URBIS: A Tool for City-Planners

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ABSTRACT

URBIS is a computer program built for AutoCAD environment (AutoLisp) which purpose is to help in urban planning's education and practice.

Motive for program creation are:

1) Needs of education at the Faculty of Architecture of the Belgrade University.
2) Exploring the AutoCAD’s capabilities in managing urban planning data bases.
3) Providing a tool for creation and manipulation of urban environment computer model.
4) Making a base for knowledge based system creation.
5) Computer based evaluation of the results of the competition "Future of New Belgrade".

The program consists of:

1) Module for model creation.
2) Module for model manipulation - remodeling.
3) Module for obtaining data from the model.

Some commands and procedures from these three modules are organized as ARCHIGAME module - a kind of game for architects.

The computer model of New Belgrade was created using this program, and three remodelations were done.

MOTIVES

Program URBIS is the result of the collaborative effort of the Faculty of Architecture in Belgrade and the IMS Institute. It was inspired by several motives:

Motive One: Needs of Education

Teachers on the courses of Urban Planning (especially the Urban Programming course) are pioneers of computer's application in architectural education at the Faculty of Architecture of the Belgrade University. The first computer programs made in our school were simple, in BASIC, for calculating certain urban elements expressed in figures. Graphic representation was limited by hardware capabilities. At the same time, teaching process was (and still is) oriented mainly toward graphic presentation of results in design and planning. During the few last years, large improvements in computer hardware enabled high quality of graphic presentation even on personal computers. Programs for computer-aided design and drafting also became closer to the architectural practice. Users are allowed to customize those programs according to their needs. This provides the possibility to use computers for solving complex design problems besides drafting. Therefore, there is a need for building programs such as URBIS.
Motive Two: Use of Databases and Graphics

Using personal computers in city planning and urban design seems to have become attractive for two, perhaps, the largest groups in software production. Those are producers of computer graphics software (especially CAD programs) and database software producers. They both find their own reasons and ways to cover that part of software market. Depending on the producers’ “standpoint” two main types of software for urban planners are available:

a) CAD programs with some elements of databases, and
b) databases with some graphics.

Most software from both groups are built for general purpose with some abilities for customizing. The second motive of ours was: exploring the real ability of AutoCAD and AutoLisp in managing large-scale databases, which may offer new possibilities for urban planning.

Motive Three: Work with the Computer Model

One of the things that may qualify the software use is the strategy used for approach to the user, often called “user friendliness” of the user interface. This usually means that the program should “work” as close as possible as the professionals usually act. Architects may consider that to be useful for their work. They would not have to change their way of thinking and way of working. But, is this the right decision? Should we (architects) reconsider our habits according to the appearance of the new medium in our working practice? Schools of architecture are the places where those reconsiderations should perform. URBIS is a step in the way of exploring and explaining the possibilities of computer models in architecture and urban planning.

Motive Four: Knowledge-Based Computer Systems in Architecture

The IMS Institute has some experience in applying knowledge-based systems in architecture and planning. Our experience indicates that those systems could he successfully used in managing computer models only if tools and means for manipulating and -measuring— that model are prepared. One of the programmed characteristic of URBIS is that it could be used equally by human expert (designer) or by expert system (in prospective).

Motive Five: Results of Competition "The Future of New Belgrade"

Competition "The Future of New Belgrade", held in 1986, gave some new ideas about the physical structure of the new part of Belgrade. Idea of evaluating those results through the computer model was another motive for creation of URBIS.
Theoretical Base

Urban Programming

Urban programming course at the Faculty of Architecture has the most adequate teaching program for computer's incorporation. Some experience was already reached in the past and the only reason that computers were not much more in use in this course is of the technical nature (shortage of hardware). Program of the course is based on the work of professor Vladimir Bjelikov (Bjelikov 1988) and partly on the work of assistant-professor Miodrag Ralevic. The concept of the program URBIS was approved by Mr. Ralevic with helpful suggestions during the realization of the program.

Urban Physical Structure

The main result of planning and design in our surrounding is its physical structure. The main representatives of urban physical structures are architectural objects, traffic infrastructure and natural elements (greenery, water areas and streams). Various classifications of physical structure are possible, but for this work the most appropriate one is that made according to the type and its location and organization (Radovic 1972):
- central, focusing
- linear
- areas

The third dimension could be added in this classification through multiplying areas and adding volumes as new element. This is possible when dealing with computer models that allow both 2D and 3D modeling.

Modeling

"Modeling" is representing of one structure (or process) with another one, under the condition that between "original" and "model" exists a definable resemblance (Petrovic 1977).

