MULTIMEDIA FOR ENVIRONMENTAL SIMULATION

Peter Dosti, Helena Linzer, Bob Martens, Andreas Voigt (*)

Vienna University of Technology, Kadsplatz 13, A-1040 Vienna,
Tel.: ++ 43-1-58801 / ext. 4330; ext. 3286
Fax.: ++43-1-5044187

dosti@erpds1.tuwien.ac.at
linzer@erpds1.tuwien.ac.at
bmartens@email.tuwien.ac.at
voigt@erpds1.tuwien.ac.at

(*)
Dipl.-Ing. Peter Dosti, lecturer on "Presentation-media for Planners" and "Multi-Media", university associate at Institut für Örtliche Raumplanung, Vienna University of Technology.

Dipl.-Ing. Helena Linzer, lecturer on "City Development and Urban Renewal", university associate at Institut für Örtliche Raumplanung, Vienna University of Technology.

Dipl.-Ing.Dr.techn. Bob Martens, lecturer on "Simulation of Architectural Spaces", university associate at Institut für Raumgestaltung, Vienna University of Technology.

Dipl.-Ing. Andreas Voigt, lecturer on "CAD-EDP-aided Spatial Planning and Spatial Information Systems", university associate at Institut für Örtliche Raumplanung, Vienna University of Technology.

ABSTRACT

MULTIMEDIA FOR ENVIRONMENTAL SIMULATION
framework of research

Nature as complete entity having existed before us, having produced us, of which we are a part of and which reaches far beyond us and our knowledge stands both for productivity and product, for stones, earth, water, air, plants, animals, human beings, for energy as such. On account of his activity and his intellectual powers and faculties the human being represents the center of this interrelation comprising his vital space, being perceived by him either consciously or unconsciously, the structure and formation of which he changes, which in turn, however, significantly codetermines his behavior and also his development.

Spatial effect analysis and spatial impact analysis take the cross-linked interrelations of nature into account and thus the correlated diverse interactions by means of integral representation, determine the direct and indirect as well as the immediate and mediate decisions as to space and furnish us with decision-conclusions by means of modifications. Based on the all-in-all outlook encompassing nature-mankind-space spatial impact also means in particular compatibility within systems giving due regard to the factor time.
The following topics are treated within the framework of research:

1. Elaboration of a methodical framework regarding research and development in the field of multimedia-implementation for environmental planning.
2. Preparative work concerning implementation areas of multimedia focussing on urban & regional planning and architecture.
3. Planning process and planning levels, furthermore in the fields of information and decision process and accompanying verification.
4. Optimizing interaction of multimedia and environmental simulation.
5. Definition of research- and development-requirements as far as subject-specific and EDP-technical aspects are concerned.
6. Structurizing of projects regarding realization of framework of research.

MULTIMEDIA FOR ENVIRONMENTAL SIMULATION

1. DETERMINING DECISIONS REGARDING SPATIAL IMPACT ANALYSIS

Nature as complete entity having existed before us, having produced us, of which we are a part of and which reaches far beyond us and our knowledge stands both for productivity and product, for stones, earth, water, air, plants, animals, human beings, for energy as such. On account of his activity and his intellectual powers and faculties the human being represents the center of this interrelation comprising his vital space, being perceived by him either consciously or unconsciously, the structure and formation of which he changes, which in turn, however, significantly codetermines his behavior and also his development.

Space represents the three-dimensional context framework for inanimate and animate organisms, for man, animal and plant, and as far as perception is concerned it is to be considered as space for individuality, for touching and smelling, for hearing and sight, for motion, it is physical and psychic space, is objective and subjective, is the positive- and negative form of the very same entirety, is the base and referential means for all human activities, vital requirements and functions of existence, for orientation, security, acquisition, identity and individuality, stimulus, communication, interaction and proximity, public and private, beauty, well-being and cosiness, for living, working and recreation. Space and time make up the interrelation- and action framework for existence as such.

A. potential
B. function
C. possible uses

Space potentials describe system functions and possibilities of utilization based on specific criteria, they enable a determination of interaction resulting between utilization, project and system and serve as a basis for decision making regarding assessment of spatial impact.

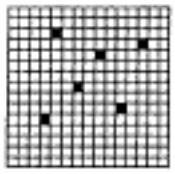
Spatial effect analysis and spatial impact analysis take the cross-linked interrelations of nature into account and thus the correlated diverse interactions by means of integral representation, determine the direct and indirect as well as the immediate and mediate decisions as to space and furnish us with decision-conclusions by means of modifications. Based on the all-in-all outlook encompassing nature-mankind-space spatial impact also means in particular compatibility within systems giving due regard to the factor time.

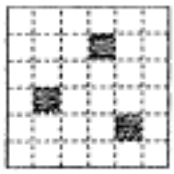
2. SPATIAL IMPACT ANALYSIS FOR ENVIRONMENTAL SIMULATION

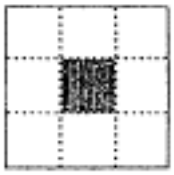
The following tables shall illustrate the most significant principle statements on the present methodical concept regarding spatial impact analysis.

Comparison of Spatial Impact Analysis (SIA)- Types [1]

This comparative enumeration of spatial impact analysis types demonstrates the differences of the various forms and types of a spatial impact analysis selected by means of itemizing essential decisive elements.







	Process-SIA	Site-SIA	Project-SIA
Level	province, region	region, Municipality	municipality
Decision-maker	federal-, province-government	province-government, municipality	municipality
Aim of SIA, depth of findings	sitings and identification of areas for specific purposes	selection of best site for specific purpose	analysis of a predetermined site
Number of sites to be analyzed	several, number not specified	several, number specified	one site, specified project
Preceding analyses		process-SIA	process- and site SIA

