SPATIAL SIMULATION IN ARCHITECTURE, CITY DEVELOPMENT AND REGIONAL PLANNING

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1. Faculty of Regional Planning & Architecture

Two study programs are offered within the Faculty of Regional Planning & Architecture: Architecture (5 years) and Urban/Regional Planning (5 years). Approx. 4400 students are enrolled in both programs (4000 in Architecture, 400 in Urban/Regional Planning); approx. 700 students enroll each year in Architecture and about 120 in Urban/Regional Planning. The studies in the faculty are organized for both study programs by about 130 academic teachers in 15 institutes and 2 departments. The teacher/student ratio is about 1/36, the average duration of studies about 8.5 years, the percentage of students finishing within prescribed time is close to zero. After a 2-year program of basic studies, students take 3 years of advanced studies. The "Diplom-Ingenieur"-Degree - equivalent to the M.A. - can be obtained after a minimum of five years' study. A "Dr.techn." Degree-program - equivalent to the Ph.D. - is furthermore offered.

Three basic one-year projects (development-planning for built-up areas, city and community development focusing on master planning and zoning, planning at the regional level) form the core of the curriculum "Urban and Regional Planning". architectural Design Projects (Housing, Building Typology, Interior Design, Town Planning, Construction Technology) represent the main subject in the curriculum "Architecture". At least three projects for each half a year and two projects for one year have to successfully be completed. Project work is accompanied by lectures and courses as offered by participating departments resp., institutes. Formal, social and regional sciences are well balanced with engineering and design, educational inputs relating the necessities of practical work. In the winter-semester 1992/93 a new curriculum for studies in Urban & Regional Planning is offered; a new curriculum for studies in Architecture will probably he available by 1993/94~

The joint electronic data processing-facilities of the departments and institutes represent a great enhancement for the "Faculty of Regional Planning & Architecture" and have proved very useful to the students. The system of free exercise time exceeding the actual amount of hours required for this exercise works excellently in practice. Integration into university work is presently being dealt with very intensively. At the same time the reform efforts regarding architectural education al the Austrian universities are in process. Due to new legislation both study programs (Architecture and Urban/Regional Planning) are being reorganized, e.g. stressing computer aided instruction-techniques (CAI). The new curriculum could thus furnish the possibility to completely integrate Computer Aided Architectural Design & City Development (CAAD-CACD) with all it has to offer, i.e. to react with an accordingly tailored educational subject. However, the basic structure of curricula offered so far will remain the same.

2. Didactic Aspects

Even though computer-aided spatial simulation-techniques and applications practically are the focussing point of the lectures and courses "Simulation of Architectural Spaces" and "CAD-EDP-Aided Spatial Planning" other simulation techniques are also used on account of didactic reasons. Thus a stereoscopic pair of pictures can be generated at the greatest ease with the computer and then can be examined stereoscopically. Drawing programs make for further processing and manipulating, resp., of video-endoscopic spatial pictures. This is to be regarded as the first *didactic approach.*

Working on a small design project represents the *second didactic approach.* First the participants are grouped into small teams, each of them designing or developing e.g. a spatial unit for a specific person or activity. At any time active participation within the team is called for. After the working model has been built together simulation techniques are applied. This way of procedure results from the firm belief that students then will be better able to find the limits and possibilities of an individual simulation technique.

The exercising classes "Simulation of Architectural Spaces", "CAD-EDP Aided Spatial Planning" and "Presentation Media for Planners" were first added to the curricula of Architecture and Urban/Regional Planning, Vienna University of Technology in the winter term of 1990/91 as an optional subject. We would like to briefly mention that the students' interest was quite remarkable at the beginning, even though often a great deal of improvisation was required. The exercise took place at two different laboratory sites, both of which were provisional at the beginning: the faculty's EDP-Lab and the Full-Scale Laboratory of the *Institut für Raumgestaltung* (Architectural Styling of Space) at the Vienna University of Technology concerning "Simulation of Architectural Spaces". The participants were requested to report on their experience at the end of project work.

3. **Spatial Simulation Techniques**

It is especially important for decision-makers, architects and planners, politicians and involved citizens to get a spatial idea of the future lay-out of buildings, the distribution and the functional fitting in of buildings like large-scale urban plannings in urban space, town- and landscape preceding their realization. In this context the formulation and discussion of planning variants are of great importance. Due to the complexity and variety of information-procedures the necessary problem- and measurement oriented information-process in the field of regional planning, city development and architecture can in the future only be achieved by integrating electronic data processing (EDP) and video simulation. The following spatial simulation techniques are put into use within the context of university education within the Faculty of Regional Planning & Architecture at the Vienna University of Technology:

Computer-aided spatial simulation and animation

The computer is acting as kind of "electronic drawing board". By means of various two- and three dimensional geometrical tools (lines, progressions, circles, triangles, extrusion specimens, etc.) the objects and plannings as described in the design are defined in the X,Y,Z,-system of coordinates. Already defined objects can be changed, multiplied or shifted as required; several representations from various stations with different angles of view do not result in additional input work. Sophisticated programs with photo-realistic rendering make for pictures hardly to be distinguished from real photographs. Animation is just being integrated into teaching.

