the materials,

etc.- then a motion graphics sequence would be chosen for the comparison. All those aspects are constant throughout the experiment, and the portion to be studied becomes variable, with a number of possible values.

For example, one of the first experiments was addressing the nature of the physical boundaries of the representation. As in filmmaking and in photography, the frame size is finite and it poses a very particular restriction on the creation of images. For this purpose, a camera path was selected and rendered the output on different frame proportions, such as 4:3, 16:9 and 1.85:1 (i.e. the ratio between the horizontal and vertical side of the frame).

The nature of these experiments was diverse, and the selection of components that were examined ranged from viewpoints to lighting conditions, from projection modes to spatial sequences. Following is a list of these topics and the hypotheses that supported their investigation:

- i. Viewpoints: probably the most obvious component and the most carefully understood aspect of an architectural representation. Sometimes it is the only aspect that architects choose self-consciously to convey an idea of the space.
- ii. Focus of attention: while a number of representations may seem to be neutral towards the reader, in computer-generated representations there are a number of tools available to enhance certain elements or relations and attract the reading to specific events that may be crucial and lead to further comprehension of other elements.
- iii. Fields of view: the amount and quality of information of the situation being represented is also dependent of the field of view in a perspective representation.

- iv. Projection modes: while keeping all other components fixed to a constant value, the meaning the reader is able to construct shall be different only with just a change from perspective view to orthographic projection. This may seem a trivial and obvious aspect of representations, but it is an essential part of it and the possibility of maintaining the other elements immutable allows for a comparative study of the two cases, and to understand the difference in the perception of the space.
- v. Spatial sequence: the reading of the idea is affected in which the elements are presented to the reader. It refers to the engagement in the locale, where the perception of elements is also affected by the continuity of other elements. Time connotations: a component in architectural representation that is often disregarded. Computer-generated representations can easily incorporate another dimension to the reading of space parallel to the concept of real-time. This allows for an exploration on the consequences of reducing or expanding the time in which the components and the links are presented to the reader. Concepts: time duration, time speed and time still.
- vi. Lighting: the construction of the situation is based on visual information, and understanding vision as a consequence of light, the reading is definitely sensitive to the characteristics of illumination. The importance of this factor increases as we move from abstract representations to more figurative visualization (so called hyper-realistic depictions).
- vii. Actions: a common feature in architectural depictions is the presence of people, generally used to evoke notions of scale. The opportunity of adding the time factor to CGR is crucial to his aspect as people not only bring a scale referent in a frozen fragment of the event, but now

these individuals are capable of being captured in a whole moment of the event. In other cultures, activity is the factor that defines a space and people develop the spatial concept after understanding how activities are carried out. The boundaries of space are not material but sociological and cultural and they have different properties than those physical ones.

- viii. Sounds and noises: audible components are not often included in architectural representations, but they constitute another dimension that impresses the perception any situation. Sounds are also directly connected to the time component, and CGR shall prove a very appropriate medium to incorporate those two variables at the same time, and help the generation of new readings.

All these tools are enhancing certain elements and relations intrinsic to the scene over others, thus attracting the attention of the reader to specific points. They put in evidence special connections in the structure that holds meaning.

[6.0] [discussion]

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[6.1] [on reality]

The connection with reality remains a fundamental factor in computer-generated images as it does in photography and cinema as well. These mediums have the power to release a mechanism of affective and perceptual participation in the spectator. It is an essential element of the motion-picture image, whether in a drama enacted expressly for the camera or in a documentary film of an event. Metz notes that the feeling of credibility operates on the spectator both in realistic films and in those of the unusual or marvelous. Fantastic art, he continues, is fantastic as long as it is convincing; otherwise it becomes ridiculous¹¹. Indeed, the power of unreality in motion pictures comes from the fact that the unreal is finally *realized* and offered to the eyes of the spectator. It might be argued that this notion derives from the motion-picture photography, as hand-made animations that lack this element of photographic realism (i.e. cartoons) tend to be taken as fantasies.

Accordingly, the means employed for visualizing the church required a technology that would render in a *convincing* way the unreality of the project. Images on the retina are product of the properties of the materials and their behavior under the light. Because surfaces react to light differently –in a combination of reflectivity, absorption or transparency- it is possible for the eye to distinguish them. In a similar fashion, in computer graphics, this behavior is simulated on the surfaces that define the geometry of the digital objects and exposed to several kinds of lighting indexes to produce a similar effect on the computer screen. Currently, the best results are obtained by using software based on radiosity algorithms, since it takes

into account the reflectivity factor of the materials and returns a certain amount of light to the scene to be redistributed through several more iterations. This process is instantaneous in reality –actually done at the speed that light travels through the air- but the technology available today involves an extremely large time for the mathematical calculations, as the light is distributed over all the surfaces that play a part in the model.

To determine the degree of proximity to the visual world achieved by computer-generated renditions is something beyond the scope of this research. Furthermore, we believe that perceptual aspects shall remain on a personal level and escape the objectiveness of the discussion. It is clear, however, that no matter how close those images are to a feasible interpretation of the building, they cannot be measured and evaluated in terms of accuracy. As it was mentioned before, to achieve the objective, the structure of elements and links that every image holds must convey a minimum degree of conceivability, but there is no precise boundary for it. Equally, by no means still images by themselves nor motion pictures enclose any portion of reality that bodily experience could catch. This is the place where realist film theory seems to lose the parallelism with films created from virtual reality. Unlike a physical camera, one placed inside a digital model does not duplicate by any mechanical procedures what the human eye does in the process of vision. Thus, even if you still accept the analogy of virtual reality, there is no capture possible that is comparable to the one that a physical camera does.

The experience of physical architectural space is influenced by infinitely many components embedded in the complex parallel dimensions of reality. Usually, representations do not intend to emulate the real life experience, but to put in evidence certain elements or connections of the structure

that hold a particular interest to both the author and the reader. The ability of the one re-presenting lies in displaying those elements and connections that may not be translated from experience, but still help to form a meaningful construction of the space. For instance, a plan is a highly abstracted depiction of a place and is certainly not descriptive of an experiential situation, but by reading it we understand other implications that may escape the sensorial input when the body is subject to the corporeal experience. In this sense, Bazin constitutes a perfect precedent when he parts from the core of the realist theory, and suggests the role of cinema as a new sense to unknown universes. He invites the filmmaker to give us knowledge of our reality that escapes our sensorial experience. The author needs to uncover those events that are would normally go unnoticed because they are “too small, too large, too fleeting, too mundane or too overwhelming for us to cope with in everyday life”¹², as Bazin notes. For Pudovkin, “to show something as everybody sees it is to have accomplished nothing”¹³.

Representations become an ideal means of accomplishing such a task, of special interest in architecture, where certain aspects require several degrees of attention at different moments in time.

Realist film theory, however, cannot be ignored, and might play a key role for parallel thought with architectural representation in motion graphics; for realism, which is based on the power of the camera to mechanically record an image, encourages the exploration of reality and the translation to the screen of the observable world. The analogy of ‘virtual space’ regains importance here as the camera inside the computer model moves freely to discover and render the appearance of a digital realm. In such a space, the lack of determinants, however, questions the validity of

the term 'appearance' and the correspondence between the representation and the object represented. Since both the object and its appearance can be modified at will at any point, without almost any constraints^d, it is not possible to translate the passive role of the filmmaker with an equivalent in digital movies. Because of the intrinsic nature of this media, the creation of computer-generated films implies the production of a 'virtual space', which, even if it resembles a physical setting, is in itself another creative task.