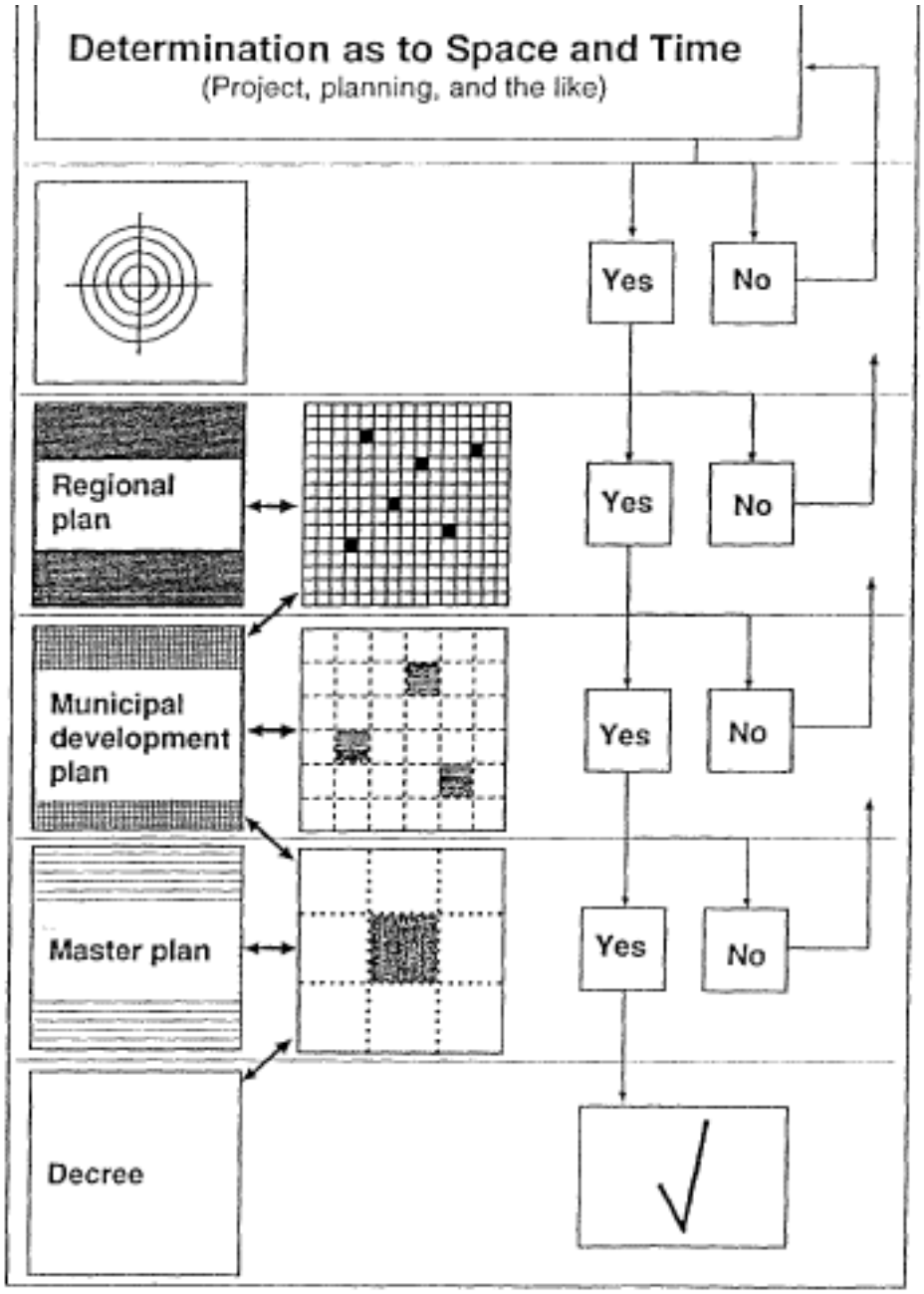
_____

[1] *copyright*: Vienna University of Technology, Institut für Örtliche Raumplanung: Frei, Linzer, Moser, Voigt, Walchhofer; on behalf of the Municipal Authornies of the City of Vienna, Municipal Department 22 - Environmental Protection

3. SPATIAL IMPACT ANALYSIS IN ENVIRONMENTAL PLANNING

Decision Structure and Flow Chart

Picture:
Phase-flow and decision chart of SIA [2]



_____

[2] copyright Vienna University of Technology, Institut für Örtliche Raumplanung: Frei, Linzer, Moser, Voigt, Walchhofer; on behalf of the Municipal Authorities of the City of Vienna, Municipal Department 22 - Environmental Protection.

The ideal-typical diagram both of decision-finding and flow of a SIA shows the interaction between "conventional" instruments of urban & regional planning - starting with the most fundamental conception, to the federal,- provincial- and regional planning, from municipal development plan by means of zoning- and master planning up to the individual-binding decree on the one hand, and the described types of SIA and possible paths through the decision-chart on the other hand.

The present Methodical Concept Regarding Spatial Impact Analysis" is aimed at contributing to an improved featuring of our vital space as well as to a lasting protection concerning our common living essence by enhancing quality and transparency in planning, creation of variants, determining decisions and public relation.

4. NEW DIMENSIONS IN REGIONAL PLANNING AND ARCHITECTURE [3] "EXPERIENCE OF SPACE"

Challenges for modern urban&regional planning are diverse: coordination of the various demands of society towards space (property development, agriculture, recreation, traffic and energy), coordination between individual planning departments (federal and local governments) as well as other participants in the planning process, establishment of transparent decision finding conditions, evaluation of spatial impacts and effects of plannings, development of planning variants, identification of citizens with spatial plannings represent just a small selection thereof.

COMPUTER AIDED SPATIAL SIMULATION IN ENVIRONMENTAL SIMULATION

Nowadays it seems especially important for decision-makers, architects, planners and involved citizens to get a spatial idea of the future lay-out, distribution and the functional fitting-in of buildings like large-scale planning projects in city, town and landscape preceding their realization. Taking this into account planning variants created by means of Computer Aided Architectural Design & City Development (CAAD-CACD) are of great importance. By using three-dimensional simulation techniques a more or less effective "Virtual Reality" can be created.

_____

[3] *copyright*: Dosti, P., Frei, W.D., Linzer, H., Moser, F., Voigt, A. Vienna, 1993

CACD - New Dimensions for City [4]

"Computer aided city development - CACD" is designed as modular, computer aided city development tool for the said applications integrating the application of electronic media into the field of regional planning, city development as well as into urban design in an optimum way.

The decisive factor is the possibility of a multidimensional representation of spatial related problems.

Depending on the field of application CACD - apart from a two-dimensional representation - makes for primarily a three-dimensional representation possible through the incorporation of spatial perception as well as a four-dimensional representation of information and data levels through the integration of movement in space (=time). MULTIMEDIA SYSTEMS internet different data streams such as texts, graphics, pictures, video and audio within a single system in order to optimize presentation and public relations.

The following fields of application for CACD are differentiated:

1. information and documentation process
2. planning process
3. optimized decision finding process and public relations

5. INTERACTIVE MULTIMEDIA SYSTEMS - Introduction

Implementation of interactive multimedia instruments has been constantly encouraged ever since the seventies. As with all technical innovations the commercially feasible usage thereof only set in many years later. On the one hand this is due to the high costs of hardware and on the other hand also due to strategic considerations of multimedia companies and the resulting development of software. And more than twenty years later advancements and improvements of these systems take place at a breath-taking pace, just as it occurred in the home video and audio business at the beginning of the eighties.

The requirements of those concerned of planning, of politicians and of inhabitants regarding comprehensive and easily comprehensible information of planning considerations exceed the conventional possibilities of information transmission. The question as to acceptance of innovative planning instruments only arises to the extent that following criteria have to be met:

- elimination of inconsistency of representation methods regarding
- substance and design

_____

[4]*copyright*: Institut für Örtliche Raumplanung, Moser, F., Dosti, P., Frei, W.-D., Voigt, A.

- reduction of transmission of information of the same and connected inputs to an output-medium in picture, animated picture and sound
- convenient call-in of complex correlations by means of easy-to-handle control panel by means of this output medium. This is aimed at a concentration on the essence at the top of a hierarchic structure down to the possibility of detail information in the branched hierarchic steps.

"MULTIMEDIA" has become a social factor in its strategic conception. The increasing wealth of information and their automated cross-linkage poses a problem, however,:

The outcomes of procedures (e.g.: planning) have become less and less traceable and demonstrable without adequate didactic and medial preparation. This does not only apply to the so-called user, but also to professional experts and decision-makers.

Interactive multimedia may be regarded as the overall term for visualizing by means of multimedia tools, provided the very complex and likewise very simple definition of multimedia is approved of: "MULTIMEDIA is the representation of various media by means of a media."

