NETWORKING: a web environment for a collaborative education

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Abstract

NETWORKING is a teaching environment developed in close connection with the course “Sistemas de Representación”, which has been carried out for the first time at the E.T.S. d’Arquitectura La Salle, Barcelona, in the academic year 1999/00. It is a web-based environment that promotes the exchange of ideas among students and their capacity to work collaboratively. There is a customized NETWORKING environment for each one of the six themes that made up the course: text, shape, object, image, space and light. In this paper we will discuss two of the six environments: OBJECT and SPACE.

1. Computer networks and collaborative work

At first, working collaboratively through computer networks was limited to sending data back and forth between remote places. The technological aspect (e.g. the possibility to transfer data among computers) was the most important issue then. In a second stage of development, the focus has been put on the possibility to develop new forms of teaching using computer networks (e.g. computer supported collaborative learning). Issues like interface design and knowledge representation have become now central to the discussion. Further development of computer-supported collaborative learning leads necessarily to the creation of new pedagogic methods and, ultimately, to a reconsideration of the whole notion of education.

1.1. Networking

NETWORKING is used in the teaching of the third year course named “Sistemas de Representación”. The course is structured in six themes, each one provides a distinct view of the notion of representation: text, shape, object, image, space and light.

The philosophy of the course responds to the spirit of the web. As the web, the
conceptual framework of the course is built up of relationships between diverse items. In the course, the items are issues taken from different disciplines (fundamentally architecture, but also painting, aesthetics, psychology, philosophy and computing) whose common denominator is the notion of Representation. The relationships, more than the issues themselves, built up the theoretical content of the course. The theoretical classes are dedicated to propose connections between the different issues, as observed from the conceptual viewpoint of a particular discipline.

In accordance with the nature of the web, the exercises are carried out in a collaborative manner. Typically, the collaborative work begins after the students have carried out the individual work. There are cases, though, in which an exercise is developed collectively right from the start.

1.1.1. Technology vs. pedagogy
With NETWORKING a student can submit the exercise from any workstation connected to Internet, inside or outside the University. All data is managed through a relational database, installed in an Apache server. The whole system is based on CGI scripts written in Perl5, and the interfaces are created with a mixed of Dynamic HTML, Java, JavaScript and VRML.

From the point of view of the pedagogical method, the distinction between a system that is integrated in a traditional class model, and a system which is meant to be a substitute of it (as in distance learning) is a crucial one. Even though the environment we have created can be used outside the classroom, we are not using it as a substitute of the traditional class. Rather, it is a complement to it. The traditional class (e.g. meaning lectures, individualized critiques, class presentations, with physical presence of students and teachers) is still our pedagogic model. However, NETWORKING adds a new dimension to it, by representing the collective work of a class in a way that encourages interaction and exchange of ideas.

Regarding the application of computers to education, we must distinguish between what it is technologically possible and what is pedagogically meaningful. Not every technical advance brings about a corresponding advance in the pedagogic method. Often, technical progress does not lead automatically to pedagogic improvements. For technology to make a qualitative change in education, it has to be part of a comprehensive conceptual framework. Building up that framework, represents the greatest intellectual challenge for educators in the information age.

2. NETWORKING: OBJECT, SPACE

In this paper, we will focus on two of the six NETWORKING environments used in the course: OBJECT, and SPACE. The theme OBJECT deals with the creation of three dimensional objects. Formal languages, transformations rules and design processes are the main issues addressed in lectures and exercises. The different
notions of SPACE (geometric, philosophical, perceptual, pictorial...) are discussed in this theme.

2.1. NETWORKING: OBJECT
The theme OBJECT deals with the creation of three-dimensional objects according to three distinct formal languages: the line, the plane and the solid. There is one exercise for each formal language. The exercises on OBJECT:LINE and OBJECT:PLANE are done individually and collaboratively. The exercise OBJECT:SOLID is done only collaboratively.

With the individual exercises on OBJECT we want students to develop basic design skills to conceive and perceive three-dimensional form. With the group exercises, we want them to develop their capacity to understand the inner structure and design potential of the objects created by others. Altogether, the exercises are designed to develop a student’s understanding of the form of an object and of the design process.