Replicating a space inside a computer-generated realm generates even more questions and problems, such as the closeness, in visual terms, with the observable world, or the possibility of action/reaction within it. Current technology is the only limitation for such proximity with reality, and the direction taken in the industry seems to bridge the gap at an incredibly fast pace. This becomes an opportunity for applications that cannot be performed otherwise because of the characteristic constraints of the physical world and it is indeed a gate for unknown universes of the mind. For architectural purposes, however, the application seems very much limited to a simulated performance of the space, since our corporeal existence implies a physical setting to develop within.

Many others principles derived from realist film theory maintain high interest in the production and experimental phases of motion graphics. The attitude of the filmmaker, could be confined to a very definite area of freedom and externalize the results for further studies. For instance, motion

^d The digital realm does have constraints, but their nature is completely different from those intrinsic to the physical domain. The immediate example is the limitation in the accuracy of objects. A digital version of a physic object is described by an enormous but finite number of discrete elements, and it is indeed one of the constraints we have to deal with. For example, although there is no gravity in virtual space, there is a limited number of colors we can work with.

graphics could help understand the notion of time and visual sequence that a certain space has, and the results could lead to refine design thinking. Unfortunately, with the technology available today, this method is highly inefficient and does not prove a viable solution for many creative activities in the architectural field.

[6.2] [on expression]

The other film theory that offers a very interesting paradigm for the creation of motion graphics is called formalism. Although its beginnings as a recognized theory are dated before realism, it seems to occupy a later stage in the development of computer graphics.

In the beginning of his celebrated work "Film as Art", Rudolf Arnheim explains:

There are still many educated people who stoutly deny the possibility that film might be art. They say, in effect: "Film cannot be art, for it does nothing but reproduce reality mechanically." Those who defend this point of view are reasoning from the analogy of painting. In painting, the way from reality to the picture lies via the artist's eye and nervous system, his head and, finally, the brush that puts strokes on canvas.¹⁴

Following this line of thought, it could be argued that computer graphics are closer to painting than to photography or film, since a computer rendering does not reproduce anything and the processes involved in such a task are radically different from those executed by an analog device. Roughly, computers generate a large number of discrete points on the screen and assign to each point a certain color based on a series of mathematical computations; whereas a camera collects ray lights from the objects in the scene through a system of lenses and direct them onto a sensitive plate where they produce chemical changes. Therefore, the

process of generating an image through computational operations is an abstract progression somehow more comparable to the intellectual activity of the painter than to the optical processes of the camera. Nevertheless, the two activities of the painter and the computer are entirely different in nature so far, and the discussion here shifts to the artificial intelligence domain. The important aspect to note is the radical difference in the mechanisms employed to achieve the images and understand its implications.

After having acknowledged the fact that computer graphics are not a mechanical reproduction of the observable world and that they cannot claim to be faithful to any reality, the importance of the formalist film theory is unquestionable. Computer generated images and motion pictures could have –in the best approach- a very short distance to images found in the visible world, but at the same time they keep an extremely large gap – maybe forever unavoidable, in a romantic sense- with the embodied experience. Still, in the same way that Arnheim found the limitations in cinema to be the basis for it to be considered as art, the nature of computer graphics –which is entirely different from reality- opens another path for creative expression.

Unlike realism, which found the content of the film to be the aspect that deserved the most attention from the filmmaker, formalism understands cinema as a *means*, primarily, of personal expression. In some ways similar to instructional prose writing, a film piece oriented towards its content would have its values, but they are not aesthetic ones, precisely because they are directed at the object rather than at the means. For realism, the filmmaker is also an artist, in the same fashion as the painter, empowered to transform reality through his creative mind. Arnheim takes an exceptional approach in this direction when he describes the

elements in which film is different from a true depiction of reality, which are the real basis for it to become an art. These elements are: the projection of solids upon a planar, two-dimensional surface; the reduction of depth; the problem of lighting and absence of color; the boundaries of the image; the absence of space-time continuum; and the absence of other sensorial input. Most of them, if not all, are also applicable to the creation of motion graphics with a digital device. For Arnheim, technological innovations in filmmaking, such as color, 3D photography, sound and widescreen, tend to narrow the gap between the experience of film and the natural experience. As Dudley Andrew points, Arnheim treats the film experience as unreal, as he is coming from Gestalt psychology, which emphasizes wholes over parts, patterns over individual sensations¹⁵. Something that is nevertheless true; even if realist theory is right when claiming that the camera reproduces the visual component just as it would be seen on the human eye, for our knowledge of reality is much more complex than just the visual factor.

For Arnheim, the raw material for the filmmaker to work with is precisely the gap that separates the film experience from the real. The fact of framing the image, which restricts the observer's view, for instance, is a greatly creative act, in which the artist filters what needs to be seen from what needs to remain out of the picture. Motion picture artists need to be conscious of the unreality of the images they create and exploit these limitations, forcing the spectator to see not just the object on the screen but the object carefully delimited via the medium. Likewise, there are some artifacts, indigenous to the medium, that have no direct correspondence with direct experience, such as slow and fast motion, fades and dissolves, superimpositions, backwards motion, filtering and so on, that create more possibilities in the art of film.

⁴⁰ One of the fundamental differences with our perception of reality for the formalist approach is the lack of space-time continuum in film, or the opportunity of deliberately breaking it by the technique of montage, as Arnheim realized. It was both Vsevolod Pudovkin and Sergey Eisenstein, however, who better understood the implications of this technique and developed it as an artistic constant throughout their work. For them, all meaning comes from the interrelation of the individual units that create a composition; green, for instance, takes on a particular meaning when placed in a relational system involving other colors. The case of cinema is not entirely similar to other arts such as painting and music, because the basic units are radically different, but the analogy still applies. In his earliest writings, Eisenstein believed that the smallest unit of film was the shot and although each shot is already capable of holding meaning in itself, by combining it with other neighboring shots the filmmaker was able to construct new and higher significations. He used the Odessa Steps sequence from his own film *The Battleship Potemkin* to demonstrate his theory of montage in filmmaking. In it, individual shots are basically meaningless by themselves, but it is “through juxtaposition with other shots that they become inflicted with meaning”¹⁶. Dudley Andrew notes that Eisenstein never considered the mere recording of reality as cinematic, explaining that in the beginning of his career he would reproach filmmakers who used extended takes. What could be gained by continuing to gaze at an event once its significance had made its imprint?¹⁷ Eisenstein transcended the thought of Pudovkin to a more complex approach, in his notion of ‘attraction’. He believed that the building blocks of a film were not only the shots -as Pudovkin would claim-, but also the discrete stimuli within it; a concept that takes into account the intention of the filmmaker as well as the psychological

processes of the spectator. Pudovkin simplified this problem by defining the units from the position of the filmmaker, but Eisenstein elaborated the concept by establishing a relation between mind and matter, as Dudley Andrew says, a question that involves the perception of the observer.