The fact that this definition also includes non-multimedia-solutions is not of relevance in terms of an allround view of considerations involved.

The use of multimedia always has a communicative objective. As far as creative aspects are concerned multimedia is used for the description of the articulation of wishes, ideas and reflections. The development of own means of style seems to be the most important requirement in this respect together with even more efficient handling and utilization of these tools. Here, too, a vast scope ranging from realism to purely abstract interpretations has developed. A further level is visualizing of "intelligent" objects which in connection with attributes are related with one another. This also means visualizing within the meaning of "artificial intelligence", i.e. systems which are able to interpret changes and to alter predetermined structures.

5.1. Fascination of Multimedia: Objections and Delight

The discussion as to use of multimedia in architecture and area planning was characterized by controversial fronts during the last decade.

Nevertheless- a certain dumbness between experts concerning contents and those concerned with the technical aspects has remained and will be existing till the appreciation for the subject multimedia of the planner has reached such an extent that qualifies him to formulate his requirements in a comprehensible manner for the information technologist.

This approach should be substantiated by the simple example of a classical closed loop:

fig.:

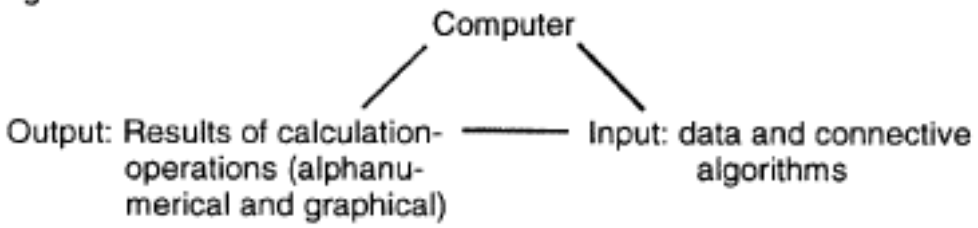
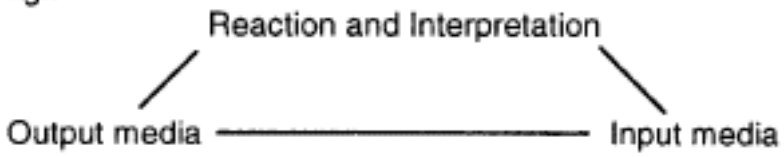


fig.:



This closed loop clearly shows the problematic phases of multimedia-aided working structures while furnishing evidence of the absolute necessity of demonstrability for the skilled expert. Furthermore, the likewise importance of input and output of data for the making of statements is illustrated. This is the only way the architect and area planner can withdraw from the steadily narrowing gatekeeper spiral which is soundly established within the media-line of news. The wealth of information is constantly increasing, the medial output practically does not change. This is due to the one fact on the one hand, as information is not passed on due to various reasons, on the other hand, as the capability to select from the wealth of information and to make the correct conclusions thereof and to spot connections, resp., is only possible for few.

It is easy to see how critical the use of complex information systems is. Furthermore, it is to be understood that even in the hypothetical assumption to provide of all information (all even without error) the results surely are far from being meaningful or to be interpreted in a meaningful way. Even as far as the smallest systems are concerned only the human understanding of contents and connections can make for this correcting power upholding circular courses of information.

Thus it absolutely is necessary to be able to express the materiality of information in the multimedia tools, i.e. the formulation of information must observe the adequate terms of technology, in order not to become entirely dependent on the rather very technically (pragmatically)-minded view of information technologist.

Knowledge should be at a stage that no overly sophisticated requirements are expected from these instruments on the one hand, and the possibilities of the multimedia-aided planning are not been over-looked totally on the other hand.

If these processes are not to be anticipated by the planner, then he is at the mercy of these instruments, as

a) his imaginative activities as planning pre-conditions are beaten by the medium
b) his imagination is something different than the pragmatics of computerized formulation turns it into
c) he might just not recognize the possibilities.

In order to achieve these anticipatory powers in planers in education at the universities it might prove meaningful to make an approach to this subject from the professional-planner-minded side.

5.2. Acceptance and Possibilities of Use of Innovative Planning Instruments.

The following represents the enumeration of some focuses for the multimedia-training based on the example GIS for architects and area planners and certain considerations are samples without furnishing any precise technical details.

GIS: Based on private or public surveying data in digital form, architectural planning with CAD and automated transfer of data in GIS and house technique solutions are an absolute must in this context. That the further utilization of the data for 3D-representation should be used for temporal and spatial simulation (visual conversion of legal regulations of local building plans and visual spatial impact analysis) may be regarded as a further aspect of the overall solution.

GIS-application should not only be considered as an instrument of administration, but also as a special tool for planning purposes.

In order to make for a vast circulation of GIS (and the digital cross-linking of information surely is a priority objective within the GIS- area) the interpretability of complex connections of flows of information has also to become accessible to nonscientific colleagues.

Due to its logistic chaining and the multimedia-based support GIS-systems have already overcome the limitations and inconsistencies resulting from the use of various media in transmission and processing of a summarized contents.

The next target now must be that the instruments implemented for the conveyance of this information are to meet the didactic requirements of users. This may be achieved by means of a combination of text, graphics, picture, video and audio in one medium, such as in an interactive electronic encyclopedia.

6. FIELDS OF APPLICATION AND INTEGRATION OF SIMULATION TECHNIQUES [1]

When stock taking the first question arising is which equipment is available for the various tasks in the field of spatial simulation and which of the available is really being put to use. The inquiry regarding the combined use and the integration resp., of simulation techniques ("multimedia") is particularly aimed at the requirements in the architectural field. The term "multimedia" has been incorporated increasingly by the computer world ever since the end of the eighties as their very own invention. Taking multimedia as a composition comprising several media aimed at specific objectives the question soon will prop up whether these objectives were explicitly defined at all. As, sometimes it seems that the fascination concerning the blurred and bumpy moving picture on the computer monitor - accompanied if anyhow possible by tone, push-buttons and many the like - leaves no space for discussions on setting of objectives. This questionnaire thus attempts to determine the state of the art in the field of spatial simulation empirically while compiling unique data enabling cross connections for evaluation purposes. The investigation only included users in the academic area, a majority of those questioned being members working in a branch of a scientific organization dealing with spatial simulation.

6.1. Conception of Questionnaire

Within the academic field scientific organizations were founded for certain branches dealing with architecture, environment and design. Though communication possibilities such as e-Mail and FTP-data exchange via Internet have become extremely popular there still is a need for personal contacts. The following organizations are of importance as far as spatial simulation is concerned:

- Environmental Design Research Association (EDRA / 1968)
- Association for Computer-Aided Design in Architecture (ACADIA / 1980)
- Education in CAAD in Europe (ECAADE / 1983)
- European Full-Scale Modelling Association (EFA / 1986)
- European Architectural Endoscopy Association (EAEA / 1992)

In order to obtain the information on the user applications in this field required for stock taking the questionnaire with the the title "Application Fields of Spatial Techniques in Architecture" was devised. The questionnaire was drawn up as a mail inquiry and was made up of 17 open and closed formulations of questions. The structure of the questionnaire covered the following topics:

- Inquiries as to technical, spatial and staff equipment;
- Data as to investments, third funds-projects and cooperations;
- Questions as to integration and evaluation of implementation fields;
- Ideas concerning medium-term and long-term developments.