There is another way of modeling in design process. It is, also, the evolution from one model to another. The first model is mental, often called - an idea. The other one is a product of the first one and only in some cases it happens that it became actualized as - an "original". Only few of designer's ideas became the reality.

This makes obvious that modeling has a key-role in design process. That is why theoreticians of design pay that much attention on modeling, and that is why each new type of model should cause a new
Computer Modeling (Figure 1)

Each new technology brings new media. New media bring new types of models. Each of them, again, should bring improvement in design process. What improvement (if any) and what eventual changes in design process should be invoked by information technology?

Two characteristics of information technology have effect on design:

a) ability to process large number of data (information) in short time

b) new possibilities in visualization

Merging these two characteristics give us ability to work in the new circumstances, where we will he more conscious about our act, where we will be more aware on the impact we are making on our surrounding.

New level of formalization is a computer model (Ralevic 1988). It is much more than just a new toy in our hands. It is powerful and therefore helpful and dangerous at the same time. Some of our incompetence and ignorance would not be possible to hide any more, but our live spirit will find a good friend for the new adventures as well.

PROGRAM

Program URBIS is an independent module created for AutoCAD environment. Structure of URBIS consists of three parts (modules):

- the module for model creating
- the module for model changing
- the module for obtaining quantitative data from the model

Each module is, actually, a set of AutoLisp procedures organized as new AutoCAD commands. Separate module consisting of same procedures is organized and presented as a kind of game - ARCHIGAME.

Objects (Figure 2)

Basic elements of physical structure are defined as:

a) architectural objects

b) traffic infrastructure

Two types of architectural objects (primitives) are defined as:

1) boxes (rectangular base) objects

2) cylinders (round base) objects
These architectural objects are defined as AutoCAD blocks with dimension of 1 m (actually 1 ACAD unit) in all directions (length, width, height - for box, and length of axes and height - for cylinder).

Beside the form, these objects have several other characteristics (defined as AutoCAD attributes):

1) purpose, function
2) length
3) width
4) number of floors
5) floor height
6) number of inhabitants (if housing object)
7) number of flats (if housing object)
8) floor area
9) total area

Several possible functions (purposes) of the object are: housing, school, nursery, shopping, business, administration, sport, culture.

Traffic infrastructure are presented as AutoCAD polylines of different width:

1) primary streets - 8m width
2) secondary streets - 6m width
3) tertiary streets - 4m width
4) parking places - 5m width
5) pedestrian lines and sidewalks- 3m width
6) "other" streets and lines - user defined width

Objects defined in this way cover most of basic types of physical structure (central, linear and areas) that planners and architects use in their work. These basic objects might be used in creation of the more complex ones, which enable the user to create more precise model of the urban structure.
Model Creation

A set of new commands on new sub-menus added to the main AutoCAD side-menu enables creation of model which elements were previously discussed. These commands provide the possibility for interactive insertion of architectural objects with desired dimensions and function on desired location in model. Separate commands are provided for creating of rectangular (box) objects and round (cylinder) objects. User is asked to input further data for correct definition and placement of an object:

- length
- width
- number of floors
- floor height
- function
- insertion point (low-left corner of the object)
- rotation angle

Length and width of round objects are lengths of two perpendicular axis of the ellipse. Also, insertion point for round object is the center of the ellipse (or circle). Desired dimension of object (building) is achieved through scaling prototype object - primitive (which dimensions are 1m), in desired direction. Dimensions and insertion points could be entered either by pointing with digitizer or entering figures from the keyboard.

Other data are placed in ACAD database as values of attributes in block structure.

Floor area, total area of the building, number of flats and inhabitants (if object has housing function) could be accounted automatically according to the dimensions of object and defined or redefined normative for flat area. Necessary changes may be done after completing definition of object.

Representation of the traffic infrastructure in the model is enabled through drawing it as polylines of certain width. Each type of road, street or area has its command for creation.

Remodeling (Figure 3)

Most changes on the model may be done through the standard AutoCAD commands for manipulating entities: ARRAY, COPY, MOVE, ROTATE.

Special commands are designed for changes of internal structure of the object and data that objects are carrying. They change the values of attributes in ACAD database parallel with change of its graphical appearance. These commands allow changes of:

- length
- width
- number of floors
- floor height
- number of flats
- number of inhabitants
- function
- floor area
- total area of building

Actions that cause change in area of building (change of dimensions or direct change of the single area figure) will automatically cause the change in number of flats and number of inhabitants, but that will not occur vice-versa.

