

ArchiCAD landscape modelling employed in designing a small garden

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Abstract

Lay persons and specialists alike need to visualise landscapes for inference. The models offered by digital landscaping not only help visualisation, but at the same time offer the possibility to simulate different aspects in connection to space, as well as to time. This naturally requires a certain level of abstraction. In order to better understand landscape development and behaviour, simplification is also a necessity. Quite often that leads inevitably to a lesser realistic effect. In order to balance that, there have been created techniques which help render elements of terrain and water as well as vegetation in an almost realistic manner. But these techniques need to be further researched as, beyond the possibilities they offer, they do not lack difficulties in implementation. In what follows ArchiCAD version 18 is employed as a specialised software for the design of a small landscape garden and its novel capabilities are discussed.

Rezumat

Specialiști și laici deopotrivă, trebuie să vizualizeze peisajul pentru a-l înțelege. Modelele oferite de peisagistica digitală nu doar ajută vizualizarea, ci, în același timp, dau posibilitatea de a simula diverse aspecte legate atât de spațiu, cât și de timp. Acest fapt necesită un anumit nivel de abstractizare, evident. Pentru o mai bună percepere a evoluției și comportamentului peisajer, simplificarea constituie un alt deziderat. Dar acest lucru va avea drept consecință o imagine deseori mai puțin realistă. Pentru contracararea acestui efect, au fost create tehnici care izbutesc să redea elemente ale terenului, apei, sau vegetației într-o manieră aproape realistă. Însă aceste tehnici reclamă continuarea cercetărilor deoarece, pe lângă posibilitățile oferite, ele se confruntă și cu dificultăți în implementare. În cele ce urmează, se utilizează versiunea 18 a ArchiCAD, un program specializat, în cazul unei grădini peisajere mici și sunt discutate noile posibilități oferite de către acesta.

Keywords: Landscape visualization, levels of details, terrain, vegetation, water.

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1. Introduction

The entire history of art, architecture and landscape is marked by natural forms as a source of inspiration for design. At present, mathematics and CAD systems enable architects to create, visualize, and edit the forms which they create. Interactivity of CAD systems quite often leads to amazing shapes and artistry [1-4].

Architecture, as well as civil engineering, or engineering design, on the other hand, rely heavily on descriptive geometry for achieving the geometric solution details of the construction representations [5-10]. Geometrical forms, together with their peculiarities, or their representations are studied in a new light following the introduction of 3-D modelling software. That has profoundly influenced the representational tools in architecture and design. Their potential has shifted the focus from the 2-D drawings and plans to the 3-D virtual spaces. 3-D modelling software is capable of rendering, of geometric analysis, and other operations by means of high-performance ray-tracing [11-13].

There are other advantages of 3-D solid modelling beyond visualization. It not only creates a framework for representing shapes of objects by means of a computer. It has also proven to be an efficient economic tool as well: it has fostered improved product quality, contributed to the reduction of product development cost and especially it has dramatically reduced the time span of the design process [14-18].

There are several means employed in planning or design for the representation of concepts. Analogue visualisation traditionally resorts to both physical models as well as to plans, sketches, perspective drawings, sections, or even photomontages [19].

One powerful tool used by landscape planners is the simulation of landscapes. Thus public understanding is fostered along with the possibility offered to the specialist to select from among alternative scenarios. One important aspect is the realism of the simulated image and today computer graphics allows for accurate landscape simulation [20].

Nowadays, landscape architecture, or design planning, along with other related disciplines rely heavily on digital computer models for visualising proposals, for evaluating alternatives, for simulating impacts. When rendered, on a hard copy as a photograph or print, the digital models gain appearance that is a concrete form. Quite often, digital models come down from the computer screen into the world of artefacts as an immersive display environment, a computer generated physical model shaped into a plastic, cardboard, or wooden form which are more intuitively perceived and assessed. However, the evaluation is actually of the data of the internal representation or the data model. The quality, the characteristics of the model will guide and determine the assessors' conclusion [21].

However important, visualisation is just one aspect of digital modelling of landscapes. Estimates of cut-and-fill volumes, road alignment geometry are all rendered three dimensionally by means of CAD systems. Usually, differential equations are used by landscape ecologists to predict the dynamics of vegetation growth or succession. Consequently the details of human perception along with vision and visualisation constitute important aspects.