---

[1] Copyright of chapter 6 to: Dr. Bob Martens, Department of Spatial Simulation, Vienna University of

What was evident from the very beginning was that topical and pertinent information would remain practically unavailable without the help of users working in educational centers of architecture or related institutions. Therefore the addresses used were made up of the aforementioned scientific organizations; in addition to this also the deans of architectural faculties were invited to reply. The following motives were set forth to the participating persons: "In times characterized by increasing 'architectural criticism' as well as weakness of anonymous users the communicational interaction between contractors, planners and users has gained considerable significance. Whether communication succeeds not only depends on the quality of project but also on the way of transmission - such as visualizing or model representation. The research project takes this in to account. (...) Regarding this aspect basic and particularly, the present information on respective application fields in teaching, research and practical work are to be recorded and experts to be questioned on future developments in this field. The combined implementation of different techniques is also to be considered in detail. (...)"

6.2. Aspects Regarding Performance

Despite excellent presentation and observance of the "rules governing the art of inquiry" the reaction to a questionnaire might not prove very satisfactory. Reasons therefore could possibly be that e.g. the topic is not "interesting" or the wrong addressees - such which are not or practically not involved in the field of the questionnaire - are being questioned. The accompanying measures to this questionnaire were as follows:

- A *pencil* with the imprint in German "Ich zähle auf Dich" and "I´m depending on you" in English resp. This tool may be regarded as a typical architect´s tool and as something which probably will not be thrown away immediately. Moreover, the imprint allows for several interpretations: Who actually is depending on who?

- A *folder* with the picture "Man penetrates heaven´s vault and perceives the spheres" (anonymous woodcut, approx. 1530) and address specifications of the inquiring Department of the Vienna University of Technology on the front side with a clipping device for visible attachment of the pencil and providing space for insertion of the accompanying letter and questionnaire.

- A *transparent envelope* attracting the immediate attention of the addressee upon receipt thereof to the folder with the clipped-on pencil. A synthetic envelope might not meet everyone´s approval in our days, therefore transparent paper which would also lend itself to architectural drafting and thus making for a thematic connection was used.

6.3. Interpretation of Information Received

The questionnaire was completed by 39 of those questioned within and 137 resp. outside the German-speaking world, i.e. from a total of 29% of those questioned [2]. A response like that is very satisfactory from a quantitative point of view, considering that the return quota with written questionnaires normally only amounts to approx. 10%. The questionnaire was returned from a total of 29 countries, the majority coming out of the U.S.A, followed by Germany and Great Britain. 41 percent of those questioned declared themselves as ACADIA-member and a third as ECAADE-member (15% thereof even are members of both organizations). Less than 5% of those questioned each hold memberships with the EAEA, EFA or EDRA.

On account of the mixture of open and closed questions it seemed wise to evaluate both in a quantitative and qualitative respect. Responses to the open questions varied in length and were compiled to a data-stock. The first classification proved useful for the preparations concerning interpretation of the closed questions, particularly in those cases were the persons questioned were able to define further sub-items (e.g. as the indicated categories did not prove sufficient). As for the evaluation in quantitative respect a coding-pattern was devised the data-input of which was achieved by means of the chart-calculation program *Excel*. The data record was transferred into the statistics-program *SPSS* for calculation. Of main importance was not particularly the aim to determine more or less isolated quantities ("who has how much of what?") - even though a first step includes the determination of the specific frequencies - but rather the attempt to visualize "invisibles" by means of adequate filtering. No further explanation is required for the fact that the appropriate application of statistical programming connectives are obtained and "patterns" may be identified.

The second series of sorting was devoted to the partly very detailed accompanying letter and to the "addenda and suggestions". Spatial simulation represents a very diversified and complex field for activities. Therefore it is not easy to issue simple specifications. The request of respondents as to explanation of terms or furnishing of definitions occurs repeatedly. This clearly shows the shortcomings of mail-questionnaires, as further information would have been required for several respondents. The questionnaire, however, had been devised for professional users ("experts") in the academic line. Those users who are using holography themselves e.g., know exactly what is meant with "HOE" (Holographic-Optical-Element). Considering that the questionnaire with its 7 pages was to be regarded as rather lengthy any additional explanations would have exceeded the frame of it and might have even discouraged some to participate.

Scattering of facilities at some faculties poses another problem with its resulting mere part-competence. This explains the answers only holding true for the direct fraction concerned. The formulation wrapped up in the second question "Does your university provide of a media-center or the like?" was absolutely aimed at multimedia. 63% of the respondents affirmed this and 11% replied that such was being planned. The formulation could have been completed with the question

_____

[2] period of questionnaire: spring - summer 1993

"Are media of such importance at said university that a media-center is to be established or carried on?" Cooperation seems pretty popular as the specifications to the question hinting at cooperation for performance of joint activities within and outside of the university stress. 39% of respondents participate in 1 to 3 and 23% even in more than 3 cooperations. This tendency may be somewhat interpreted as the pendant regarding scattering. Though 80% of respondents stated not to be sufficiently informed on other users of spatial simulation techniques in the academic field (question 17), there were not equally as many suggestions as to the improvements in information supply. The suggestions furnished can be divided roughly up into three groups with a response quota ranging between 9 and 17%: "e-mail/newsgroup", "newsletter" and "conference/seminars".

6.3.1 Information as to Equipment

The question as to which technical and spatial equipment is available with regard to representation and depiction of architecture was split up into sub-items in five categories (CAD-CAAD-CAI,..; video-endoscopy, holography, stereo-photography and 1:1) [3]. The possibility for supplementing according to the specific situation also existed. The categories "Stereo-photography" and "1:1" were expanded to comprise "Model Photography" and "Model Construction" (including 1:1) several times. The sixth - not distinctly defined - category featured special equipment such as artificial sun, artificial sky, wind tunnel and climatic chamber. The category "Video-endoscopy" was completed by mentioning the formats Video-8, Betacam-SP and Still-Video.

The most sub-items were marked within the category "CAAD-CAD-CAI-..."., which does not take us by surprise (diagram 1). The users-systems MS-DOS, Apple (MacOS) and Unix are at the disposal of 78%, 66% and 46% of the respondents. An interpretation regarding the implementation of all three systems demonstrates that this is the case with 31% of the respondents. What should be considered, however, is that this does not represent a comparison with the absolute number of system-units available. The interpretation regarding software showed similar tendencies: 2D/3D (90%), graphics (85%), rendering (76%) and multimedia (56%). The combination of the sub-items rendering, multimedia and 2D/3D results in an average of 54%. More than the half of the respondents provide of special periphery, such as color printers (62%), color scanner (53%) and video in/out facilities (53%). Stereo-display and paintbox are not as frequently available (11 and 18% resp.).