Eisenstein saw in haiku poetry the basis for the dynamics of cinema, and it helped him elaborate his theory of montage. A series of ideograms, in haiku poetry, induce the mind to create a unified meaning, by the collision of two ideas, two 'attractions'. In a similar manner, a new expression in film could be created from the juxtaposition of individual shots that carry different stimuli, by selecting and assembling short pieces of film in the process of editing. Whereas Pudovkin thought that the most effective scene is made through a smooth –almost invisible– linkage of selected details from the scene's action, Eisenstein insisted that film continuity should progress through collision, a series of shocks arising out of conflict between spliced shots. Largely influenced by the thinking of Marx and Engels, Eisenstein sees the basis of every art is this sort of dialectical conflict, dynamically creating new concepts from the constant argument of opposites. He went on and found that conflict could be organized rhythmically, tonally and overtonally; and discovered five methods of montage.

Eisenstein thought that reality spoke in very obscure ways, if at all. He was appalled at how inefficient and dull most cinema was, especially the one interested in replicating reality. This was the power of filmmaker: to rip reality apart and rebuild it into a system capable of generating the greatest possible emotional effects.

42 **[6.3] [on meaning]**

Many aspects outlined by Christian Metz in his theory of semiology in cinema can also be used as a paradigm in the understanding and creation of motion graphics for architectural representation. Metz has been leading the attempts of formalizing a system that explains how meaning is conveyed in films. As with any semiotic approach, his interest is directed to the permanent dynamism in every communication system between the symbol and its referent.

His approach is rather scientific, analyzing very specific problems and trying to give a rational explanation to them, with two big different implications in the field of film theory. On the one hand, his writings are work-in-progress reports that later might be studied again and reformulated; on the other, his work relies largely on the research by others, especially in semiology; thus giving to film theory the appearance of a progressive human science.

Metz starts looking for the material to study by comparing film to other systems of communication. It is never about reality itself or a particular way of signification –such as montage- that we distinguish film from any other form of art. For him, the study should be directed towards the channels of information by which we can construct meaning when we watch a film. They include: images, graphics and text, speech, music and noise or sound effects. The semiotician is interested in the meaning resulting from this combination of material.

To help understand how meaning is constructed and conveyed through cinematic means, film has always been compared to language, by far the most studied communication system. For Metz, however, previous comparisons with language have not been entirely successful in their conclusion because the analogy was never pushed far enough. He used

the analogy to understand the similarities by which both systems are used to express meaning, but also pointed the radical differences between both of them.

He refrained from calling cinema a true language, since the analogy in terms of function is not quite applicable. Metz found that the arbitrariness of language has no parallel in cinema. Much on the contrary, the relation between the signifier and its reference is always immediate and direct, because the images are realistic figurative representations and sounds are exact reproductions of what they refer to. In film, that close relationship between signifier and signified cannot be broken without destroying also the meaning they construct. Another radical difference between motion pictures and language is the lack of recognizable smallest units. Verbal language is comprised by a finite number of combinable sounds (phonemes) that he thought have no direct correspondence in filmmaking. Shots, or even single images in film, already are directly significant. Neither did he find the equivalents of simple nouns in film, for an image itself is more like a complete sentence, or at least an assertion. In film, there are statements within a narrative, unlike verbal language, that is made up by monemes within a statement or even phonemes within a moneme. Therefore, there can be no synonyms either, especially since the signifier is directly related to the signified: another picture would call up another referent altogether. Furthermore, for Metz, cinema cannot claim to have a grammar. Although he admits there are certain rules of usage, they are neither so strict nor so complicate as in verbal language. In cinema, there is no absolute objective thing as wrong use of images or improper syntax. Yet another discrepancy is the lack of basic usage. In verbal language there is a simple way to express what we want, yet there are also some other ways to

communicate the same idea in a much different manner, more or less appropriate for diverse situations and styles. In film, however, since we do not frequently communicate by means of images, there is not one basic way to express something. And although there are many stylistic approaches to a problem, none of them can claim to be more basic than another.

Derived from these problems is his study at the level of denotation and connotation, which brings cinema closer to the notion of 'art'. Because of the tight relationship between the signifier and signified, in film scene is harder to separate its denotative aspects of the signifier –its direct specific meaning- from its connotation –the suggested meaning apart from what it explicitly refers to. He found that the properly aesthetic orderings and constraints –versification, composition and tropes in language; framing, camera movements, and lighting effects in cinema- serve as the connoted instance, which is superimposed over the denoted meaning.

Metz concluded that cinema was not a language system, but some concepts of linguistics –terms such as *code*, *message*, *text*, *system*- could be applied with “greatest caution”¹⁸, as long as they only refer to aspects of a general communication theory. In any case, there is no argument on the possibility of films as a medium to construct meaning. To convey messages to the spectator –i.e. the real process of signification- filmmakers use a logical relationship that allows the message to be understood, or in technical terms, a *code*. Metz found that also in cinema, codes have degrees of specificity, classifying those codes that are only found in film art and nowhere else from those non-specific ones that can also be applied to cinema (accelerated montage would be a code specific to film, as opposed to broad cultural codes such as dressing

habits or lighting techniques that film shares with other arts).

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Furthermore, levels of generality can organize codes as well, since some codes can be applied to a small group of films whereas others are common to all of them –although still building different implications. Some of these codes allow identifying films according to notion of genre, periods, or even their authors.

[7.0] [project]

In a very *formalist* approach, one of the hypotheses supporting this research can be expressed in a single sentence. Even having the same description on the geometrical properties of objects, the reading of the situation is not independent of the intrinsic characteristic of the means selected to represent it. As Perez-Gomez and Pelletier have noted, “there is an intimate complicity between architectural meaning and the *modus operandi* of the architect (...) but meaning is never simply the result of its author’s will”¹⁹.

This hypothesis suggested a number of experiments attempting to test the validity of some of the notions expressed by several film theories in the realm of computer-generated motion graphics. The basic scheme is as follows: an experiment would render several alternative representations of the same architectural event, in this case, the church of Saint Pierre. They represented the same object, but those representations would have a completely different character and, arguably, might evoke a different reading of the space. These representations of the church would be an attempt to help understand how to synthesize visually different ideas and convey distinct meanings, and hopefully to provoke the reading of the building in divergent directions.

To draw analytical conclusions on the Le Corbusier’s intentions for this church was beyond the scope of this research, but they were a continuous discussion throughout the process of elaboration.