The scale of a real-world landscape differs greatly. Landscapes are the result of a variety of processes at organic and inorganic levels. Erosion is one of the main processes and it depends greatly on the mineral composition of the soils and the way the minerals were formed. The resulting landscape will determine the biosphere populating it. In their turn, the organisms populating the

mineral world will influence its erosion, thus changing the physical appearance of the landscape [22].

All the details contributing to the outline of a landscape demand a laborious effort from the renderer attempting visualisation. If details of the real landscape are omitted, virtual landscapes might look quite sterile.

2.1 Landscape constituents

There are six main constituents which are combined in shaping a landscape. These are: landform, vegetation, water, structures, people/animals, atmosphere [23]. Traditionally only the first four constituents were taken into consideration when landscape was considered. However, people and animals are not only key factors for the ecological tableau, but much of the landscape shaping is a result of their direct or indirect actions and many interventions are intentionally carried out for human benefit. Atmosphere, including all its elements like the wind or the sun contribute enormously to the shaping and visualisation of a landscape. That has to be mirrored by digital models if they be true. Each of these constituents poses different problems when modelled. Researchers and software developers are constantly improving techniques to bring the virtual closer and closer to the real. Consequently they are facing real challenges as most landscapes are combinations, under different ratios of all these, or most of the above constituents [24].

2.1.1 Landform

Landscape architects, as well as earth sculptors see the landform geometrically, as a series of planes which may be simple or rather complex [25]. Landform, or terrain constitutes the basis for landscapes. The surface of terrains is formed of mild waves of earth or more dramatic rugged surfaces. The surface may be covered by grass, asphalt, sand, bricks, stones, etc. Generally, landform may be described by a simple function, such as $z = f(x,y)$. The simple elevation function is sufficient for surface description, in general, when natural forms are described. However, in the case of anthropic structures, such as tunnels, or bridges, multiple coincidence z values appear.

These are not frequent, but may be present when natural forms like overhanging or extremely steep, nearly vertical shapes are present. In order to translate these into digital forms, different conventions have been established: spot elevations, contour lines, 3-D meshes, ruled surfaces, triangulated surfaces or arbitrarily curved surfaces. Usually very large data sets are necessary for rendering landform even when the usual coarse sub-sampling is considered satisfactory. Especially in the case of smooth surfaces. But generally terrain is extensive and various data structures support different inferences, different rendering, or different visualization tasks [26].

2.1.2 Vegetation

Rendering vegetation properly imposes even higher demands. Landforms and buildings generally demand an extension from 2-D to 3-D. Real vegetation: trees, shrubs, ground covers are all very complex. They are generally present in large numbers and expose an even larger number of objects, such as branches and twigs, leaves, and flowers. These volumetric complex forms cannot be rendered properly by any 2-D representation [27]. Buildings, even sophisticated ones, may usually well be represented by polygons and simple geometric primitive solids, which asks for a rather straightforward representation in spite of the large number, of several thousands. In contrast, a tree might require millions of polygons. No part of a tree or plant is absolutely flat, square, triangular or cylindrical. And the shapes and sub-shapes needed for rendering are fractally complex with regard to every detail. One fairly simple technique employed largely nowadays for the modelling of

vegetation is that of using photographic texture which is applied to flat billboards or cut-outs. Immediate photo realism is thus obtained for individual tree images, for example. However, applying it to 3-D models, which are more complex, is less successful due to limitations [20, 26].

2.1.3 Water

At first sight, water seems to pose a quite simple task when rendered. For example, a lake is a simple flat plane, but it is reflecting the surrounding landscape, mirror like. Moreover, water is present in landscapes under a variety of forms: a small pool after rain, a wet stone in the shade, a vivid brook, or a gurgling waterfall. Water also contributes to the dynamics of a landscape. It presents ripples, splashes, waves, foam or mist – it is a host for deformations as it changes not only its appearance, but also its physical state. And quite often, water is accompanied by sound, which should be rendered in order to attain verisimilitude and maximise its expressive potential.

2.1.4 Structures (including infrastructure)

The presence of structures in most landscapes is of paramount importance. And that is even more so in the case of designed or built landscapes. However, the treatment of issues of an architectural and engineering nature will constitute the subject of a subsequent paper. Mention should be made that however developed, architectural digital modelling and visualisation techniques, even when perfect for gears and buildings, they do have their limitations – not all of them can be adequately employed for solving the problems of landscape modelling [28, 29].

2.1.5 People and animals

Elements belonging to the biosphere – people and animals – are also essential. They are present in most landscapes, be these natural or manmade. Their presence may be direct, visible, or not. The animal world is just as complex as that of the plants - fuzzy, curved, complex, dynamic, etc. features are all present. Behaviour representation poses yet another, greater challenge. Digital modelling tools for realistic people as well as behaviour modelling have been already approached and progress is on its way [26].