The category "Video-Endoscopy" furnished some interesting findings (diagram 2). 26% of the respondents have an endoscope at their disposal, the half of which also disposes of a mechanical installation (13%) to drive the optics with periphery through a model (simulation of movement). The result of the combination "video-in/out" (53%) in the absence of an endoscope comes also as a surpri-

---

[3] Certain indistinctness has to be put up with in the answers which is mainly due to pooling of equipment and facilities. The specifications absolutely serve as indicators with regard to spotting certain activities and points of focus, resp. The sub-items in the six categories marked by less than 10% of the respondents will not be explicitly illustrated here.

se. The number of 42% of respondents clearly shows which user-potential remains unused which could enter into endoscopy with only relatively low investments ("video in/out for digitalization is already available). Though the endoscope represents the "core" of this category specifications as to video installation were issued by respondents independently thereof. Thus 60% of the respondents are working with the VHS-format, 22% with the S-VHS-format and 13% with U-Matic. Approx. half of the respondents dispose of a videocamcorder and 16% of a miniature camera; 30% each have a film camera or an editing device.

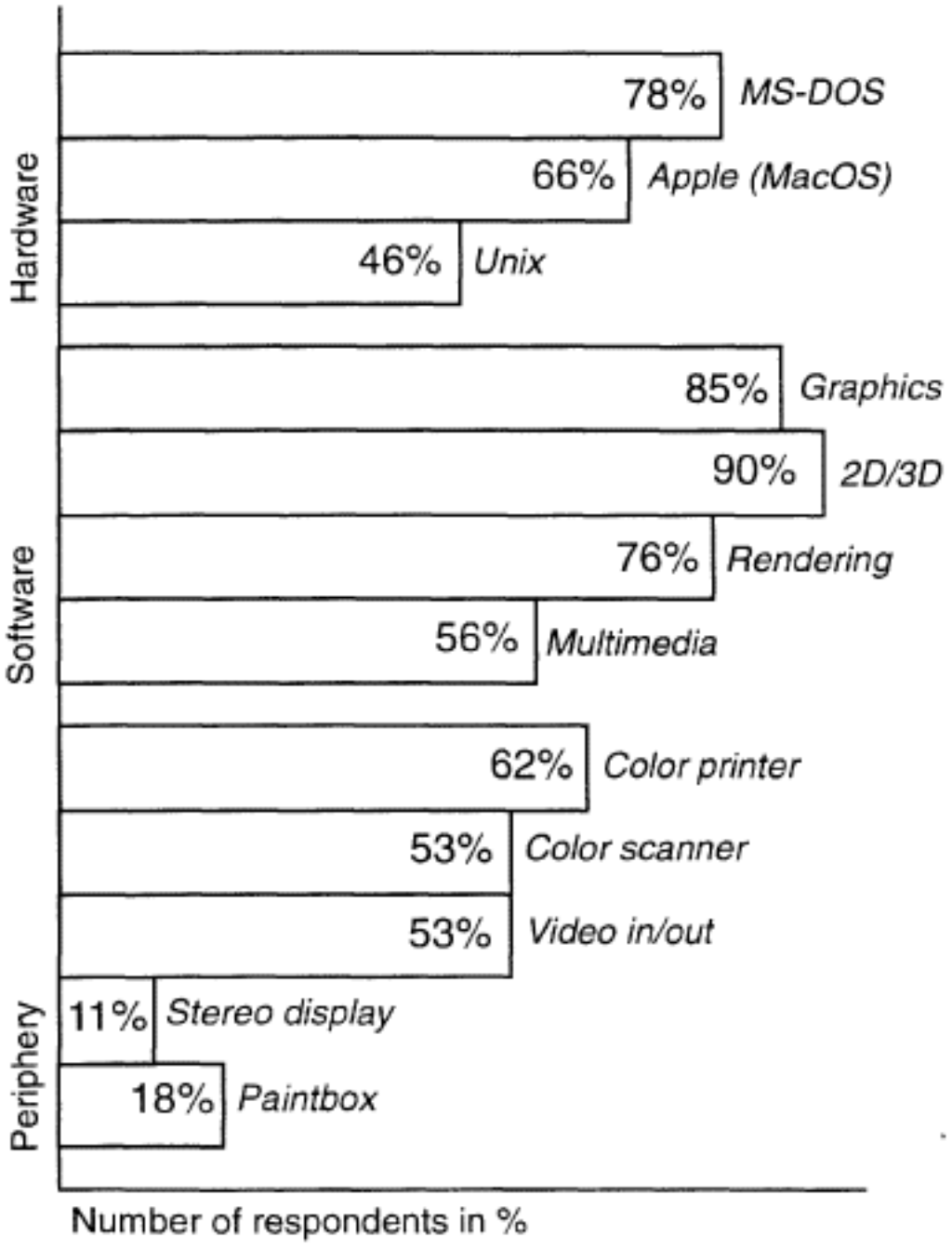


Diagram 1 Technical Equipment in the Category "CAD-CAAD-..."

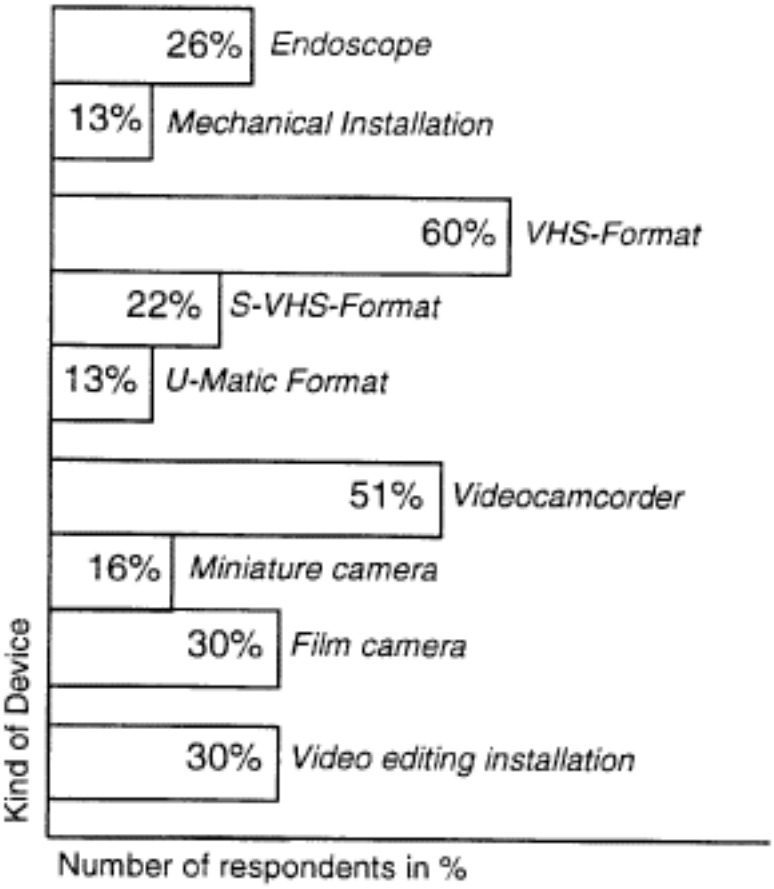


Diagram 2 Technical Equipment in the Category "Video Endoscopy"

As for the category “Holography” no significant specifications were furnished. The specifications in the category “Stereo-Photography” also do not suggest a very intense concentration of respondents with stereoscopy. That fact that approx. a fifth of the respondents dispose of a photo camera does not lead to the conclusion that stereo-pictures are taken with it. We should, however, also be aware of the fact that so far no scientific organization within the field of architecture has been founded in both of these specialized fields and therefore it could be possible that the questionnaire failed to reach competent users. A fifth of the respondents confirmed in the category “1:1” to dispose of a workshop. Full-scale simulation can be interpreted in a very special scale in this context, the same as model construction.