We are working in the Apple Macintosh resp. DEC-station vicinity and to this end individual rooms in the EDP-Laboratory of the faculty are at our disposal. The major part of the participants to the mentioned classes have practically no computer experience concerning computer-aided spatial simulation techniques up to that point. Previous experience in the Apple-Room e.g. has, however, clearly shown that this does not mean that this project are doomed to fail. Due to the Apple Macintosh graphic user's surface it e.g. was possible to acquaint architecture or regional planning students with the main system functions within one morning session so that independent working - with assistance at regular intervals - became possible. On the other hand the DEC-station vicinity calls for previous experience and continuous assistance. As far as education is concerned the following software programs are being approved of:

Zoom is developed by the French company Abvent and can be characterized by its "user-optimized" operation. Up to four working windows can be activated simultaneously. *Zoom* allows for description of an entered object in four different modes: top view, elevation, side view and axonometric view, whereby the possibility for interactions between ground plan, side and front view exists. The available rendering possibilities are very promising, up to 128 sources of light and structured surfaces can be described. The available "Texture Mapping" enables projections of surface structures scanned or developed by means of a paint program to the surface of a flat object generated by "Zoom". The numerous interfaces (DXF, RIB-format for Showplace and Renderman, Archicad, Pict and Pics, etc.) are to be mentioned in this context.

As far as not extremely complex geometrical objects are concerned the ***Archicad***-program developed by the Hungarian company Graphisoft is used. Advanced users often use the possibility to define objects with the *Geometric Description Language*. Input in several interactive ground plan-windows and top view-windows is planned for the near future. What is of great interest are the representation possibilities offered, in particular in the 3D-section. This enables us to describe the object in the sectioned condition and to continue processing thereafter in a 2D-drawing.

GDS by EDS is a highly complex structured CAD- and planning-software with spatial database management tools and powerful GIS-features being used for complex plannings and constructions within urban and regional planning-education and research at the *Institut für örtliche Raumplanung*, running on DEC-stations.

The majority of students finds data-input very time-costly, as an exact input is necessary from the very beginning. Depending on the specific requirements (e.g. realistic material- and color effects) not only accordingly high investments are necessary, but also intensive initial training and constant confrontation and further education are inevitable. We, however, do not want to conceal from you that photo-realistic pictures calculated with shadow-casting and "antialiasing" (=smoothing the outlines of an object) take a calculation time of several hours depending on their complexity, data file and size of picture.

Paintbox-aided spatial simulation

Real images - imported by means of scanning, still-video or frame-grabbing - are combined with computer aided simulations. The modelled and possibly rendered descriptions can be retouched or improved by means of the program ***Photoshop*** so required. The implementation of this technique should be treated and developed with own values. This means that the potentials are powerful to achieve a result which is more as only a kind of finishing touch. Due to the lack in course-time unfortunately few experiences were made in the past so far.

Stereoscopic spatial simulation

This technique needs two exposures from one object which then can be viewed together. The necessity for two pictures is more or less self-explanatory when considering that two eyes are also required in the human process of sight. Two retina pictures are produced which merge to spatial vision. The procedure of stereoscopic pictures was transmitted to the students by very simple means. Theoretical backgrounds of stereo-photography are characterized by a certain degree of complexity. The students have to acquire a certain basic knowledge, in order to determine the basis-distance. Compared with "monophotography" the students agreed upon the fact that stereo-photography makes for an increase of spatial effect. Reproduction of spatial objects photographed this way turned out much more satisfactory as also applies to the remarkably good depth effect. Therefore stereoscopy was regarded as particularly well-suited for the documentation and description of building substance and not as an aid for designing regarding interactive work. What was interesting, however, is that stereo-photography can be accomplished without huge investments.