2.1.6 Atmosphere (including sun, wind, etc.)

All five elements discussed above are essential constituents of any landscape model built for visualisation purposes. Beside these, atmosphere is also crucial. The presence or absence of the sun, the moon, the clouds, the wind will all influence the result of the visualisation process and the perception of the landscape, even if these are distant elements and do not belong to the landscape as such.

The present paper contributes a new possibility of modelling a small landscape garden by means of computer graphics software, namely by ArchiCAD version 18.

3. An ArchiCAD generated small garden

ArchiCAD version 18 has been used in order to simulate a small garden [30]. Figs. 1-20 illustrate the garden map. To begin with, the terrain data were created. That constituted the first stage, the basis for creating the landscape simulation. The environmental research resulting map was fed into the computer. Every species and individual plant was investigated and recorded: their location, number, height, diameter at breast height (at about 120 cm). The garden investigated comprised 456 plants belonging to 67 species, 35 genera, and 12 families. For the present study, the number of

plants used was 256, belonging to 35 species. Their height was above 3 m and their girth at breast height exceeded 30 cm. An image database provided the data for the plants – the data used were considered for summer. In Figs. 1-20 the location of these plants can be observed.

The observer of a landscape may find the images and montages created by computer graphics quite useful for looking at subtle details from different viewpoints. The ratio of a standard view field image of three-fourth can be contrasted to the panoramic image obtained from panned video sequence images resulting in an almost life-like scenery. But sometimes details are difficult to observe. An association of sequences of zoomed video images and computer generated still images results in a vivid impression of a given landscape. The observer may choose from among the several useful techniques employed in the visual environmental assessment the qualities of which have been confirmed by the examples. And, as already mentioned, each type of technique used in rendering has strong and less strong characteristics. Consequently, the one(s) suitable to the given circumstances should be chosen.

Since the spatial orientation of the park, with regard to the cardinal points, which was considered when planning by the landscape architect, is achieved in such a manner that the access to the park along the main alley is set from the East, it is but natural that the perspective view of the park presented below, should be labelled with regard to the cardinal point orientation as well. Consequently, here are Fig. 1 - Fig. 20:



Figure 1. A 3-D ArchiCAD generated landscape: top view of the park from SW → E



Figure 2. A 3-D ArchiCAD generated landscape: inside view of the park from the SW of the secondary lake → NE of the park



Figure 3. A 3-D ArchiCAD generated landscape: top view from inside the park on the SW main lake → NE park axis



Figure 4. A 3-D ArchiCAD generated landscape: top view from inside the park on the SE main lake → NW park axis