Considering that the most data material i.e. the lowest number of missing values was obtained within the categories “CAD-CAAD-CAI..” and “Video-Endoscopy” the integral investigation of spatial facilities of all 5 categories was neglected. Mixed space utilization is marked by each 33% and 24%, resp., of the respondents, the average values amount to 57 and 15 m2, resp., (maximum figures 300 and 400 m2 resp. ,). The mixture with other functions probably may be traced back to the fact that the implementation only progressed in many cases within the past ten years step by step (planning- and construction periods of building measures call for much more time than the installation of equipment). The interpreted specifications surely are merely to be regarded as rough indicators and are to be treated with caution.

As to staff members available one establishment was predetermined with a working capacity of 38 hours per week. The calculated values show that ≈1.5 scientific, ≈1.0 technical and ≈0.5 administrative staff members are available for activities in the field of architectural representation. It may be assumed that the scientific staff probably will often have to perform different activities and will also have to take over general tasks in the field of architectural education.

6.3.2 Data as to Investment Planning

Information as to financial affairs requires some intuition and may lead to a great number of missing values. The question as to the scope of annual investments which are financed by extern projects (research contracts etc.,) thus did not include the absolute figures regarding total turn-over.

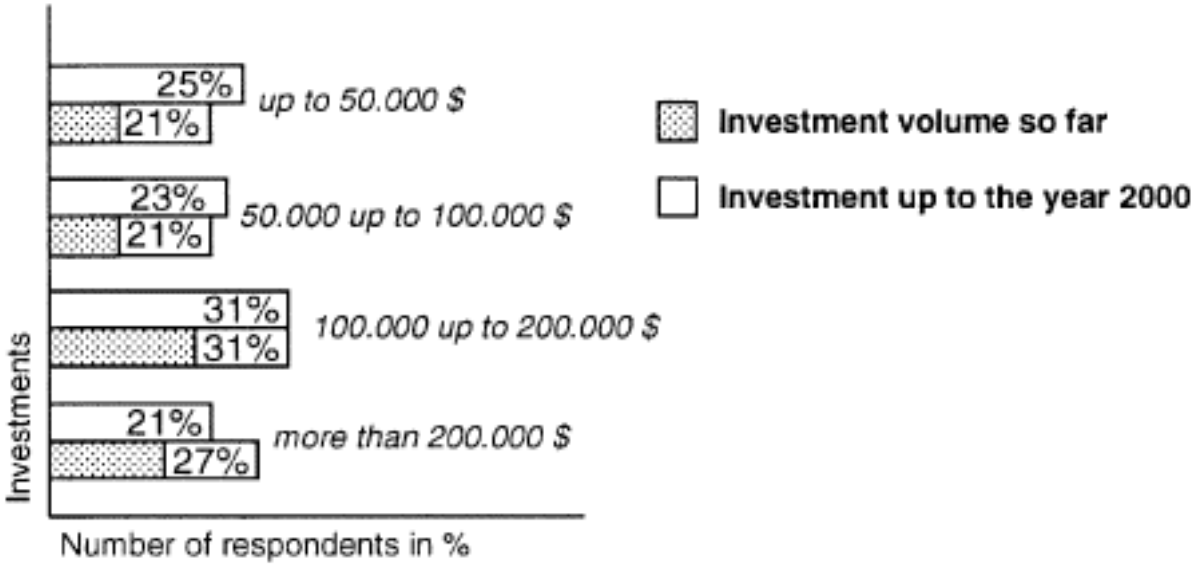


Diagram 3.1 Investment volume so far and requirement up to the year 2000

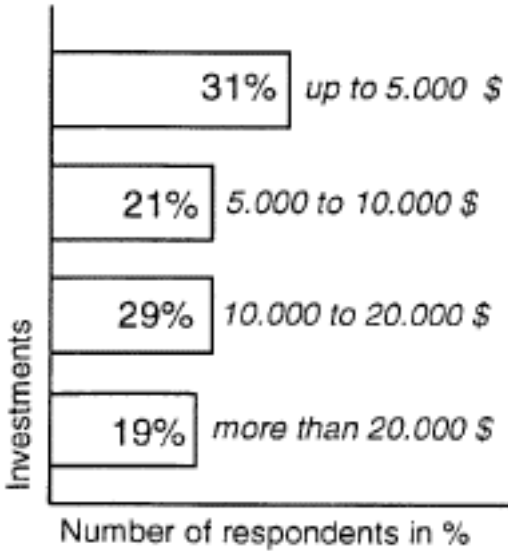


Diagram 3.2 Estimated annual acquisition budget

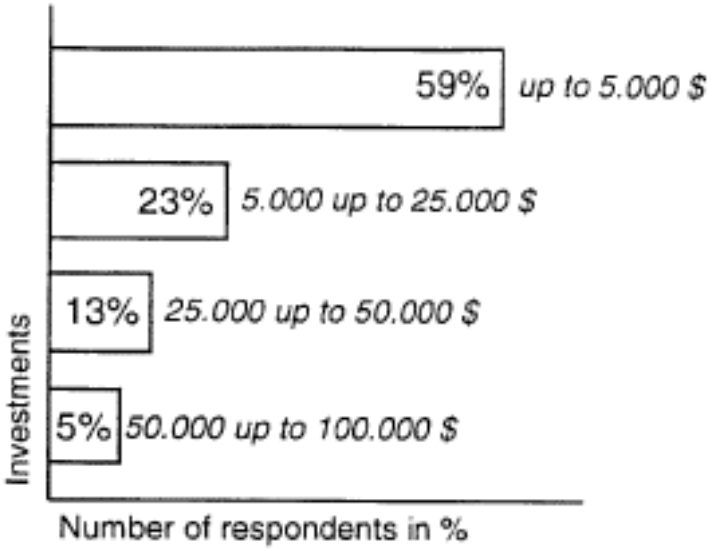


Diagram 3.3 Financing of equipment by means of external projects

Any ancillary expenses, e.g. for adaptation of rooms, were neglected. Diagrams 3.1 and 3.2 show the even representation. Diagram 3.3 clearly demonstrates that the equipment is only financed externally for a scarce portion. What could prove interesting with regard to a further research study is to investigate into the correlations of technical, spatial and personnel equipment taken as total system.

6.3.3 Integration and Rating of Fields of Application

Regarding the implementation of individual spatial simulation techniques (question 6) it does not seem wise - to differentiate the findings except for those concerning computer-aided spatial simulation - according to the fields of research, teaching and practical work.