2.1.1. NETWORKING: LINE, PLANE, individual exercises
In the individual exercise OBJECT:LINE students created an object connecting lines in 3d space. Lines can be rectilinear or curvilinear; they can give rise to well-defined volumes, or they can be freely arranged in space; they can be conceived as rigid elements, as if they were part of an structural frame; or they can be flexible lines, continuously changing their forms under the influence of forces.

In the exercise OBJECT: PLANE, each student created a system of planes which brings about different spatial configurations. The exercise was presented with static views and with animations. The potential of the formal system to create different objects unfolded in the animation.

The exercises were done with 3d computer modelers (mostly AutoCAD and 3dStudio) and with physical models.

2.1.2 . NETWORKING: LINE, PLANE: group exercises
The individual exercises were submitted to NETWORKING. Typically the exercise is represented in the system by an icon, the title of the exercise, a short description, and a list of attached concepts. Other information which is submitted is the geometric model (.dwg or .3ds), views (.gif, .jpeg) and animations (.avi). (Figure 1)

The individual exercises can then be viewed according to different categories. For example, by theme (line, plane), by exercise title, by author and by concept.

Once the individual work was in the system, we asked students to perform a series of collaborative works on the exercises of their choice:

1. adding views. The student downloads the model of an object created by another student and then creates new views which represent the essential qualities of the object, according to her perception. Basically, we wanted students to explain with the views how they understand someone else's object. With this exercise, a student develops the capacity to understand form. (Figure 2)

2. adding concepts. Each student submitted the individual exercise with a
Figure 1: NETWORKING OBJECT. Representation of the exercises. Clicking on the icon opens up a viewer, which shows all of the views of the object.

Figure 2: NETWORKING: OBJECT [LINE, PLANE]. Interface to add views to an existing object. If a view has been added by a third student, her name appears at the bottom. The arrows located at the foot of the object icon are used to upload and download files. Under the header ‘objetos relacionados’ (related objects) appear all other objects related to it (see Figure 4).
series of attached concepts. The student defined the meaning of those terms in relation to her work. As a result, a vocabulary of critical terms was collectively created by the class. Then, we asked students to establish new relationships between the list of concepts and all of the works. Through this exercise, students are able to develop their associative skills, both at the visual and textual level (Figure 3).

3. grouping objects. From all the submitted works, each student made one or more groups with objects which shared some attribute, according to the student’s interpretation. With this exercise we want students to develop their perceptual skills, mostly at the visual level. (Figure 4)

2.1.3. NETWORKING: SOLID
Unlike the exercises on the languages LINE and PLANE, the exercise on the formal language SOLID was done exclusively in a collaborative fashion. The purpose of the work was to come up with different development processes of an object. The exercise was carried out in the following way. The forty-student class was divided into four groups of ten. Four different objects started to be developed at once, each one represented by a color. Each group of students was given 2-3 days to carry out one stage of development of the object. After finishing one stage, a group would move to another object (Figure 5). The whole process would end in the fourth stage. This way, at the end of the process each student would have participated in the development of the four objects.

Before starting with the development process, the class created a set of transformation rules that would later be applied to the transformation process (Figure 6). Then each student would choose one or more rules of the vocabulary to be applied in the first stage of development, represented by a cube. For the second stage, students were asked to choose the object that was most appealing to them, to describe its gestalt with a written text, and to apply another transformation that was coherent with the perceived form.

The next two stages proceeded in a similar fashion, giving rise to a tree structure (Figure 7). However, as the process went on, new issues were coming into play that would influence the development of the forms. Whereas at the beginning of the process the set of rules was fundamental to the form development. Later on, other issues, like narratives and its aesthetic qualities of the object (color, proportion, gestalt) became the most influential factors driving the development of the object.

Through this exercise, the processes, as opposed to the objects themselves, became the focus of debate in the class. After every stage, a critical review was held in the class to reflect upon the abstract process that was taking shape. Trying to answer the question ‘what happened to the object?’ helped to bring across the nature of the transformation process. Once these characteristics of the process were made clear to the class, we could move to the next stage of development.

