IN-SPACE: LEARNING TO GIVE FORM TO SPACE

Leandro Madrazo, Gonçal Costa
Universitat Ramon Llull, Barcelona, Spain
e-mail: madrazo@salle.url.edu

Keywords: space conception, space perception, space representation, computer-supported collaborative learning

Experience, perception and conception of space

Space is inseparable from our existence. As Heidegger contended, our existence is spatial ("Das Dasein, ist in einem ursprünglichen Sinn räumlich") [1]. Space, according to Heidegger, is not in the subject, nor is the world in space. Rather, space is an a priori condition which transcends the distinction between subject and object. However, through our powers of abstraction we can distinguish both, our experience of space and the knowledge of it. We can, for instance, protrude from the actual space we are in, to see it –so to speak– from the outside, as if we would perceive an object. In this case, we are not referring so much to the space in which we are immersed –the space of our existence– as to some conceptual structures by which we become aware of space itself –our perception of space– the kantian a priori intuitions (reine Anschauung) of space and time. "Space" –in the heideggerian sense– is connected with existence, with the Dasein; the "idea of space" –in the kantian sense– concerns to the transcendental subject.

A perspective represents space as seen from the outside, with the eye of the transcendental subject; an eye –represented by a geometric view point– which not only sees a space, but a space as it is seen by the subject. Motion is inherent to our experience of space which is not fixed and static –like a perspective assumes– but dynamic. According to Bergson, movement would consist of two separate elements: the space that is traversed and the act of going through it. As we talk about space, we tend to confuse both elements, although they have distinct qualities: one is objective, and can be quantified; the other subjective, and can only be qualified [2]. Even though we can represent the spatio-temporal dimension through a film, for example, such representation –like a perspective– cannot be identified with the spatial experience itself, with being in space.

The distinction between an objective and a subjective space has pervaded in the works of theorists. Merleau-Ponty, in his "Phénoménologie de la perception" [3], distinguished between a physical space where things are ordered in relationship to our bodies (up and down, left and right, far and near) and a geometric space, homogeneous and isotropic. The first concept of space would result from our spontaneous interaction with objects in a physical environment, while the second can only be the result of a conscious reflection. In "Psychologie de l'espace", Moles also differentiates between a space which is perceived by *me, here, now* and the space which is perceived from outside, as an *extension*. He thinks that "Les deux systèmes que nous venons de décrire sont à la fois *essentiels* et *contradictoires*; irréductibles l'un à l'autre, ils se partagent nos pensées d'espace et nous passons de l'un à l'autre dans notre vocabulaires comme dans nos comportements" [4]. We could conclude that subjective space can only be experienced, but not represented whereas objective space can be represented as geometric object, but it cannot be experienced. This dilemma has the greatest significance for the architect, since only a space that can be represented, can be designed.

Space as the essence of architecture

In his influential work "Das Wesen der architektonischen Schöpfung", 1894, Schmarsow considered space the essence of architecture. In order to aesthetically perceive a building, the spatial qualities were more relevant than the formal and material ones. Space, however, could not be an exclusive quality of an architectural work –as its style could be–, but needed be considered in relation to the subject ("die Raumschöpfung sich zunächst garnicht loslöst vom

Subjekt, sondern immer den Zusammenhang mit dem anschauenden Urheber voraussetzt") [5]. A strong link is then created between anthropological space and architectural space. As Schmarsow, contends, the idea of space arises as soon as the subject stands vertically on the ground. The body carries the system of axes and as it moves on the horizontal plane, space is endowed with direction and structure. This moment represents not only the birth of space but the origin of architecture itself. Architecture is the outcome of a human spatial intuition which feels compelled to give artistic expression to a spatial feeling and to a spatial imagination inherent to the human being ("Die Architektur ist also Raumgestalterin nach den Idealformen der menschlichen Raumanschauung") [5].

Later, in his "Grundlegung zur einer vergleichenden Kunstwissenschaft", published in 1949, Frey stressed the link between the motion of the body and architecture space, by defining architecture as the structuring of space by means of a goal or a path ("Alle Baukunst ist Gestaltung des Raumes durch ein Mal oder einen Weg") [6]. According to Frey, we give form to formless space as we move about it in the search of an end or goal ("Indem ich im freien, unbegrenzten, formlosen Raum ein 'Mal' errichte, gestalte ich bereits diesen Raum") [6].