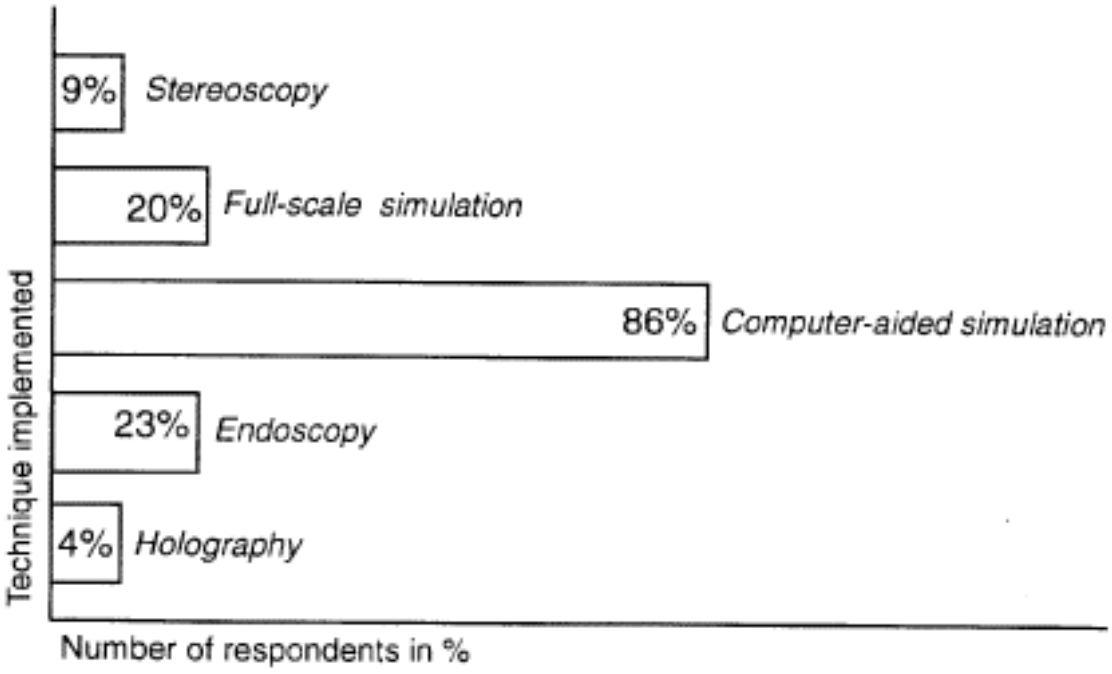


Diagram 4 Implementation of Spatial Simulation Techniques

Diagram 4 demonstrates what can be practically regarded as a total establishment of technique. 29% of respondents indicate that this simulation techniques is used in teaching and research work, 50% even make use of it in teaching, research and practical work. The use of endoscopy is significantly lower at 23% and by percents only matches the available equipment (i.e. only few endoscopes are presently not being used). The same applies to full-scale simulation, the specified figure of 20% seems remarkably high compared to equipment available (perhaps the building projects not resulting directly from the lab situation are included?), stereoscopy (9%) and holography (4%) are in the lowest range. The category "Other" was frequently completed, featuring two further categories: "model construction" (scale-models) and "visualizing" (video, photography, drawings, slides, etc.). A rather remarkable individual specification amongst others was a stereo-display with the dimensions of 3 x 6 m and the simulation of urban climate.

The possibilities "Endoscope as HOE", "Endoscopic stereo exposures" and "Stereo exposures of 1:1 models" indicated as combinations in diagram 5 are negligible in terms of figures. The specifications as to digital picture processing (51%) correspond to the video-in/out equipment, 15% of the respondents each stating use thereof for teaching and research purposes and further 15% resp., for all three fields. That virtual reality is being implemented by 25% (!) of the respondents may very probably result from differing definition of this term. Computer-aided applications of stereoscopy (virtual reality is one of such) have constantly been gaining in importance - contrary to stereo-photography. This assumption is supported by the entries regarding computer generated stereo exposures (14%) as well as those of stereo display (11%). The computer-generated holography (6%) is probably aquired in form of an external service on the basis of a specific 3D-computer model (data as to holographic equipment practically did not occur).

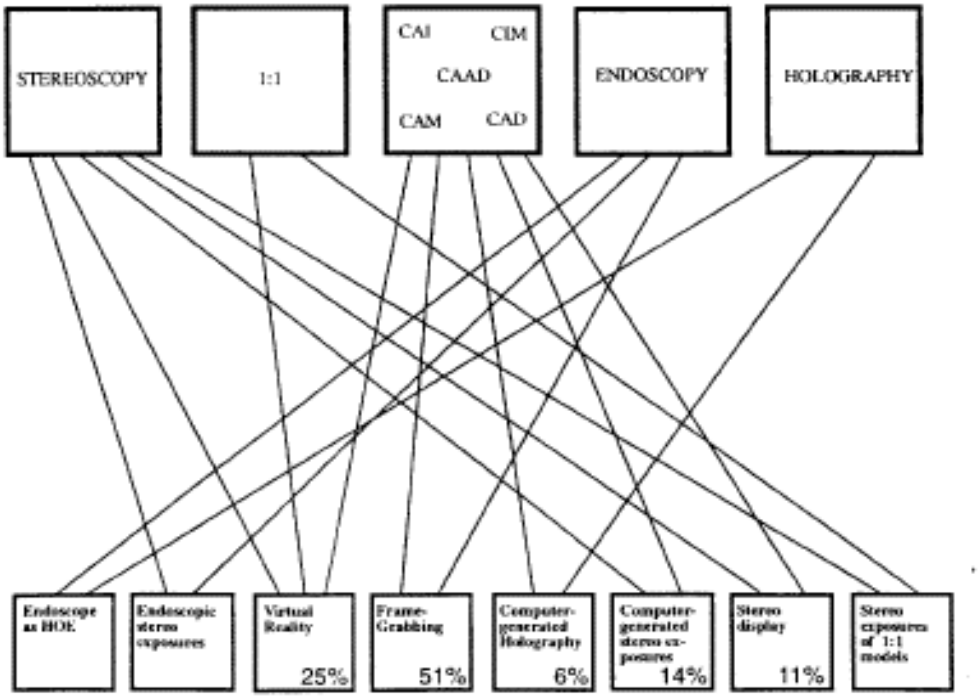


Diagram 5 Implementation of specified combinations

The question as to which combinations are missing was answered with animation (simulation of motion), multi- and hypermedia, real picture simulation (overlapping of computer-aided and endoscopic simulations with real pictures and films resp.). Furthermore, the computer-aided architectural model construction (combination of CAD and model construction) and also the mounting of digital image data sets with manually achieved perspective representations were registered. All of the specified combinations would have to be considered accordingly in the case of a new study.

The ninth question focussed on the frequency of implementations in the fields of teaching, research and practical work. What became evident for the second time in this context was that any such differentiating practically does not uncover any significant differences, the reasons enumerated for doing so occur repeatedly. What is remarkable is that those techniques which are the most costly are named most often, the range starts of with computer-aided simulation followed -at a significant distance - by endoscopy. Model construction and visualizing range at the lower end with far fewer entries (these implementations could be achieved with the least investments).

With regard to computer-aided simulation the pragmatic arguments such as availability and accessibility, expense-profit ratio, usefulness in design work, demand, habit and practicability are stressed. Further facts in favor thereof underline that the need for “spatial effect analysis” can be met and thus the visual dimension in design gains in importance. Instruction of use is simple and may be acquired autodidactically. The possibilities regarding alteration of a modelled object encourages experimenting.

As for video-endoscopy also pragmatic arguments in favor thereof such as availability, simpleness and expense-profit ratio were enumerated. This technique also bears the great advantage that e.g. “traditional” working models can be used immediately and that training of an improved spatial imaginative power is promoted. The endoscopic image is obtained rapidly and supports an interactive mode of working (representing, checking, improving, etc.) providing a high level of reality. Even in complex architectural modelling the production of a low-cost video film by means of endoscopy may prove useful.