The processes that follow were not necessarily done in the order implied and they do not account for a progressive line of thought, as results from one process would invariably affect some other processes and experiments; and small but final decisions were made constantly to delimitate the range of possibilities to explore. For instance, one of the first experiments

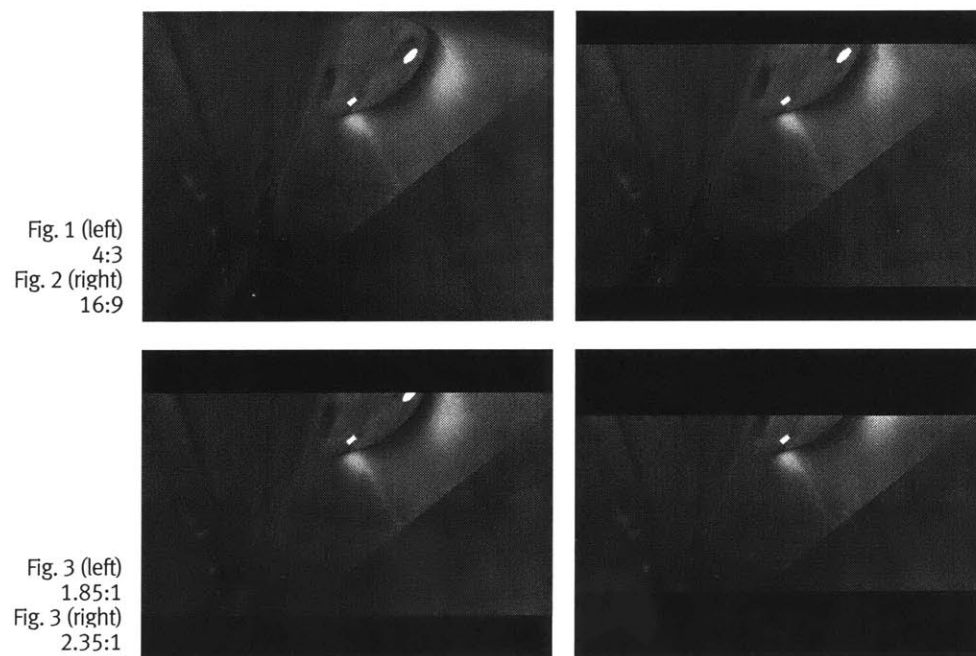
that remained open throughout the project to further investigation had to do with the visual appearance of the materiality of the surfaces. There is no final conclusion –and we think there should not be one– about the color of the wood that Le Corbusier would have picked for the seats. It should be obvious that under no circumstances throughout its development, this experiment claimed any correspondence with what the experience of the unbuilt space might have been. At any point, the images were trying to allege any historical accuracy, not even at the hypothetical level, but they rather they are product of a personal interpretation, which comes as a result of a systematic research.

In addition, not all the decisions were made upon experimentation of several alternatives, since that procedure would have made the whole process intolerably long and distract the attention away from the cinematic aspects of the representations.

[7.1] [frame size]

This experiment addresses the problem of the physical boundaries in the vision of the camera, only in its geometrical terms. Aspect ratio is the appropriate term and refers to the relationship between the width and the height of the image. Four different ratios for the frames were chosen to render the same animation: 4:3 (NTSC TV standard ratio), 16:9 (widescreen TV), 1.85:1 and 2.35:1 (Cinemascope, Panavision). A letterboxing method was used to display widescreen formats onto the NTSC standard –which was the required output for the sequences. By this method, the motion graphic uses the entire width of the display and black bars are added to the top and bottom to achieve the correct aspect ratio. The larger the width (2.35), the thicker the black bars (figures 1-4).

In objective terms, it can be said that the amount of information available in each case is different. The vision of the camera is represented by a pyramid of square base, the apex being the position of the camera, and the target of vision located in the exact center of the base –the base is located at any distance from the camera.



By changing the frame ratio, the proportion between the sides of the base of the pyramid also changes, consequently altering the content in the vision of the camera (figures 5-6). This is a change in the proportions of the image, rather than a change in its size –the image size is ultimately determined by the screen size, a relative value marked by the technology used in each case.

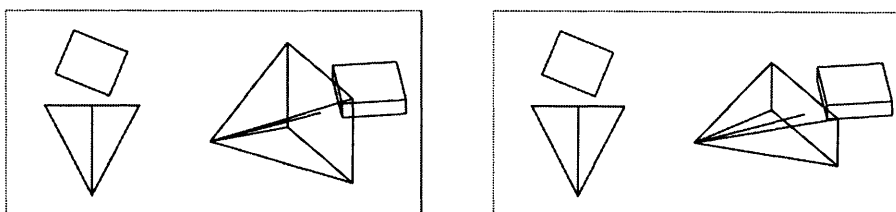


Fig. 5 (left)
Camera with ratio 4:3
Fig. 6 (right)
Camera with ratio 16:9

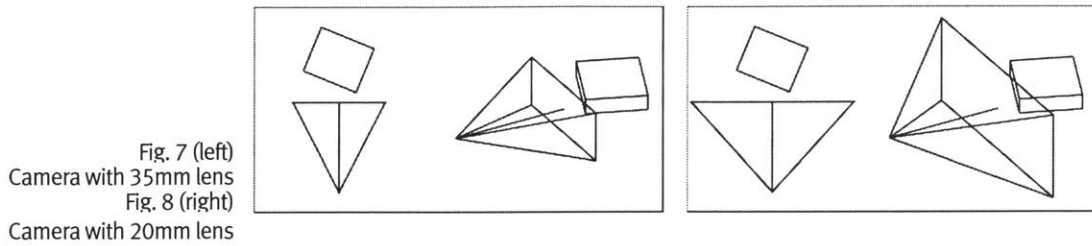
[7.2] [field of view]

In some sense also dealing with the amount of information displayed on the screen –but this time not only varying in its quantity but also in its quality-, in this experiment, the same camera movement was rendered using different fields of view for the camera (35mm and 20mm). This experiment was carried out for the same sequence rendered in the testing of frame size, and later the two experiments were combined⁶. In addition, it was also applied to another camera path.

The problem addressed in this experiment has some interesting connections with the previous one. Having determined one frame size –or aspect ratio- it is also possible to alter the pyramid defining the vision of the camera by using a different angle in the aperture at the apex, usually referred as the camera's field of view (FOV). The software utilized provides some standard FOV values corresponding to common lenses, such as 20, 28, 35, 50 mm and others. The effect is a change in the amount of information displayed on a single frame as a wider angle in the field of view expands the vision of the camera; but since the frame size does not

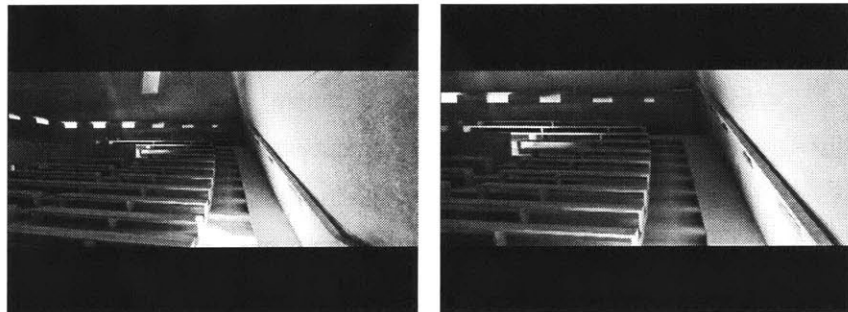
⁶ The combination of these two experiments involved the same camera movement rendered in four different frame sizes and two different FOVs.

change, it is obvious that the information common to both cases is also altered (figures 7-8).



The perspective shown in both cases is the same. One of them, however, shows only the central portion of the perspective –how *much* of the central portion of the perspective is determined by the difference in the camera lens- expanded to fit the whole available area for the frame. This means that the vanishing points in the perspective of this last perspective are actually more distant to each other when the sequence is seen on the same screen size, since it is nothing but a *zoomed* version of the previous image (figures 9-10).