2.1.4. Reflections on the exercise
This sort of collaborative design done on the web has contributed greatly to the
Figure 3: NETWORKING: OBJECT [LINE, PLANE]. Interface to assign a keyword of the existing vocabulary to an object. The list of available concepts appears in the left column. The main window shows the various definitions of each concept, as formulated by students. If none of the existing definitions fits the object, it is possible to add a new one.

Figure 4: NETWORKING: OBJECT [LINE, PLANE]. Interface to group objects that share some attributes, according to the student’s perception. To create a group it is enough to drag the icons to the lower frame. A description of the common attributes is introduced afterwards. The relationship established in this way is reflected in the view per object (see Figure 2).
Figure 5: NETWORKING: OBJECT [SOLID]. Diagram of the process of collective development of a solid object in four stages.

Figure 6: NETWORKING: OBJECT [SOLID]. First stage of the development process of OBJECT#3. Before starting the process, a set of transformation rules has been collectively created by all students. Then, students choose one or more rules and apply them to the original cube.
Figure 7: NETWORKING OBJECT [SOLID]. Third stage of development of OBJECT #3. Objects 1, 2, and 4 were being developed in parallel. To visualize the development, one must select the corresponding button in the lower frame.

Figure 8: NETWORKING OBJECT [SOLID]. Retrospective view of the object’s development. At every stage in the process, one can trace back the development of the object in the process viewer. This shows in the lower part the path of evolution of the object. Placing the mouse over the icon one can see the enlarged image of the object and its precedent. The stages appear sequentially in pairs in the central part of the window. This way, it is possible to compare the shapes of the objects as well as the narrative of the development process.
group dynamics. It has made students more interested in the work of their peers and it has stimulated the exchange of opinions. For this to occur, however, the web environment has to be understood as a supporting medium which brings another level of interaction (and abstraction) to the traditional education, rather than as substitute for it.

Interface design is a critical issue in making this sort of work appealing and effective. In this regard, it was important to have the tree structure showing the development process of the four objects in real time. Also, it was important to provide an interface that would show the whole thread of the development stages of the object at a given moment (Figure 8). This way, it was possible to check the consistency of the development process, both from the point of view of the form and the narrative.

2.2. NETWORKING: SPACE

In the theme SPACE, we discussed the notions of space proposed from different fields (architecture, philosophy, painting, perception, information,....). In the individual exercises we first focused on bodily perception of and its representation by means of a cognitive map. Then, students created a space unit, and then made different abstractions of the perception of that space on the computer, using texts, images and animations. These units were then combined into spatial sequences, working collaboratively with the environment NETWORKING.

2.2.1. NETWORKING SPACE: individual exercise

The individual exercise consisted of two parts: 1. explanation of a spatial experience with a cognitive map; and 2. design of a spatial unit on the computer.

**Cognitive maps**

As an introduction to the representation of space in the computer, we first asked students to explain their personal experience of a space by means of a cognitive map. The representation should not rely on established conventions to depict space, like plan or section, nor should it adhere to established graphic languages. Rather, students had to propose a representation and a graphic language of their own, to explain their experience of space. (Figure 9, 10).

**Creating a spatial unit**

The next individual task took place on the computer. It consisted of the creation a spatial unit (limited to a cubic volume), which was then described according to three different dimensions:

1. geometric. A geometric description of a space, understood as an object (e.g. dividing planes, objects place in rooms, enclosing boundaries, openings).
2. perceptual. A description of the sensations that an spectator (e.g. the virtual camera that moves through the computer model) receives from the space (whether there is a feeling of being enclosed, a desire to move from one
Figure 9: Cognitive map of the Jewish Museum in Berlin. Marçal Dasquens Tapia. SDR 99/00.

Figure 10: Cognitive map of the dome of the Reichstag, in Berlin. Esther Díaz Salas. SDR 99/00.

Figure 11: NETWORKING: SPACE. Representation of a spatial unit. The three text areas that contain the description of the space (geometric, perceptual, narrative) are identified with a color. Clicking on the icon opens up the VRML window, while the .avi animation starts after clicking on the corresponding label, above the icon.
room to another, disorientation,.....).  

3. narrative. An association between the space and a literary text (taken from a novel or poem, or written by the student herself) and an image.