As we move outside and inside a building, we reproduce in our mind its spatial qualities as plans, or as perspectives seen from a fixed view points. These separate views are put together in a single image in the spectator's mind. According to Frankl, "to see architecture means to draw together into a single mental image (Vorstellung) the series of three-dimensionally interpreted images that are presented to us as we walk through interior spaces and round their exterior shell" [7]. When, as architects, we are confronted to the task of conceiving a space we resort to the same abstractions that arise in the mind as we perceive a physical space with all our senses. However, these abstractions do not seize the haptic qualities derived from the presence of body in space, but mostly the optic ones grasped through the sense of vision.

Therefore, our capacity to conceive architectural space is constrainted by our abstractions. In the Cartesian space which limits our architectural conceptions, we conceive rooms as voids carved in solids, as interstices left between planes, and as areas bounded by lines. When it comes to creating –and, therefore, representing a space– form and space, solid and void, become hardly distinguishable. A drawing of a geometric body –like for example, an axonometric view of a cube– represents both its form and the space it embodies. For instance, in Ching's book "Architecture: Form, Space, Order" [8], some of the drawings of spatial organizations can hardly be differentiated from the drawings of formal compositions. Drawings are abstractions that allow us to capture the objective properties of a space, but not its temporal dimension, the experience of space. Bernard Tschumi, in his "Manhattan Transcripts" [9], proposed some cinematographic techniques to encompass the time dimension in architectural representation and, therefore, in the conception of architecture: disjoining a spatial experience in spaces, movements and events, and then reorganizing them in sequences of frames, which in turn give rise to different narratives.

The experience of space and the computer

After the advent of computers, our spatial experience has been enhanced. Computer networks furnish spaces of communication where people gather and share time (chat rooms, forums) as well as virtual worlds (computer games, MUDs) which enable them to be present in a non-physical world by means of an avatar. With VR technologies, we have the possibility to break away with the physical world that surrounds us to submerge in a virtual environment (CAVE, for example). More often, our experience of virtual space is limited to interacting with a projection displayed on a screen. In this case, the sense of space is not necessarily less immersive than it is using VR technology. Identifying ourselves with an avatar by means of the power of empathy, we feel in a space represented by two-dimensional images on a computer screen. We can perceive the visual characteristics of this space (dimension, depth, orientation) in much the same way as we would do through a bodily experience. As Franck has written: "Virtual reality is very physical. I won't just see changing images on a flat screen; I will have the feeling of occupying those images with my entire body. I will enter a graphic, three-dimensional, computer-constructed world that does not look real but feels real, one that may respond immediately to my movements and commands" [10].

This spatial experience achieved by interacting with images displayed on a computer screen shows the difficulty to make a clear distinction between real and virtual spaces. It is equally difficult to establish a distinction between physical and virtual realms. In fact, the opposition physical/virtual is loosing significance as physical and virtual worlds become more and more interwoven. For instance, economic transactions taking place in front of a computer screen have a tangible effect on the physical assets of the real world. In this situation, it makes sense then to characterize a "place" in a computer network as an access point "where physical actions invoke computational processes, and where computational processes manifest themselves physically" [11].

Spaces brought into existence by computer software and computer networks are essentially the result of establishing relations between items: between computers, between data, and between users. This dynamic of interrelationships contributes to supersede existing boundaries – geographic, but also disciplinary. Computers, however, can not only contribute to overcome territorial limits, but also disciplinary boundaries, helping to bring about new knowledge spaces.

Computer-supported learning environments for space education

With the course Systems of Representation (www.salle.url.edu/sdr/info) we have created an interdisciplinary knowledge space resulting from establishing relationships between *theory bits* taken from different disciplines, in particular: gestaltung, art theory, visual communication, and computation [12]. The course consists of six themes, each one dedicated to one representation system: Text, Figure, Image, Object, Space and Light. The theme Space is dedicated to exploring the relationships between the representation of space in architecture and other disciplines, like geometry, painting, and cinema (Fig. 1).