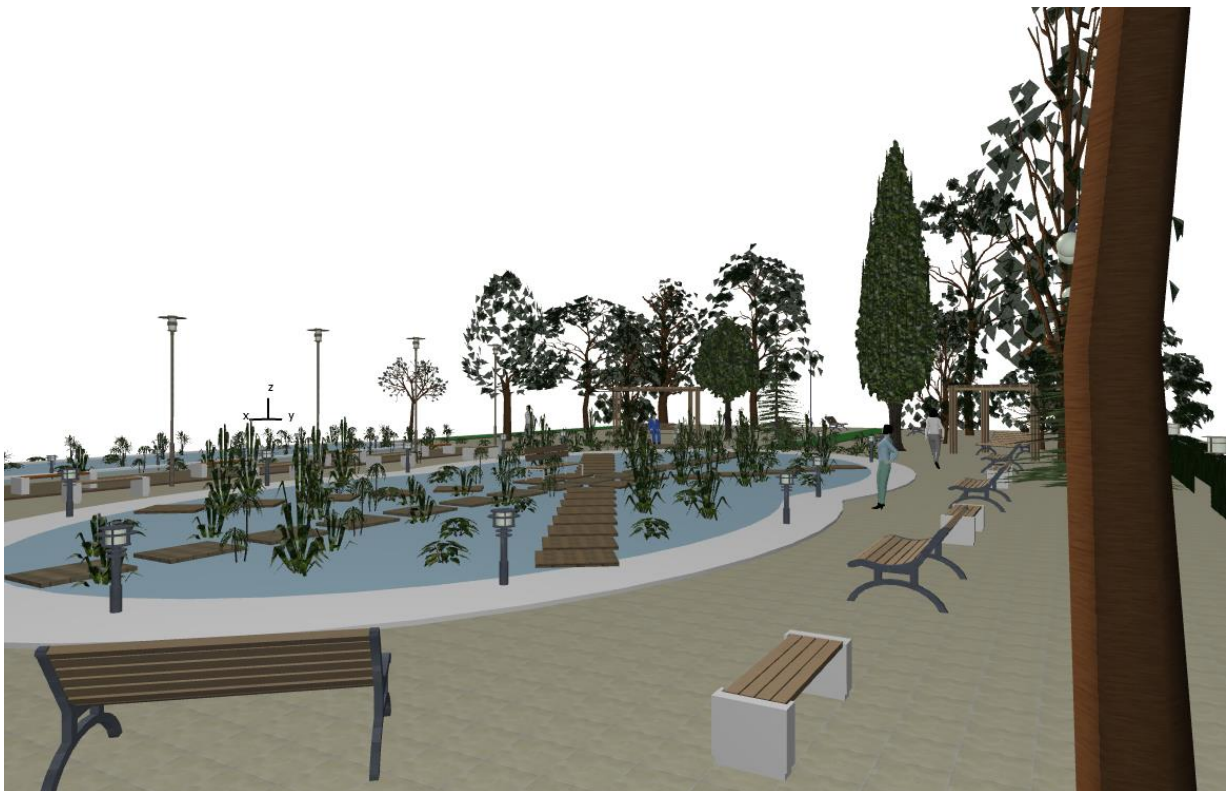


Figure 5. A 3-D ArchiCAD generated landscape: inside view of the park with the promenade path of the main lake along the SE → NW axis



Figure 6. A 3-D ArchiCAD generated landscape: top perspective view of the park on the SE → NW axis



Figure 7. A 3-D ArchiCAD generated landscape: top perspective view of the park in the NE direction



Figure 8. A 3-D ArchiCAD generated landscape: inside view of the park along the NE direction of the exit alley of the park toward the S of the park



Figure 9. A 3-D ArchiCAD generated landscape: top view of the main lake along the NW→ SE axis



Figure 10. A 3-D ArchiCAD generated landscape: inside view of the park from the NE of the main lake → W of the park



Figure 11. A 3-D ArchiCAD generated landscape: inside view of the park from the E of the main lake → NE of the park



Figure 12. A 3-D ArchiCAD generated landscape: inside view of the park from the E of the main lake → N of the park