**Obtaining Data From The Object Or/And Model (Figure 4)**

Two separate groups of commands are defined for obtaining data from a single object and for data from the whole model or its parts ("blocks"). Data that could be received from a single object are:

- floor area
- total area
- number of flats
- number of inhabitants

Invoking command for obtaining data about object will cause the activating of AutoCAD's selecting procedure that will ask from user to select an object which data are to be obtained from. After selecting object, the AutoLisp procedure will retrieve the data from ACAD database.

Getting information about the model or its parts needs definition of model surface to be covered. User will be asked to input two opposite corners of the rectangle that will envelope the desired area - a "block". This rectangle will he also used for selecting the object that will be taken in account. AutoCAD's "Crossing" method of selection is used. After entities are selected required data will be retrieved from database, processed and scores will be presented. Information that could he obtained are:

- area of the "block"
- area of the "block" covered with object and traffic infrastructure
- "developed built area" (summed of all total areas in buildings):
- total area
- separate areas of some functions
- density of habitation in the "block"
This information is possible to get individually or altogether.

ARCHIGAME

The ARCHIitectural GAME is separate module of URBIS. Most of AutoLisp routines for this "game" are already used in commands for creating, changing or -measuring- model. Script of the game has five steps:

1. Placing the 'Nocks
2. Assembling "blocks" into -measuring area"
3. Placing the diagrams
4. (Re)modeling
5. Getting information from "measuring areas"

Step 1: Placing rectangular "blocks" that will be used for selecting objects and retrieving data from database.

Step2: Unlimited number of "blocks" maybe joined into one -measuring area- which will be given by the five-letter name. Up to five suchlike areas could be defined during one game.

Step 3: Three diagrams (for measured information of density of habitation, percent of used terrain, total-built-area/area-of-"block" relation) should be placed anywhere on drawing.

Step 4: Remodelation of the model through adding new elements, deleting or changing existing ones.

Step 5: Single command will start a procedure for obtaining information from each of the -housing-area/public-functions-area relation "measuring areas". Results will he shown on diagrams and also placed in the f-ife with the same name as the name of the "measuring area".

User (player) proposes the rules of the game and the goals to he achieved.

Repeating steps 4 and 5 game could be continued until the player is satisfied with the results "measured" from the model or with its form.
Examples

New Belgrade
New Belgrade is situated on the left bank of the Sava river on its mouth to the Danube and across the old part of the city. First objects on this area were built before the World War II, but the real start of building was in the year of 1948. The general plan of the city was defined, mostly according to the rules of modern movement expressed in the "Athens chart". The base idea was the rectangular grid of 400m x 400m and 400m x 600m blocks. Some government buildings and experimental housing areas were built in the first couple of years. The extensive building of housing area begun in 1960's, and it is still on. Today, New Belgrade is more-or-less typical representative of "modern city" with the architecture of the same type. Blocks in the central area of the New Belgrade (on the axis from federal government building to the railway station of New Belgrade) remained unbuilt and preserved for trade, administration and other "central functions".

New Belgrade: Model of the Present Physical Structure (Figure 5)
One of the motives for creating this program was to provide possibility for evaluation of results of the competition for the new ideas for physical structure of New Belgrade. For that reason the model of present physical structure of New Belgrade was built. Maps and other data provided to the competition participants were the main source for creating the model.

This model was the basis for remodelling and "playing" the ARCHIGAME.

Five "measuring areas" were defined on this model. Four of them are blocks of New Belgrade built in various periods. The fifth one covers whole central area of New Belgrade. This last "measuring area" is the only one kept through the whole process of remodelling because that is the only area which transformation is interesting on all models. The results obtained from this model fulfilled the expectations since model was built on the basis of the same data that are measured afterwards.

Remodelling 1: The Model "Corbu" (Figure 6)
The first remodelling is a try of "finishing" the central area in Le Corbusier's manner. Four high-rises taken from LC's projects "Voisin" for the center of Paris or "The modern city for three million inhabitants" are placed on the nodes of traffic net in the central area. The functions of the buildings are mainly administration and business with small percentage of residences.

The first -measuring area- spreads over the narrow area of the very center, with LC's high-rises, the second one envelopes three blocks on the central axis and the third one covers nine central blocks (with present and new blocks).

The results obtained from this model correspond to those reached by LC's calculations. That means that existing structure is completely constructed in Corbu's spirit.
Remodelling II: The "Manhattan" Model (*Figure 7*)

The second try was to fill the central area with blocks organized, functionally and formally, as those on Manhattan (high-rises with commercial functions and low scale of permanent residences). The existing blocks suffered minor changes mostly caused by changes in traffic infrastructure.

One -measuring area- is covering the central area with all newly built blocks. The second one is covering partly newly built and partly existing blocks while the third one entirely covers the existing blocks. The fourth area is the common one for all models.