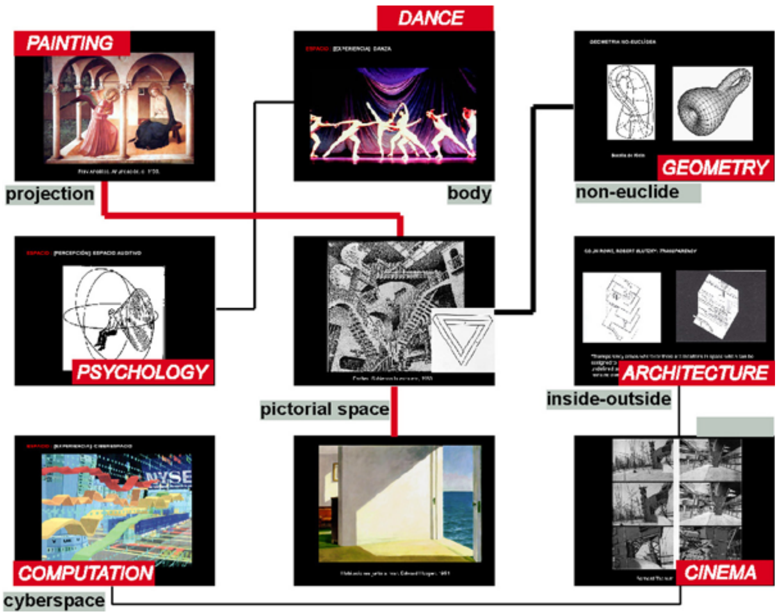

Fig. 1. Structure of theory bits in the theme SPACE

Seven years ago, we created a web-based learning environment called NETWORKING: SPACE to use it as a pedagogic tool in our course [13]. With this environment students could construct a network of spatial units in collaboration, working on the Internet. The cubic units had three different dimensions or properties: *geometric*, meaning the objective qualities, like form and color; *perceptual*, that is to say, the subjective qualities, like emotions or memories associated to a space; and *narrative*, namely, the literary descriptions describing the events taking place in a space. Cubic units were inserted in a VRML space where each one of the three Cartesian axes would correspond to one of the three properties of the cubic unit. Thus, assembling units vertically was tantamount to establishing a geometric relation between spaces, whereas arranging them along a horizontal axis meant that the spaces had a perceptual or narrative connection. Working in this environment, students could become aware of the mutual relations between different space dimensions in the process of creating a space, collaboratively.

IN-SPACE: giving form to space

After the experience gained applying the system in our teaching, in the year 2003 we started to develop a new environment called IN-SPACE which was completed in 2005. Unlike its predecessor, with IN-SPACE it is possible to give form to space from inside, avoiding having to model it from outside, as a volume.

IN-SPACE is a web-based modelling tool especially conceived to develop the capacity to give form to space. At the outcome, the user is placed inside a cubic cell placed at the center of a three-dimensional grid. From this starting position, space is created as a result of the movement of the viewer along each one of the six directions of the Cartesian space. As the viewer moves, the surfaces of the inner envelope expand in any of the six directions. Conversely, a space can become smaller by pulling the bounding surfaces towards the viewer, as if the inner envelope of the space would contract. Once a space is created, a viewer can move from cell to cell with the help of the mouse or it can be driven automatically along the motion paths that have brought out the space.

With IN-SPACE some established notions of architectural space can be reconsidered. In his book “The dynamics of architectural form”, 1977, Rudolf Arnheim contended: “A building is thought of either as a closed container, into which holes are punched as needed, or it is a set of units –boxes, boards and posts– added to one another until the space is sufficiently closed. Every architectural design dwells somewhere between these two extremes” [14]. With IN-SPACE, a third way is possible: to think of space as a void which expands and contracts according to the viewer’s motion. This is an abstraction of the idea of architectural space created as extension of the body, as Schmarsow, and others, had suggested. Therefore, we do not have to choose between seeing a space from outside –as an object– or seeing it from inside –as a void. Spaces can be created from the void, rather than from the mass. The void is the space defining element. Since the limits of a space are defined as the viewer moves, the limit between the moment of giving form to a space and the subsequent action of moving in it starts to blur.

With this system, a student can give form to space in two different ways: constructing a space from inside, and moving about in spaces already created by other students. In the first case, a space is the representation of a mental construct of the student who created it. In the second case, a student can grasp the form of an already created space or can give a new form to it by setting the plane of reference and determining the form of the motion (a linear or circular path; a vertical or horizontal direction).