Despite the fact that scale models cannot be endoscoped there might be didactic arguments in favor of model construction (learning, to “think with one´s hands”). Anyhow, (working) models can be built and altered in a cheap, simple and fast manner. Model photography does not call for high investments concerning the machinery required. The usefulness of manually constructed perspectives still remains undoubtedly; a perspective can be constructed rapidly using simple means, provided the know-how has been aquired in the course of education. Mounting of perspective representations and photography based on adequate instruction therein can be achieved in similar efficiency.

The tenth question enumerated three fields of activities requiring a specification as to location by the respondents. 48% of the respondents stated that spatial simulation techniques were used for the information as to user requirements before planning (“User Need Evaluation”) and 50% in “Participatory Planning”. “Post-

Occupancy Evaluation" at 17% ranges significantly lower. Even though this category actually represents the circular connection to user need evaluation this area is practically grossly neglected. Uses in this category are predominantly concerned with "Facility Management" and video observation of spatial behavior.

Regarding the concrete use of spatial simulation techniques in the two other categories it should be registered that similar specifications were named. Decision-finding by means of visualizing (the need of pictures for the purpose of communication); visual impact analysis, performance and evaluation of compa rison of variants and experiments resp., and the illustration and checking resp., of alternative designs. Special attention deserves readability of representation by the layman and the usefulness of the representation for design on the one hand and those concerned of planning on the other hand.

The main users of the simulation work of the respondents work at universities including specialized colleges and academies of art (43%). Also students were counted to this category. On account of the Yes-No-structure multiple choices were possible. 31% of the respondents stated that architecture- and planning offices were their main users. The categories "research labs", "public service" and "private sector" are specified equally often (12 to 15%).

28% of the respondents stated that studies concerning architectural psychology or user research were performed by them (question 11); approx. the half of respondents are planning such studies. The most important topics in this respect are: phenomenology and architectural space, aesthetics, spatial perception, color and light in architectural space, visual semiotics and environmental psychology.

Question 12 aimed at the importance of individual simulation techniques and their combinations resp. with regard to architecture. What is to be considered is that if the questioned institution does not dispose of certain equipment this does not mean it is regarded as "unimportant". On the other hand the availability of equipment might significantly attract the categorization "important". The relatively high number of missing values is striking. The category "CAD-CAAD-CAI-.." is classified as very important; "virtual reality and "digital image processing range as important. If the respondents tend to consider the category "1:1" as rather important they place the category "endoscopy" at rather indifferent range between "rather important" and "neither/nor". With regard to the categories "holography" and "stereoscopy" this tendency increases even more so in the direction of "neither/nor".

6.3.4 Considerations as to Long- and Medium-Term Developments

Which developments and improvements resp. seem desirable for the future regarding the various simulation techniques? Some of the respondents issued phi losophical statements in as far as spatial simulation techniques are to be further developed and used, in order to comprise the complete interactions of a building or building system in a built environment. The various considerations concerning the individual techniques are issued briefly as follows.

Stereoscopy is regarded as a useful technique which, however, cannot be used on its own to improve the quality of architecture. The computer-aided generation for stereo single frames will increase in importance, provided suitable (infrared) LCD-viewing aids and adequate low-cost-software become available. Regarding simultaneous viewing by several persons a back projection methods would be required as this would also make for a possible mobility within space without any disturbances.

As far as *full-scale simulation* is concerned reduction of costs represents the crucial point as minimizing expenses by means of reduction of detailing calls for great attention. What would be required is the development of a modularity and adequate building methods in order to achieve rapid simulations of walls, ceilings and floors. The 1:1 simulation should, particularly in architectural studies, be used more frequently (some of the respondents stated that they are looking for facilities for this activity). Further fields of activities were enumerated, such as the testing of building constructions, the utilization of this simulation type in connection with carefully planned, theory-supported ecologic-psychological basis research. Moreover, the combination with virtual reality and with real image fading over should be developed.

Regarding *computer-aided spatial simulation* more user-optimization, a higher working speed, easy handling, comprehensive building component libraries, low-cost hard- and software and better interfaces are amongst the suggestions. Software solutions which can be used with more intuition are sought ("architect-oriented" approach instead of graphic-geometrical manner). The computer-aided model construction (cutting, sinking, mould making, production) is still at its very beginning. The integration of CAD with subject data banks and scientific simulation programs (temperature, thermics, motion sequences, etc.) also are of importance. The results would have to be less abstract in future, but even more so animated (details, light effects, textures, amongst others). What could be noticed was that virtual reality has not been considered deeply enough in the questionnaire, especially regarding the vision that virtual reality could come to the fore as far as architectural design is concerned in a few years from now (presentation for a larger audience). In view of this not only the visual sense is to be served.

The *endoscopic spatial simulation* as such seems increasingly to be being replaced by other simulation techniques. More and more users are convinced that scale models are only produced for the purpose of presentation. Great interest, however, has arisen for the developments of light-intense rigid endoscopes with simultaneous improvement of the image. This optical improvements will also enhance the combination of stereoscopy and endoscopy. The process of miniaturizing of the camera periphery is surely not over with. Further developments are to be expected towards a computer-controlled control of animation (including the number of degrees of freedom and coping of terrain jumps). The mixture of endoscopic exposure techniques with computer simulation and with real image fading over resp., will gain in importance.

Practical application of *holography* in architecture is still very limited. Pictures of larger models (exposure scale 1:1) presently still pose a big problem. Scale-independent of computer-generated holograms could make up for this problem.

Developments concerning true-color-holography give hope that the real colors of an object to be taken can be depicted. If the production procedures get less complicated and low-cost production devices become available application use will grow. Laser-printers are come across in every (architect´s) office, and the same could happen with “holographic printers”).

Concludingly, it is to be pointed out that the respondents were not asked for narrate visions, but for brief specifications. This approach is based on the premise that wishes and improvements can be transmitted as messages if the user is familiar with the application himself.

6.3.5 Overall Evaluation

The provocative question may be put to what extent communication problems in architectural representation and -instruction may be traced back to the simulation technique put to use or to the unawareness of the user. Very often techniques are only used for the purpose of illustration, i.e. after completion of design work and not as a checking device during the architectural design work. Which drafting room e.g. provides an endoscope next to the model construction set? It should be considered that all senses play a role regarding perception. Tools have to be combined with one another and be at hand, quick alterations should be feasible without problems. Not the medium is to determine the decision. The pencil as such- if aptly used - still has its positive aspects. Certain questions concerning spatial simulation techniques in architectural design were treated in a second-rate manner. This may be due to the form of a questionnaire in writing. Further investigations could devote themselves to the selection of criteria governing the choice of alternative representation methods or might also study the change in representation methodics within the design process (e.g. of plotted print continued by manual drawing. The possibilities and limits of individual techniques could be periodically determined and the disadvantages and advantages of joint use of resources (pooling) could be dealt with in more detail. A personal interview in situ would surely prove very effective in order to be able to answer the questions more extensively. Which ideas were of major importance concerning the construction and expansion of the lab visited? Such research should concentrate on those architectural schools where spatial simulation techniques range high. Several respondents stated their interest in a cooperation in the course of this questionnaire. In view of the fact that GIS and CAAD are growing increasingly an integration of the fields of urban and regional planning could be envisaged.