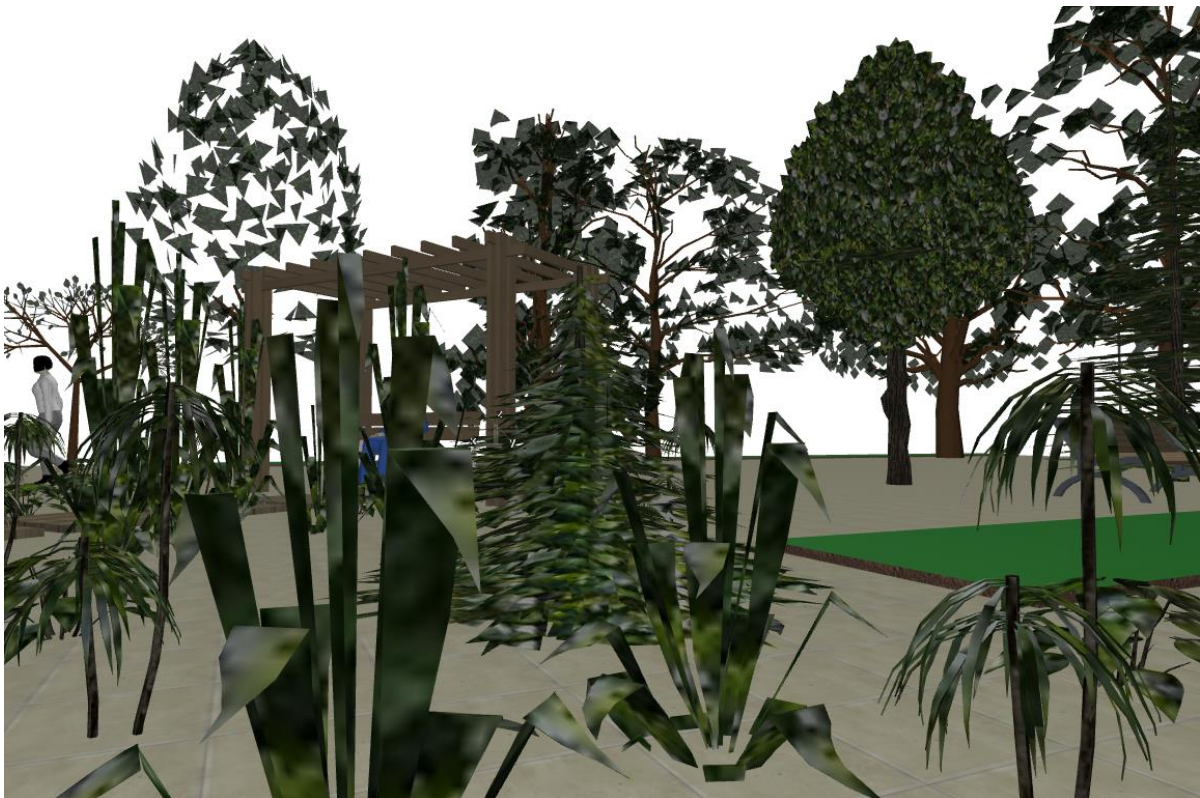


Figure 13. A 3-D ArchiCAD generated landscape: inside view of the park from the S, of the exit alley from the park → NW of the park



Figure 14. A 3-D ArchiCAD generated landscape: perspective view of the promenade path from the inside of the main lake along the SE → NW axis

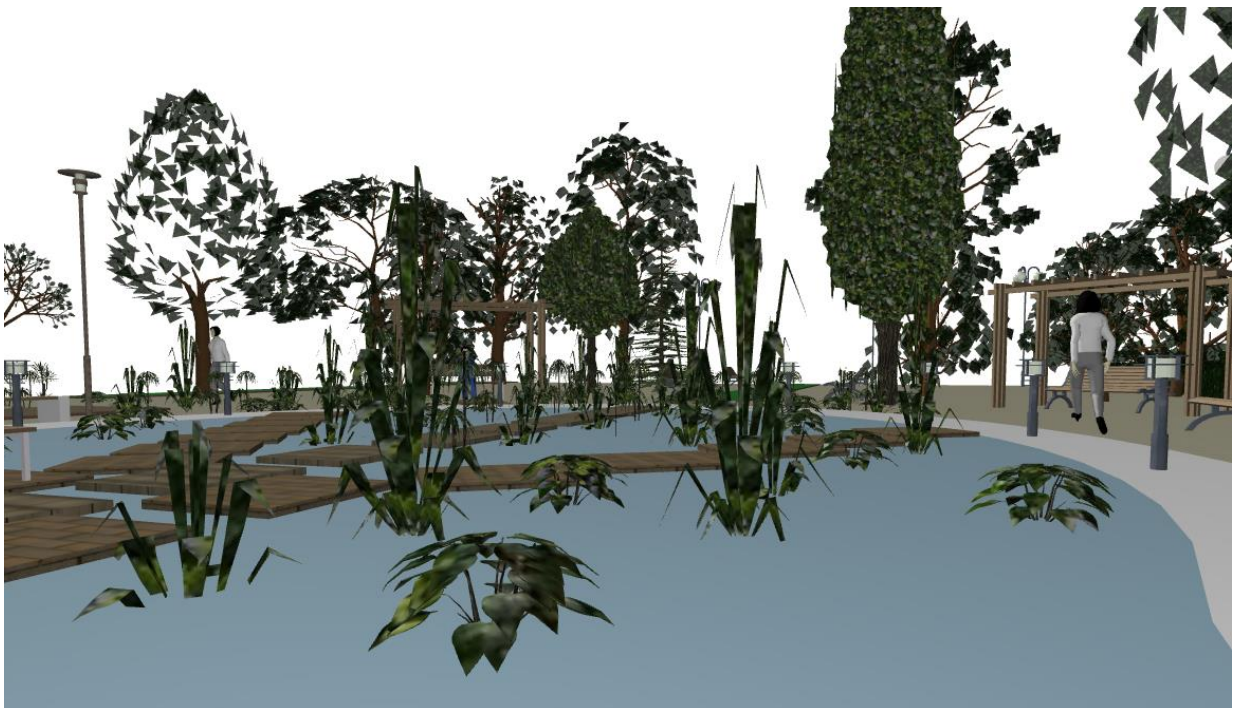


Figure 15. A 3-D ArchiCAD generated landscape: inside view of the main lake along the E → NW axis



Figure 16. A 3-D ArchiCAD generated landscape: inside perspective view of the park with the promenade path between the lakes from the E of the secondary lake → W of the main lake