Fig. 9 (left)
20 mm perspective
Fig. 10 (right)
35 mm perspective



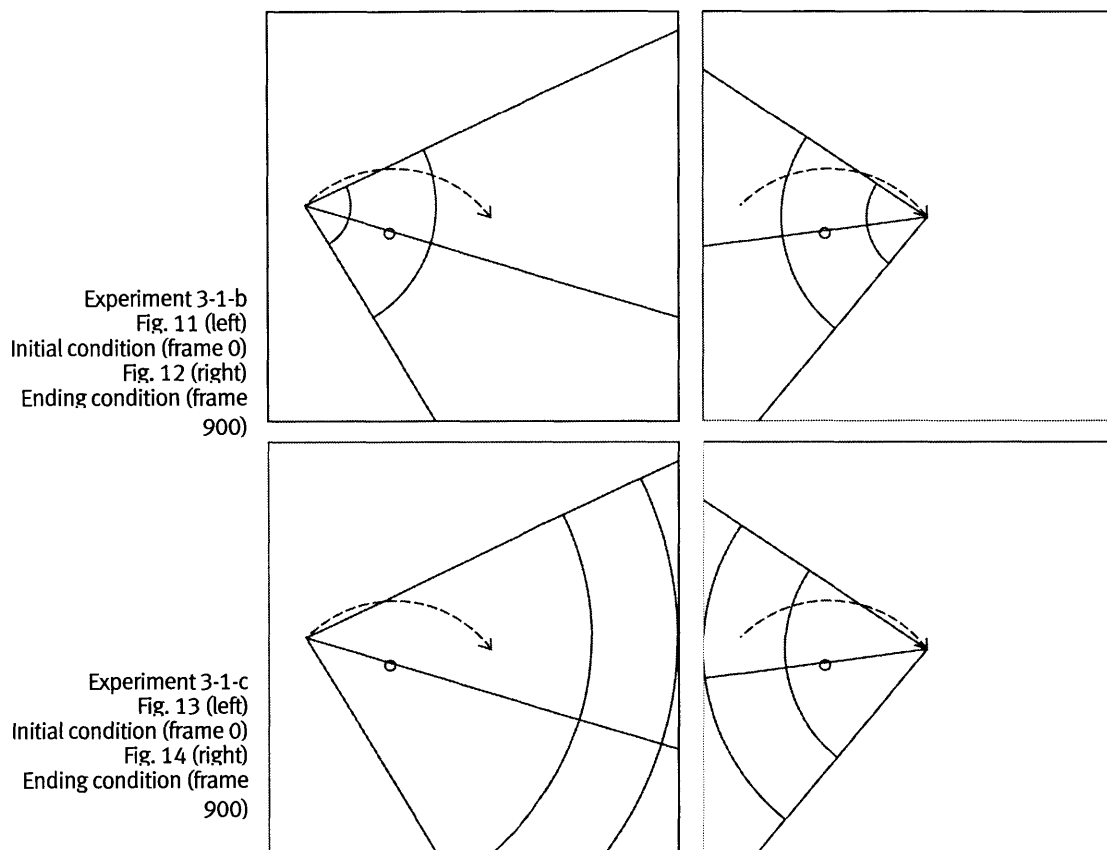
52 **[7.3] [depth of field]**

The subject of study was the attention of the viewer, and depth of field is one of the codes indigenous to the medium that permits a manipulation in that aspect. It refers to a portion of the three dimensional space represented through the camera lens that is the focus of attention. The rest of the space shown in the frame appears less understandable due to a process of blurring on the image. Unlike a physical camera, the process in computer-generated images is simulated by applying a mathematical algorithm that fades that portion of the image. This is known as a post-production technique, since it is not intrinsic to the process of generating the image, which by default has an infinite depth of field, meaning that everything in it is in focus.

The video post procedure requires the rendering of the image as a previous step, and it is calculated on the basis of the position of a certain element in the scene. For that matter, an invisible object is placed inside the computer model, around which a field is created to determine whether – or how much- the other objects should appear blurred. This invisible entity can be animated during the sequence, achieving a similar effect to the action of focusing with a regular camera.

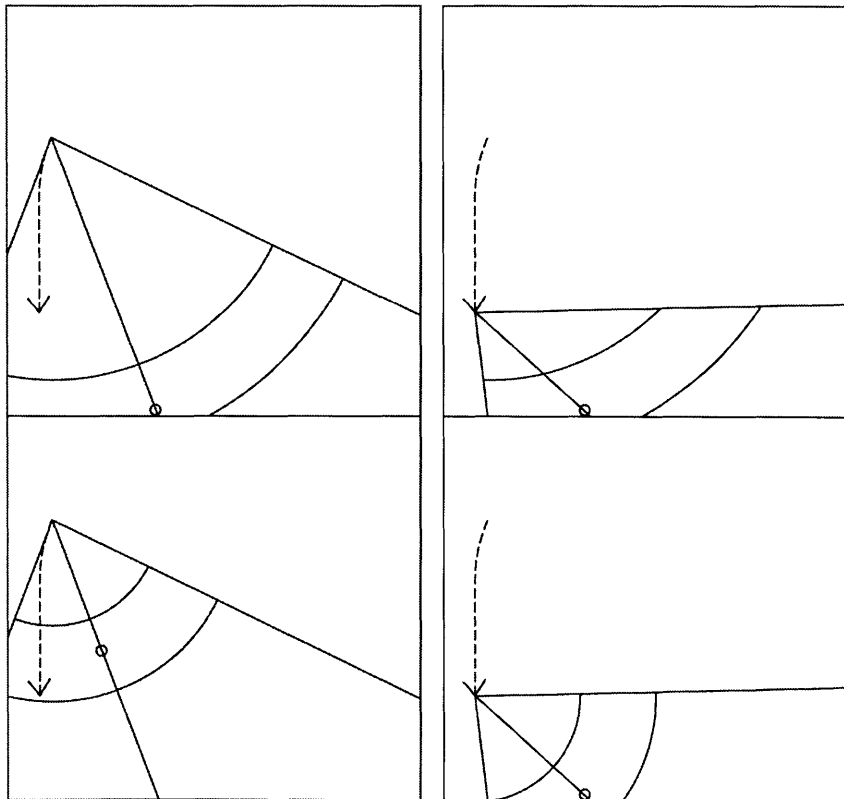
The experiment was performed on three different camera sequences. One of the camera orbits around a specific point in space, and it was rendered using: a) infinite depth of field –default rendering procedure; b) using a shallow depth of field surrounding the point around which the camera moves (figures 11-12); and c) a medium depth of field set to the elements in the background of the image (figures 13-14). In the second case, the depth of field is set to an imaginary object –the mentioned point did not correspond with any object in the scene- that does not move, directing the attention to a void. The third case takes the depth of field further

away from the camera, destroying the notion of an imaginary object, although there is still an invisible entity used for the calculations.