This way, it becomes possible to supersede the separation between conceiving and perceiving a space. To conceive a space, it is not necessary to think of it as interlocking volumes seen from the outside. On the other hand, perceiving a space becomes a conscious act of creation. In order to give form to space, the user needs to set a plane of reference, in much the same way as it occurs when space is experienced through the body placed vertically on the ground. This means that a space created with IN-SPACE has no intrinsic orientation, but it is the viewer who furnishes a certain orientation to it. The same occurs as we contemplate the impossible world in Escher’s picture “Relativity”: to see a Euclidean world on it, an observer must choose one of the reference planes conveyed by the figures in the picture. Then the beholder can perceive –through the eyes of the selected figure– a Cartesian, although inconsistent, space.

Representing the structure of space

Spaces created with IN-SPACE are devoid or any narrative dimension. They do not provide a scenario for life, but are only pure geometric envelops. The film "Cube", directed by Vincenzo Natali in 1997, can help us to understand this. In this film, two concepts of space exist at the same time:

1. A purely geometric space, resulting from the continuous assembling and re-assembling of cubic cells.
2. A narrative space, that is, the life-space where the vicissitudes of the protagonists take place, a space supporting narration and story-telling.

Unlike spaces in the film, spaces created with IN_SPACE are pure geometric constructions. With IN-SPACE architecture students are confronted with different challenges: to give form to an inner void which exists with independence of an external mass, and to create spaces without scale and without function. Spaces are only conformed by abstract geometric elements devoid of architectural significance: there are no walls or columns to enclose a space, and no doors or windows that imply a scale. There are no events taking place in these pure abstract spaces. Unlike in the spaces that can be experienced in computer games, there are no avatars nor actions, no goals, and no rewards.

A space devoid of function, material, scale, body and events can only be aesthetically appreciated. As Schmarsow suggested, when we transcend the material and functional qualities of an architectural work then we are able to grasp the architectural idea, the spatial essence. This essence is not so much in space itself (e.g. its physical embodiment in a building, for example) as in the mental structure of the viewer. A space created with IN-SPACE stands for a pure spatial structure, a representation of a mental construct. In this regard, it can be thought of as an empty space which fulfils the same purpose as Malevich's white paintings: to activate the mental mechanisms of perception, so that an empty surface –or an empty space– conveys the "reproduction of a subjective state of mind" [15]. This way, architecture students can develop their capacities to imagine space (*Raumphantasie*, as Schmarsow had named it), in a manner which has no counterpart neither in spatial representations related to sensorial space nor in virtual environments like computer games.

Process to create and visualize a space

The construction of a space within IN-SPACE follows this sequence:

Step 1 - MODELING A SPACE

Modelling of a space begins with a cubic cell located at the center of a three-dimensional grid where the user is placed right from the start (Fig. 2). From this initial position, the user can extend the boundaries of the cell, projecting the inner faces of the cube outwards (and in the subsequent steps also inwards) along each one of the six possible directions of movement within the grid. To expand or contract the spatial envelope, it is enough to select the corresponding icon in the menu and then click on one of the faces of a cubic cell. As a result, the initial spatial cell grows along the selected direction the specified number of cells. Then, the viewer can move to another cell. From the new position, the same operation can be repeated to expand the space in any direction.