This model also expressed results that were predicted.

Remodelling III: The "Urban Block" Model (*Figure 7*)

This model is based on the concept of the "urban block" developed by Milos Perovic in his book "Experiences of the past" (Perovic 85). The "urban block" has size of 60mx90m, with four and five-floor residence buildings on the regulation line, with commerce in ground floors facing the street, and with green areas inside the block. One corner of the block is free of buildings providing better possibilities for air circulation inside the block (microclimate). The existing blocks are again minimally changed.

The -measured areas- are placed on the same places as on the "Manhattan" model.

The achieved results correspond to those provided by the author of the "UrbanBlock" model.

CONCLUSIONS

Values, Problems and Further Steps

Probably the best way of evaluating this program and the whole project is through judging the success in satisfying motives that inspire the project.

Motive One: Needs of Education

Since the program is approved by teachers at the Faculty the author expects that the program will be possible to use in teaching process of both Urban programming course and CAA D courses. The lack of an adequate hardware at the school may cause delay of its wider use among students.
Motive Two: Databases and Graphics

This experiment of using ACAD's internal database for storing data other than those necessary for drawing proved that that connection between graphics and database could be helpful for architects, planners and designers. As the graphic presentation, of either 2D, 3D model or data obtained from it, is expected as final result it is a good decision for realization of such program in graphic environment. Advantage of AutoCAD is its open structure with AutoLisp and the powerful graphic capabilities that enable completion of graphic presentation to the desired level.

The problems arise concerning the time necessary for retrieving data from the database. For the large models it may take five minutes or more, even on 80386 based machines.

Many improvements are still possible in searching method through the database, as well as in the object definition and organization of the program.

Motive Three: Work with the Computer Model (Figure 8)

The satisfaction of this motive is probably the biggest achievement of the program. Having the 3D model on screen (in front of the eyes), which means any/each of projections and perspective views, and having opportunity to work on that model knowing that at the same time we actually work on large database without need to know anything about databases at all - that really brings new dimensions in design process. Possibilities of visualization of the results reached in that process are enriched since computer medium is closely related to video technology. The "walk through- the urban or architectural environment that exists just in the computer memory and designers imagination is not only possible, but also becomes desirable and probably imperative in the future. Work on the computer model is really "something else---; an entirely new dimension in a comparison to classical way.

Motive Four: Knowledge-Based Computer Systems in Architecture

The tools for creating, operating and "measuring" models are here. Some knowledge is necessary to produce model using those tools. One way is to give those tools to the expert (designer, architect or planner). He knows the rules for using the provided tools.

The other way is to "teach" the computer to use those means. There are again couple of solutions. Knowledge-based systems are one of them. Computer can learn- those rules, which expert knows, if they are presented in the right way. And we hope that we know the right way.

Motive Five: Results of Competition "The Future of New Belgrade"

The base for evaluating those results are prepared. It just needs some time and some other resources for the realization of that project.
Further Steps

This program will, certainly, not solve all the problems we (architects and planners) have, but it might help in our efforts to make "the better world". The help that this program provides is in learning the way to handle and accept the new media.

Some of the previous motives are not completely fulfilled. Also, some new problems and new ideas appeared during the creation and testing of this, first release of the program.

New version of URBIS will be capable to involve characteristics of terrain (its 3D presentation) and to operate with wider range of primitives (even those user-defined).

The first step to be undertaken will be the connection of URBIS and M-ARIA, an expert system shell designed for AutoCAD environment (Cubric, Simovic 1988). That will enable not only the computer simulation of urban forms but also the modeling and simulating of urban processes.

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ILLUSTRATIONS

Figure 1.
New Belgrade - The Computer Model of Actual Situation
a) entire model; b) architectural objects c) traffic infrastructure

Figure 2. Elements of Physical Structure:
a) architectural objects; b) traffic infrastructure

Figure 3.
Work With The Computer Model-Block 38 (plan, perspective views and graphs)
a) before remodelling; b) after remodeling

Figure 4.
Work With The Computer Model - Block 38 (tables of results obtained from model)
a) before remodelling; b) after remodeling

Figure 5.
Model Of The Present Situation
a) 3D model (isometry);
b) 3D model (plan), model with "measuring areas" and "measuring areas"
   1. graphs with results obtained

Figure 6.
Model "Corbu" - 3D model (isometry);

Figure 7.
Models "Manhattan" and "Urban Block" (isometry)

Figure 8.
a) original LC’s project for “The city for three million inhabitants” (plan and perspective view)
b) model "Corbu" (perspective view)
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