Another experiment employing a certain depth of field for the images was based on a sequence that brings the camera closer to its target of vision, in a dolly-like movement. Again, three cases were rendered using the same shot but different depth of field effects: a) with infinite depth of field; b) with a shallow depth of field set around an object which the camera is looking at and moving to (figures 15-16); c) with a shallow depth of field set at a constant distance from the camera, which in the end of the

sequence is coincident with the position of the object in the target of vision (figures 17-18). In the second case, the distance between the area that remains in focus and the position of the camera is always changing throughout the shot. In the third case, the invisible object used to determine the depth of field moves together with the camera, progressively blurring and showing different things as the sequence develops.

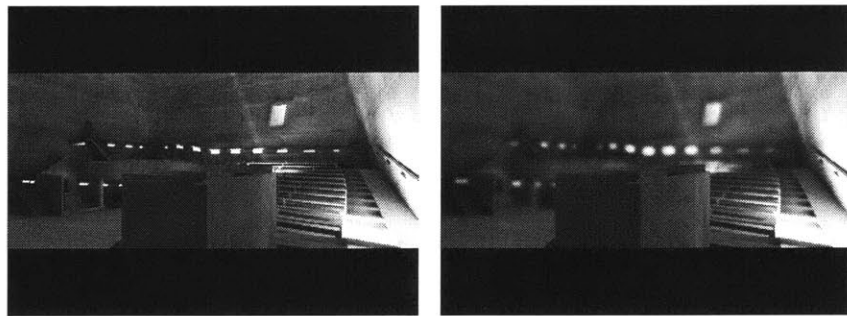


Experiment 3-2-b
 Fig. 15 (left)
 Initial condition (frame 0)
 Fig. 16 (right)
 Ending condition (frame 900)

Experiment 3-2-c
 Fig. 17 (left)
 Initial condition (frame 0)
 Fig. 18 (right)
 Ending condition (frame 900)

The third experiment was a repetition of the first one, but the camera movement (orbit) this time was around a particular object in the scene –the pulpit– in a continuous circular path (figures 19-20).

Experiment 3-3
 Fig. 19 (left)
 Case a: infinite DOF
 Fig. 20 (right)
 Case b: focus effect



[7.4] [exposure control]

In photography, like the human eye does, the camera needs to adjust the amount of light that will fit in the spectrum of light that it can record. Darker areas than the lowest value in the spectrum will remain black, and brighter areas will be white. Accordingly, if a scene is very bright, it might be desired to capture the most differences within the brighter areas –i.e. expose to the brighter areas– leaving the few darker portions in black. On the contrary, if it is a somewhat dark scene, it will be necessary to emphasize the contrast on the lower side of the spectrum, thus taking the brighter areas to a value close to white.

This is very true in the case of digital images, where the palette of colors is always exceptionally limited compared to an analog device. Moreover, in motion pictures, it is a feature that needs to be precisely controlled as not all the images have the same level distribution. Exposure settings that are used for a particular frame might have an undesired effect on another

frame, even more evident when both are taking part in the same camera sequence.

Because of the limited amount of light allowed inside the church, which creates a rather dark space, this experiment became obvious when trying to render a sequence that would combine both an exterior and an interior scene in the same shot. The exposure settings used for an image of the interior of the church were unacceptable for one with surfaces directly illuminated by sunlight, since they would go all white; and vice versa, exposure settings for exterior views of the model would produce almost completely black frames in the interior, where the geometry is defined by subtle variations of indirect light.

In computer-generated motion graphics, there are two ways of accomplishing this task, one of them being done before the sequence is rendered, the other afterwards. For the latter case, it is necessary to set a medium value for the exposure at the time of rendering, trying to make sure that both the dark and bright areas all through the sequence are not lost to extreme values of black or white, respectively. The other option is to manually adjust the exposure in each frame before it is rendered, which yields a better result at the cost of time in the production stage.

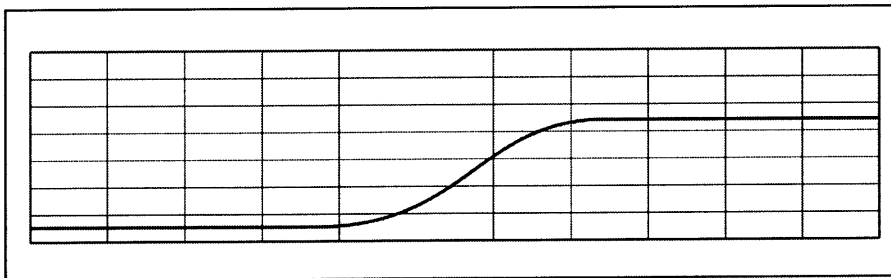


Fig. 21
Experiment 4-1-c
Change of brightness over time

The experiment was also carried out on two different shots, and in both cases it was done by an adjustment *a priori*. The first sequence is a camera moving from the exterior and entering the church through one of the openings in the roof. The other sequence takes place inside the church but the beginning frames are images from the entrance, a transitional room open to the exterior before the main space. Both of them contain a gradual change in the values of brightness and contrast of the image – exposure control as such is not available in the software- described by a parabolic line in a time/value chart (figure 21).

[7.5] [lighting]

One of the decisions that needs to be made before the rendering process is to determine the daylight characteristics (position of the sun respect to the model, intensity). As mentioned before, because of the algorithm chosen to generate the images, this is an extremely slow stage; but at least four different lighting conditions were tested and compared on the same sequence. This camera movement is an extension of another path, which was completed to describe a circular path around the center of the space. Although lighting is an important part of the form of film –it does not have the same to meaning to illuminate the scene or the subject with different criteria-; in this case, it could be argued that a change in the position of the light was a more content-oriented variation than a formal cinematic artifact.

In the first case of this experiment, sunrays were aligned in such a way that they would penetrate directly through the tubular perforations on the roof. Although it is almost impossible to accurately determine, these would be the position the sun would have at noon in a day of early April; consistent with the intention Le Corbusier had for the commemoration

of Holy Friday in the Catholic calendar. For the second case the position of the sun was adjusted to be aligned with the opening on the west side, a condition that illuminates directly the altar, likely to occur also on some day in April, right before the sunset. The third case did not reflect any particular day and time (it is possible that the sun never reaches that position in Firminy) but looked to display a direct incidence of the sunlight on the seating area.

[8.0] [conclusions]

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[8.1] [on the experimentation]

These experiments help prove the fact that computer graphics are another form of architectural representation in which both the content and the medium have fundamental importance that should be carefully considered to achieve the goals.

Some of the experiments provided more interesting material to work with than others. For example, the study of the depth of field seemed to be very rich though rarely used in the actual practice of computer graphics. The first example where it was tested supposed the presence of an object around which the camera orbits. Although there was no object in that location, the mechanism of depth of field generated a strong sense of presence, since great part of the image was blurred directing the observer's attention to a very limited area that remained sharp. Moreover, the effect is greatly emphasized by the kind of movement the camera does, described by an arc that has a center approximately coincident with the target of vision in the whole sequence. The facts are: the camera is moving around a point in space; it is looking at that point; and everything in the image but that point is hardly distinguishable. The conflict is created because there is nothing in that point, stimulating the observer to create the concept that "something is missing". This led the test of another sequence, based on the same concept. The idea was to apply the same two principles, namely orbital movement of the camera and a shallow depth of field, but there would be an actual object in the center of vision. For that matter, the pulpit was chosen, because of its

sculptural appearance as a stand-alone object. The path in this case was exaggerated to be a complete circle around the object, leaving no doubt to the observer to where the center of attention is. The results were somehow more convincing than in the sequence where the camera has no object as center of its vision, or at least the motion picture appeared more coherent to the observer. At any point, the observer has a problem identifying what he is looking at, even if the geometry of the object is not familiar enough to interpret what it is; whereas in the first case, the viewer understands clearly where to look at but he finds nothing in that place. Because the latter segment was lacking this 'conflicting' element, it was definitely more coherent, more conventional, while at the same time, rather dull.