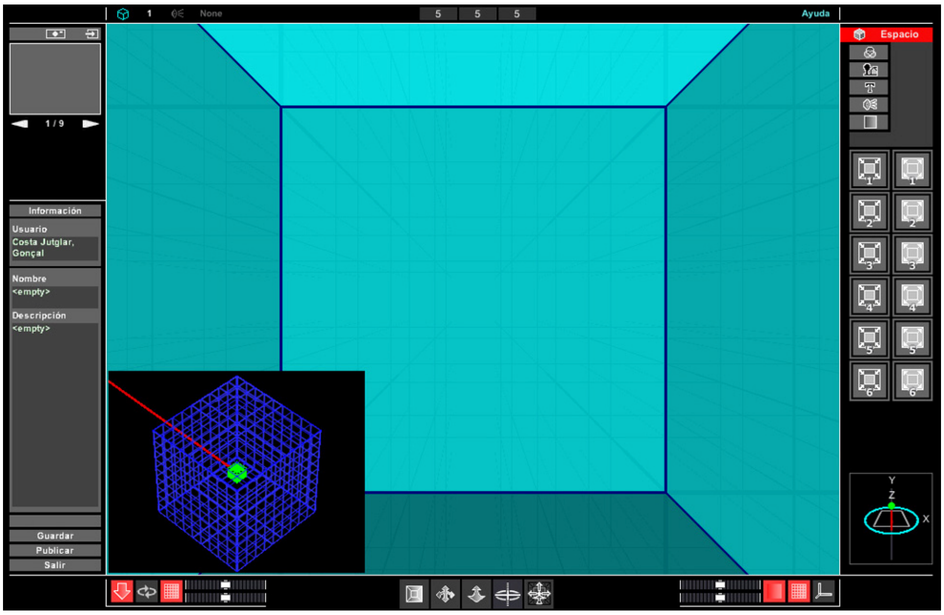

Fig. 2. Starting of the modelling process

Step 2 - CHARACTERIZING A SPACE

Spatial cells can be characterized with some attributes like color, images, texts, sound, and light. These are spatial elements, which add new dimensions to the purely geometric form [16]. For each one of these attributes there is a corresponding icon in a menu which is first selected and then assigned to a face in the cubic cell. Color, images and texts, are assigned separately to each one of the faces. Sound and light, on the other hand, are attributes of the space of the cell, rather than of the limiting faces. In any case, attributes can only be assigned to one cell at a time. It is not possible, for example, to change the color of all of the cells at once.

Step 3 - DESCRIBING A SPACE

After a space has been created –this means, the geometric envelope has been defined and the individual cells characterized– it is necessary to describe it: graphically, with a set of representative viewpoints; and textually, with a short description.

To describe a space graphically means to create a sequence of the most representative views. This way the author is required to illustrate the qualities of a space in a very simple format: an animation of nine frames. This short animation allows other students to take a quick look before deciding to explore it in depth.

The textual description consists of three fields: name of the user, name of the space, and a short explanation of the characteristics of the space. In order to publish a space, the graphical and textual descriptions need to be completed first.

Once the space has been created and described, it can be published to make it accessible to other users in the web-based environment created specifically for this course.

Step 4 – EXPLORING A SPACE

Spaces created by students are published in the web-based environment called NETWORKING: SPACE, created expressly for the course (Fig. 3). In this environment all spaces are represented by an icon and a description. The icon can be animated showing the sequence of nine frames. If a student wants to see the space, it is enough to click the icon to open the application IN-SPACE with the selected space loaded. In this situation, the user can navigate in the space created by another student in the same application used to create it.

However, a space created by another student cannot be modified in the current implementation of the system.

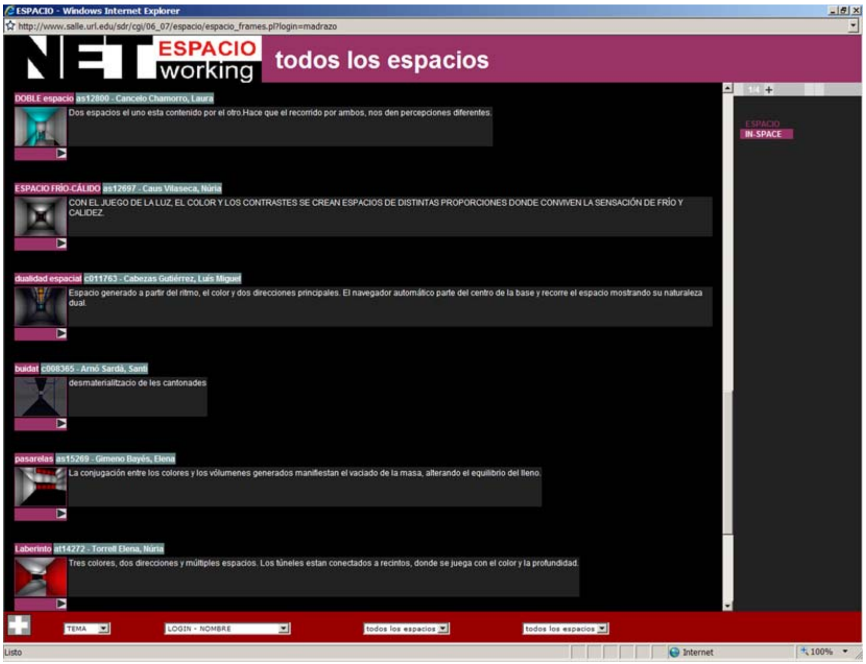

Fig. 3. Web-based learning environment of the course Systems of Representation

Thanks to the carefully designed user-friendly interfaces students can start to create a space within the first hour of working with the program. No special training is required. The exercises shown in this paper have been done in two to three sessions, that is, four to six hours of work (Fig. 4, Fig. 5).