The perceptual dimension of the space was expressed through an animation. The virtual camera that moves through the space became an abstraction of the bodily perception. It could express the anxiety of being enclosed; the tension of reaching a goal; or the curiosity to explore the limits of the space. The animations were done in two different formats: .avi and .wrl. (Figure 11)

2.2.2. NETWORKING SPACE: group exercises

After the spatial cells and their three-level descriptions had been submitted to the system, it began the group exercises. Basically, they were three:

A. Perceiving someone else’s spaces: seeing the space created by other student, and recording the animation path.

B. Creating spatial relations: connecting spatial units that have some relationship in any of the three spatial dimensions considered (geometric, perceptual, narrative).

C. Constructing spatial narratives: connecting spaces along a narrative path, according to the relationships previously established.

Perceiving someone else’s spaces.

In much the same way as it was done in the theme OBJECT, we asked students to take an exercise of their choice and add a new view to the space. The view, this time, was not static but animated. The animation should convey their experience of that space, which might differ from the one from the student who designed it. (Figure 12)

Creating spatial relationships

Spatial units were assembled in sequences, each one created collaboratively by students. Each sequence was made up of spatial units that shared some relationship with the adjacent one, according to the student's perception. Adjacent units could be related at three different levels: geometric, perceptual and narrative. The construction of the sequence was carried out with a NETWORKING environment based on VRML (Figure 13). The whole class, divided into groups, participated in the construction of each spatial sequence. Each group dealt with a sequence at a given time. After adding spatial units in one sequence, a group moved to the next one, in much the same way as in the OBJECT:SOLID exercise.

Constructing spatial narratives

Through the construction of the 3d models, a many-to-many relationship among all spatial units was created. Based upon those relationships, multiple spatial narratives could be created moving through the network of connected spaces. The environment to create the narrative shows two spaces simultaneously in the two
Figure 12: NETWORKING: SPACE. This viewing mode allows to perceive a space through all different cameras that the students have attached to it. This way, one can perceive the same space 'through the eyes of different persons'. Each view of the space is explained with a text that appears in the lower part of the window.

Figure 13: NETWORKING: SPACE. View of one of the sequences of spatial units, constructed in collaboration by several students. The units are assembled directly in 3d space, in a special environment programmed with VRML. Each axis of coordinates corresponds to one of the three levels of definition of a spatial unit (geometric, perceptual, narrative).
central windows (Figure 14). On the left and right sides, there are the icons of those spaces that hold some sort of relation with the two displayed ones. Selecting an icon on the left or right sides allows one to move within the network of relations. Thus, the selected space appears in the corresponding central window while and the list of associated spaces is renewed.

3. Conclusions

With NETWORKING, we have adopted a hybrid pedagogic model that combines the traditional classroom concept (lectures, reviews, ...) with an Internet-based collaborative system. To assess the validity of the pedagogic model, therefore, we should consider separately:

A. the collaborative system itself
B. the connections between traditional model and the collaborative system

The collaborative system

The application of collaborative learning systems into education raises a whole new range of issues, whose pedagogic implications still need to be understood. Representing an exercise on the net, for instance, asks for new forms of expression and communication suited to that medium. For example, purposeful use of words as labels and concepts; concise descriptions of the exercise content;
and expressive visual depiction of objects, characterize the works represented in the net. Concision and clarity, expressiveness and intelligibility, both are the textual and visual levels, seems to be the conditions that the media demands in this regard. The interaction that takes place in the information space also demands specific modes of representation and communication. User interfaces should be designed as to facilitate seeing and understanding the collective work. They should be reliable and intuitive. Through their use, a student must gain a new understanding which is specific to the media.

**Connections between traditional models and collaborative systems**

In the hybrid approach we have adopted, we do not see a collaborative system as a replacement of the traditional class, but rather as an added value to it. In this context, it is the responsibility of educators to forge links between the two conceptual spaces: the space of the classroom and the space of the collaborative system. This can be achieved, for example, discussing the development of the collaborative work in the classroom. Educators in the information age, therefore, must play simultaneously to roles: 1. as outsider, being the guide of students in the process of acquiring knowledge; 2. as insider, being one more active learner, together with students.

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