It might be argued that some of the concepts or experiments were trying to emulate in a more or less accurate manner the procedures performed in reality with a physical camera. While to some extent this might be true, it is important to clarify that the intention was not to get closer to reality or simulate it by any means, but rather use those concepts as analogies. Because nothing is entirely new, analogies work in such a way that allows gaining knowledge on something new by applying a concept that is already understood by the subject. This means both cases are not equal, but to some extent they share similarities.

Furthermore, in other cases, the relationship between computer-generated graphics and other medium is a direct similarity, and the concepts might be applied straightforward. Such is the case of exposure control. As it was mentioned, the experimentation became imperative because there were no common settings for extreme situations –interior and exterior spaces– that would render an acceptable output. In any case, this experiment also proved that this aspect would act not only towards the content –as it was

a mandatory adjustment for the legibility of the image- but it also provided more control on the *form* of the sequence. Both shots used for the experiment on exposure control show a clear intention over what needs to be seen at exactly what point in time. The sequence is releasing information in a very controlled method. In the case of the camera entering through the hole in the roof, the prismatic passage in the beginning of the sequence is perfectly comprehensible, but the object begins to appear smaller –as the camera moves away from it- while still preserving its supremacy within the frame since it is the only thing visible for a period of time. Later on, a number of other objects begin to question that hierarchical scheme as the exposure gets adjusted to a more adequate setting for the interior space. A comparable effect is achieved in the other case too, where the camera –also in a backwards motion- gets away from the entrance space. The manipulation of the exposure and the composition of the frame are slightly different but the scene unfolds in the same way.

This sequence had a certain development. It was originally conceived after the closing animation for the exhibition clip, but the idea for the new one was to violate the experiential reminiscence while keeping the sequential idea of the spiral path. The original clip shows the interior of the church as the camera is elevating from the floor level inside the drum until it finally goes outside through one of the openings in the roof. It was decided to experiment on the same movement, but exploring the perception of the space as the camera goes into it, as opposed as going out of it. Still, for the new shot, it was essential to maintain the backwards movement of the camera, in a clear attempt to contradict the human experience. The necessity of exposure control, as it was narrated before, became evident. The camera movement was studied a dozen

times at least until the desired effect was achieved. Further special video post effects were added to the scene, such as superimposing of a natural sky captured with a camera, depth of field effects, and flare effect for the sunlight. The composition of the camera movement also has noticeable connections to the opening shot of Orson Welles' *Citizen Kane*, one of the most celebrated shots in the history of cinema. Critics have referred to this clip as bearing incredibly strong connections to an architectural drawing, as it was permanently unfolding to the eyes of the spectator as time passes, showing what needs to be shown at the right time.

This research does not intend to be a comprehensive study on the concepts of film theory or a thorough application of film techniques to the understanding and creation of architectural representations in motion graphics. Much more modestly, it is just an idea of transposition and experimentation of both aspects to help formulate ideas on this new territory for architecture. It seems that there are infinitely many concepts and techniques that could prove more or less valuable resources, and many of them would require a special frame of time to be better understood.

For example, an element that remains to be explored in its own terms is the narrative as a structural component on the composition of the film as a text. This is a fundamental factor in the creation of films, but its importance in the creation of architectural representations needs yet to be studied. Certainly, the possibility of including it as an expressive component is there -for instance, a poem that sets the rhythm of images-, but the hypothesis of conflictive situations is not unimaginable either. In addition, it would have clearly a different meaning a narrative

that considers the spatial quality as the main event from one that bears the space as a mere support for another incident happening there.

Another aspect in the creation of motion pictures as it was indicated by several film theories is the notion of montage, or edition. Although some experimentation was performed in this sense, it was obvious that the problem was much more complex and it required more than a couple of experiments for an initial understanding of the concepts involved. This might have been the immediate next step for this research, but the frame of time imposed did not allow for the kind of consideration the problem deserves.

Even more interesting is the notion of meaning, which also needs to be the core of further study, rather than an accidental aspect. The possibility of representational devices to carry signification is beyond discussion but there is a need for a very careful consideration of the denotative and connotative aspects of the representation. Techniques such as montage have a strong philosophical argument and it needs to be recreated in motion graphics to test its extents of adaptability.

The same applies to the factor of sound. It is a decisive portion that -without discussion- has great influence in the reading of a motion picture sequence; which translates also to a vast impact in the perception of the space when the sequence is an architectural representation. Notions of synchronization with the image, mental *re*-construction of a reality, denotation and connotation, are key to the discussion of sound and noise in motion graphics; but the field of study is much greater than the limits imposed for this thesis.

64 **[8.2] [on film theory]**

On a much more personal level, this medium seems perfectly apt as a vehicle of expression for many reasons, and in this sense much closer to the concepts that formalism as a film theory deals with. The connection with reality appears to be a delicate issue and not very evident, so the principles found in the core of realist film theory might not resist direct application onto the field of motion graphics rendered with computers. At least, the philosophical doctrine lacks applicability exactly because we are not dealing with reality in the first place. On the other hand, formalism appears to be much more helpful in the creation of architectural representation in motion graphics, even if many of the technicalities have no direct correspondence. And maybe this is the only aspect that experiments proved as a fact. The perception of the same content is not the equal in every case, so it must be also dependent on the qualitative aspects of the medium chosen.

It should be noted, however, there is still a strong validity in the assertion that Perez-Gomez and Pelletier make on this sense. There is strong resistance to deconstruction in the architecture of computers, as it “tends to represent itself in its products with utter transparency, resulting in an often redundant self-referential formalism”.²⁰

It seems clear that the many of the notions of film theory have an interesting applicability, even if the translation is not direct, or maybe exactly when it does not happen. There have been many attempts to define in a more or less structured way something similar to a “screen grammar”. Although it is true that some procedures have proved to convey certain meanings, it is hard to claim that a particular connotation is achieved just by using specific means. Many studies explain how to put together

two different pieces of film to better achieve a result, but it still the creative potential of the artist what goes beyond those standards to engage in a different communication process.

[appendix a]

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Following is a list of design interventions that were made upon the lack or the inconsistency of information available at the time of the modeling process.

Materials. The appearance of the materials applied to the surfaces is only product of our intervention, and bears no connection with the actual materials, in those cases where the equivalent object exists in reality. There are different sources for the images of the concrete, but most of them come from photographs of the Carpenter Center for Visual Arts in Harvard University, Cambridge, MA. This is one of Le Corbusier's last projects as well, and its design is dated approximately in the same years. All the photographs taken were crafted using digital imagery software to generate more appropriate patterns for the geometry of the church.