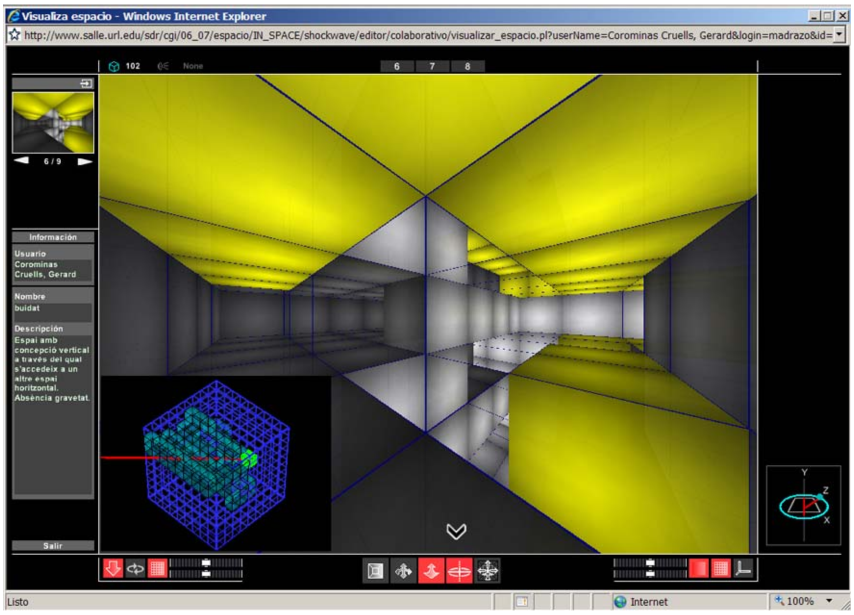

Fig. 4. Exercise by Gerard Corominas, course 06/07

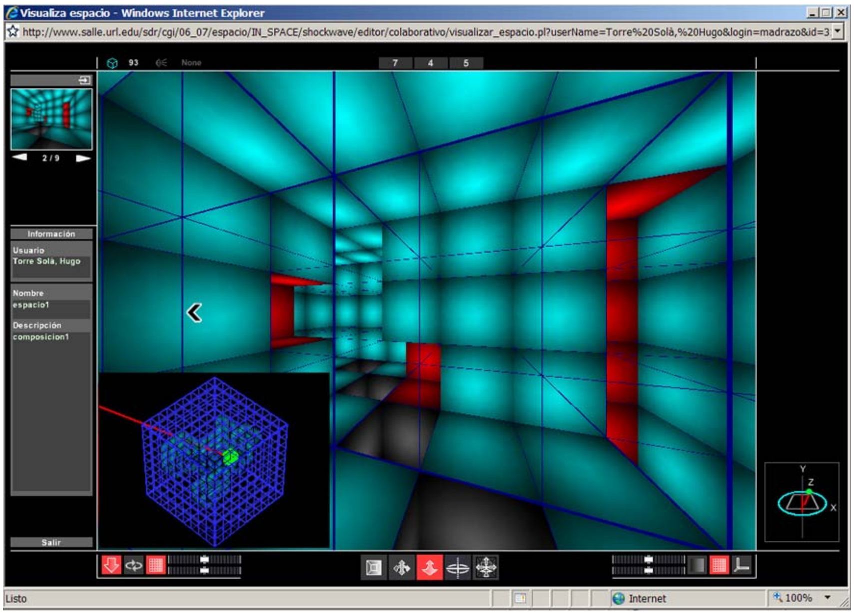

Fig. 5. Exercise by Hugo Torre, course 06/07

Evaluation and future enhancements of the tool

IN-SPACE has been used since the academic year 2004/05 within the course Systems of Representation. Students have appreciated the capacity of the tool to make space the focus of the form-giving process. They have also evaluated positively the easiness of creating complex spatial envelopes in an intuitive manner. Even though the level of functionality of the environment is satisfactory, there are still enhancements to be done. For instance, it would be better to move the position of the viewer directly with the mouse, avoiding having to click on an icon to first choose the direction of the movement. Similarly, the expansion and contraction of the spatial envelope could be improved avoiding the previous selection of the action in the menu. Also, there could be global editing operations to change the attributes of all the cells at once, instead of changing them individually. This way it would be possible, for instance, to change the color of all the inner faces with a single action. In the absence of such tool, it would also be useful to copy and paste attributes from one to another cell. Finally, the possibility of modifying the space created by another user would facilitate creating variations of the same space, in collaboration.

Conclusions

With IN-SPACE we have created a learning environment that enables us to focus on the abstract qualities of space. Spaces created with this tool could be considered to be non-architectural, in so far as function, material, body and scale have not been taken into consideration in their design. On the other hand, they can be seen as architectural if we take them as mental constructs, as the outcome of exercising our capacity to structure space; a capacity which, incidentally, is decisive both for the conception and the perception of architecture. From this point of view, we can contend that the computer system –in conjunction with the theoretical background provided in the lectures– has fulfilled the pedagogic purpose of enhancing the capacity of architectural students to understand space.

Acknowledgements

IN-SPACE has been created within the research group ARC from Enginyeria i Arquitectura La Salle (www.salle.url.edu/arc) during the period 2003-2005. It has been programmed by Gonçal Costa, Technical Engineer in Multimedia, using Macromedia Director. We would like to thank