Holographic spatial simulation

This technique enables us to store spatial pictures while maintaining their three-dimensional quality. Holograms offer a new perspective when the angle of view is changed and back parts of the picture are more or less to be seen. The actual color- and material effect, however, is usually lost. This problem could be solved with the so-called *True Color Holography*. Holography as such seems mystically veiled which is not justified, even though the conditions on taking holographic pictures are completely different than those governing conventional photographic procedures. Analogously to stereoscopic simulation technique a certain basic knowledge has to be acquired in order to succeed in taking holographs. The Dutch Holographic Laboratory (DHL Eindhoven, The Netherlands) developed a so-called *Holotrack*,which is a recording setup for Multiple Photo Generated Holograms (MPGH) for this reason. Approx. 150 pictures are taken of a scene, according to a special geometry. This results, for example, in color slides with all the information needed to make a hologram. The conversion service of the film into the hologram could be done by a processing service (which is offered by DHL and others), as long as no installation for holography is available at the Vienna University of Technology. Of course those pictures could also be generated from a 3D-computer model with a special software-utility.

The experiencing of the holographic taking of exposures under traditional circumstances as well as the developing of the holographic plates in the dark room did not turn out to be very spectacular. And anyway the students themselves had acquired the least working experience with this technique. According to the student's opinion a hologram could act as the "model in one's port-folio": an economical way of storage with considerable information content. Even though it is possible to achieve a different view when changing the angle of view while looking at the hologram it was determined that a single exposure normally is not sufficient to get an impression of the object in its entirety. Doubtlessly, very impressing effects can be achieved using holography, such as the representation of spatial objects which seems optically to he leaving the focal plane. In this context, however, the question as to meaningfulness of such effects arises, whether this technique is to be used as an architect's tool in the course of design work.

(Video-) Endoscopic spatial simulation and animation

By means of an endoscope scaled-down models can be regarded in such a way that e.g. pictures from the perspective of a pedestrian result. The rigid endoscope is connected via an adapter with a CCD-video-camera, in order to furnish any picture sequences (movements) in addition to the still pictures. Contrary to computer-aided spatial simulation a video-endoscopic model picture is relatively easily arrived at according to the overall opening of the students. This even more so, as practically no initial training is required before presentable results are come up with. If a model exists this can be subjected to endoscopy without much effort. Only as for interior space some adjustments may become necessary in order to make it accessible to endoscopy. Even with models in a urban planning scale (l:500) a practically authentic description is achieved. We also approved of the fact that endoscopic pictures match the built reality more precisely than photographic pictures having been taken by wide angle- or by fisheye-lenses An endoscope (without peripheral equipment) proves sufficient for individual viewing. As soon as the spatial impressions are to be stored in some kind of a means it becomes more costly. The possibility to stroll through a project is fascinating. In order to be able to check the exact speed when doing this a machine-technical plant would become necessary which would drive the endoscope through the model at exactly the required speed and would simultaneously check the direction of view.

At several other universities and colleges experiences with endoscopy were already made in the sixties and seventies. Its missing popularity may result from the mediocre picture quality in transmission by the peripheral equipment. The CCD-camera-technology developed in the eighties has done away with such problems. Video-cameras with much more light-sensitivity and less sensitivity to sudden light-changes are now on the market.

Full-scale modelling

This technique is only being used in architectural education. Even though it is considerably more difficult to take the future surroundings into full account in a full-scale laboratory, the 1:1 model representation is able to acquaint you with the (interactive) effects of light, color and material or surface, resp. in architectural space. Many facilities, both on the inside and on the outside could be declared as a "full-scale laboratory". Dealing with in-situ experiments the main aim is to erect a (part-) model in full-scale, e.g. a section of a façade, and to examine its effect within its future spatial surrounding. This procedure may lead to further improvements which, if possible, are to be depicted directly in the 1:1 model. As soon as building construction is ready to commence the 1:1 model is removed. In situ-model work of this kind is rather of inferior importance, as constructional realization of the study projects are not intended within one's studies. But, so that not only "paper-architecture" is created during the studies, model work in full-scale in laboratory conditions could represent an alternative. Under such conditions the future situation is not taken into account in the simulation process and thus work in the laboratory is always dealing with different experiments. In practical work the presence of an appropriate basic equipment or the technical infrastructure has to be taken into consideration in this context, as too much working capacity would have to be applied for the erection of auxilliary constructions otherwise. Though a well-functioning laboratory can rely on sufficient pertinent experience of its staff, it often is the unfavorable economic relation between expenses, effort and usefullness that 1:1 models are so rarely built.

4. Future Perspectives

The appropriate use of spatial simulation techniques considerably tends to increase the depth of evidence and the realistic content of the design and plannings to be described and moreover may encourage experimentations, trial attempts and planning variants. This means also the more frequent use of combinations between different techniques, having in mind that they are not equivalent, but making use of the respective advantages each offers. Until now the main attention of the EDP-Lab was directed on achieving quantity. For the time to come time it will be the formation of quality. The challenge in the educational system at the Vienna University of Technology is to obtain appropriate results in the frame-work of low-cost simulation. This aspect seems also to be meaningful in order to enforce the final implementation in architectural practice.