Openings. The two openings on the roof and the opening on the west side of the shell were left without any kind of glazing. Even though some drawings show a line that would be applicable to some sort of windowing surface, the lack of other design responses –such as drainage- and other intentions on the rendering process –like camera movements- suggested the necessity of leaving these holes as ideal conduits of light disregarding other factors such as weather.

Star-like openings. On the East wall of the drum, there are a number of perforations that are an abstraction of the medieval rose window. The set of drawings we had available did not include detailed information on object that size, and although the location was traced from the elevations, the exact dimensions for those perforations had to be improvised.

Wood Materials. Although there is an apparent code for materials on the plan views, expressed by a rendering pattern in the figures, it seems to be

incoherent with other sources of information. Seemingly, this pattern indicates the wooden materiality of the object in question –the bench behind the altar, the top surface of the altars- but it is also applied to a staircase and to the pulpit’s steps. These two latter objects have been casted in concrete and they exist in the actual construction. To this point, it is not clear to what this pattern alludes to, so the appearance of these objects was decided to be as follows: wood for the bench in the back of the sanctuary, wood for the altar tops, wood for the last bench against the west wall, concrete for the staircase, wood for the horizontal planes of the pulpit (where the texts are placed) except the floor and steps, and concrete for the rest of the it.

Handrails. Again, another matter of detailing: the drawings do not have precise information on the characteristics, dimensions and materiality of such elements. The design used is an adaptation of the ones seen in the Carpenter Center for Visual Arts in Cambridge, USA, and the Youth and Cultural Center (Espace Le Corbusier), Firminy, France.

Columns. There are three round columns in remnants of the construction to hold the second-level tray on top of the side chapel. The drawings, however, show only two circular columns and a rectangular pillar attached to the back wall of the secondary altar. It was decided to follow the drawings.

Benches. The height of the benches in the congregation tiers is unknown. It was set to 45cm.

Access ladder to bell tower. It is only present on one of the plan drawings, and there is not information on what the ladder looks like from the side. It was replaced by a small staircase in concrete.

Side chapel ceiling. The information on the section drawings is incomplete to determine the exact geometry of the bottom side of the tray. The set of

drawings from 1974 show a much thinner slab to support the tray but it is impossible to determine how it changes as the section perpendicular to the seating area rotates. It was decided to develop a constant section throughout the tray, which created a conflict with its appearance from the front (as it appears in a previous drawing). Consequentially, the front view of the tray is inconsistent with one of the drawings from 1970, but coherent with the constructed version.

[appendix b]

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Following is the technical information on the experiments submitted on VHS tape as part of this thesis.

[1] [frame size]

[1.1] Camera 26
model: 345-67_99-675.max
camera path: 26
camera lens: 20mm
length: 601 frames
duration: 00:20:01
ratio:
video post: n/a

[1.1.a] ratio: 1.334 (4:3) (NTSC TV)

[1.1.b] ratio 1.778 (16:9) (HDTV)

[1.1.c] ratio 1.85 (1.85:1)

[1.1.d] ratio 2.35 (2.35:1) (Cinemascope, Panavision)

[2] [field of view]

[2.1] Camera 26
model: 345-67_99-675.max
camera path: 26
camera lens:
length: 601 frames
duration: 00:20:01
ratio: 2.35:1
video post: n/a

[2.1.a] 20mm (83.974°)

[2.1.b] 35mm (54.432°)

[2.1.c] 50mm (39.598°)

[2.2] Camera 12
model: 345-67_99-675.max
camera path: 12
camera lens:
length: 901 frames
duration: 00:30:01
ratio: 2.35:1
video post: n/a

- [2.2.a] 20mm (83.974°)
- [2.2.b] 35mm (54.432°)
- [2.2.c] 50mm (39.598°)

[3] [depth of field]

[3.1] Camera 13

model: 345-67_99-675.max

camera path: 13

camera lens: 20mm

length: 901 frames

duration: 00:30:01

ratio: 2.35:1

video post: focus effect

[3.1.a] No effects (infinite depth of field)

[3.1.b] Depth of field set to camera target (loss: 5%, range: , limit:)

[3.1.c] Depth of field set to helper (loss: 5% range: , limit:)

[3.2] Camera 07b

model: 345-67_99-675.max

camera path: 07b

camera lens: 20mm

length: 601 frames

duration: 00:20:01

ratio: 2.35:1

video post: focus effect

[3.2.a] No effects (infinite depth of field)

[3.2.b] Depth of field set to helper (loss: 5% range: , limit:)

[3.2.c] Depth of field set to camera target (loss: 5%, range: , limit:)

[3.3] Camera 19circle

model: 345-67_99-675.max

camera path: 19

camera lens: 20mm

length: 1400 frames

duration: 00:46:21

ratio: 2.35:1

video post: focus effect

[3.3.a] No effects (infinite depth of field)

[3.3.b] Depth of field set to camera target (loss: 5%, range: , limit:)

[4] [exposure control]

[4.1] Camera 35
model: 345-67_99-675.max
camera path: 31
camera lens: 20mm
length: 2000 frames
duration: 01:06:21
ratio: 2.35:1
video post: lens flare effect
 [4.1.a] Exposed to the interior (brightness: 55; contrast: 45)
 [4.1.b] Exposed to the exterior (brightness: 15; contrast: 80)
 [4.1.c] Variable exposure

[4.2] Camera 29
model: 345-67_99-675.max
camera path: 29
camera lens: 20mm
length: 1700 frames
duration: 00:56:01
ratio: 2.35:1
video post: n/a
 [4.2.a] Exposed to the interior (brightness: 55; contrast: 45)
 [4.2.b] Exposed to the exterior (brightness: 15; contrast: 80)
 [4.2.c] Variable exposure

[5] [lighting]

[5] Camera 25
model:
camera path: 25
camera lens: 20mm
length: 3000 frames
duration: 01:40:01
ratio: 1.85:1
video post: n/a
 [5.a] April day (noon)
 [5.b] April day (sunset)
 [5.c] Arbitrary

[appendix c]

Software

AutoCAD (R14, 2000, 2000i) (Windows)
Rhinoceros v1.1 (Windows)
Lightscape (3.1; 3.2; 3.2.1) (Windows)
3DS Max (3.0) (Windows)
Adobe Photoshop (5.0, 5.5)
Adobe Premiere (4.2) (SGI)
Adobe Premiere (5.1) (Windows)
I-Finish (Windows)
Media Cleaner (Windows)

[literature review]

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Consistent with the main areas of this research, bibliographic references may be broadly grouped into three areas, narrowing from the general to the specific: issues of representation, film theory and case-specific literature. First, readings on the background theories on representation, architectural meaning and reading process helped understand the inherent implications in our task. Maybe more important, though, was the analogy created from the field of cinema, that took the most large part of the referential literature. Lastly, the architectural case selected as a case study required a deep investigation, which includes study of the building itself, and its contextual extensions. Location in time and space were fundamental to the construction of meaningful concepts: modernism and Le Corbusier, Firminy and the project.

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- ² Ibid., p. 20
- ³ Porter, William. "RE: Reading", p. 18
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- ⁵ Norberg-Schulz, Christian. "Meaning in Architecture", p. 22
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