the students who have used the tool in the last three years, for the excellent results they have achieved with it. The tool can be freely accessed at www.salle.url.edu/arc/IN_SPACE.

References

1. Heidegger, M.// Sein und Zeit, Tübingen, Max Niemeyer Verlag, 2001, p. 111.

2. Krogh Jensen, M.// Mapping Virtual Materiality, in P. Weibel (ed.) Olafur Eliasson: Surroundings Surrounded. Essays on Space and Science, Cambridge and London, MIT Press, 2002, pp.302-312.

3. Merleau-Ponty, M.// Phénoménologie de la perception, Paris, Éditions Gallimard, 1945.

4. Moles, A./ É. Rohmer// Psychologie de l'espace, Tournai, Casterman, 1972, p.10.

5. Schmarsow, A.// Das Wesen der architektonischen Schöpfung, in F. Neumeyer, Quellentexte zur Architekturtheorie, Munich, Berlin, London and New York, Prestel Verlag, 2002, pp. 319-333.

6. Frey, D.// Grundlegung zu einer vergleichenden Kunstwissenschaft, Innsbruck and Wien, Margarete Friedrich Rohrer Verlag, 1949, p. 6.

7. Frankl, P.// Principles of Art History. The Four Phases of Architectural Style, 1420-1900, Cambridge, MIT Press, 1968, p. 142.

8. Ching, F. D. K.// Architecture: form, space and order, New York, Van Nostrand Reinhold, 1979.

9. Tschumi, B.// The Manhattan transcripts London and New York, Academy Editions, 1981.

10. Franck, K. A.// “When I Enter Virtual Reality, What Body Will I Leave Behind?, Architectural Design, in Neil Spiller (ed.), Cyber_Reader. Critical writings for the digital era, New York, Phaidon Press, 2002, p.240.

11. Mitchell, W.// E-topia. Urban Life, Jim-But Not As We Know It, Cambridge, MIT Press, 1999, pp. 31-32.

12. Madrazo, L.//. Systems of representation: a pedagogical model for design education in the information age. Digital Creativity, Vol. 17, No. 2, pp. 73-90.

13. Madrazo, L./ F. Duran// NETWORKING:SPACE, multiple space representations in a web-based learning environment, proceedings of CADE, Computers in Art and Design Education Conference, Glasgow, 2001.

14. Arnheim, R.//The Dynamics of Architectural Form, Berkeley, Los Angeles and London,University of California Press, 1977.

15. Malevich, K. / The Non-Objective World. The Manifesto of Suprematism, New York, Dover Publications, 2003.

16. Porter, T./ The Architect’s Eye. Visualization and depiction of space in architecture, London, E&FN Spon, 1997.