Figure 17. A 3-D ArchiCAD generated landscape: inside view of the park from the N of the promenade path between the lakes → NE of the park



Figure 18. A 3-D ArchiCAD generated landscape: inside view of the park along the N → W axis



Figure 19. A 3-D ArchiCAD generated landscape: external view of the park from the W

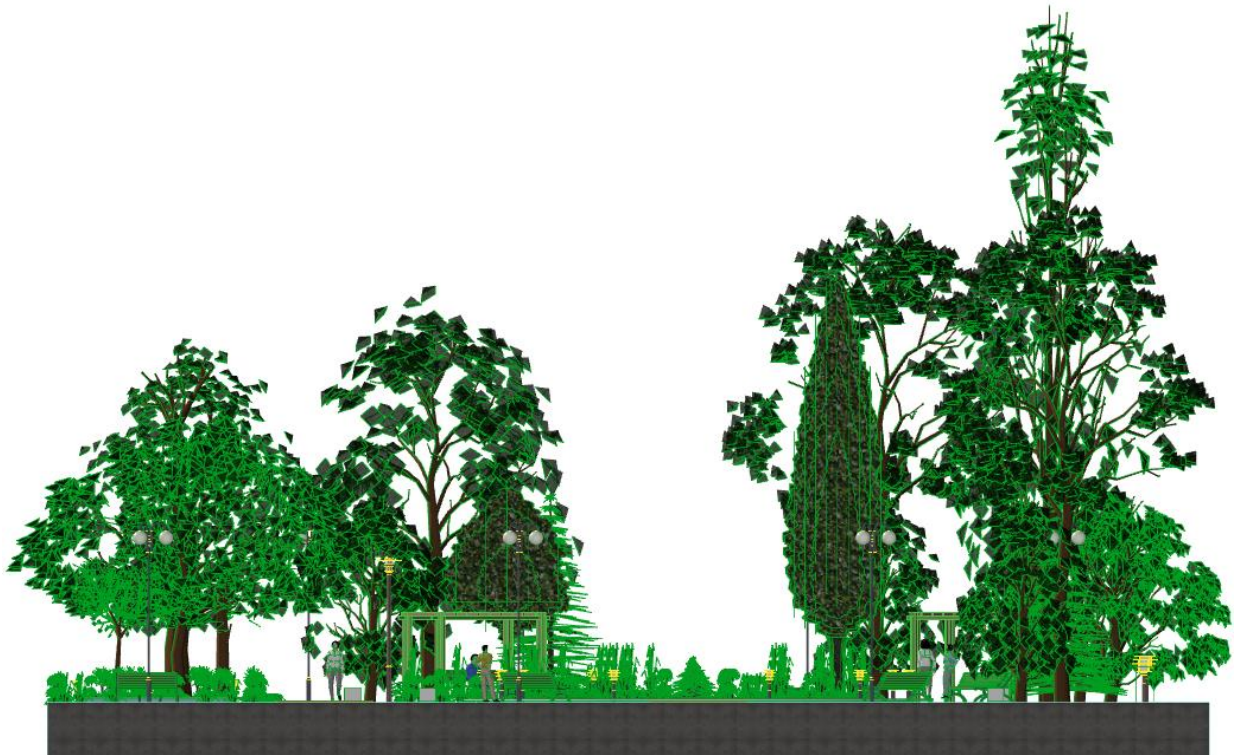


Figure 20. A 3-D ArchiCAD generated landscape: external view of the park from the S

3-D modelling software is generally conceived so that it be compatible with other software packages and with the aim of serving several disciplines. For this model architectural shapes were taken into consideration firstly, but spaces, construction costs, functions and activities, dynamics and other abstract concepts were also considered. And that, because the associated properties of entities, such as their texture, material, geometry, relationships, lifetime etc. are all important.

3. Conclusions

Nowadays, large scale projects, even controversial ones, are usually assessed by means of landscape visualisation. It is also largely used for simulations, not only for research purposes, but for a fair prediction of landscape changes over the years. Therefore architects and planners find visual representations an essential means of communicating what they think of the real world. Consequently they are looking for ever better means and procedures fostering improved creation and replication of the environment.

CAD systems are versatile systems; they are not frozen in time and space. They may be easily adapted to the domains or tasks at hand, such as the modelling or designing of a site or a landscape together with their constituent elements. The work of designers is thus fostered - not only accelerated, but also granting it an increased outcome quality. One detail of utmost importance is the fact that CAD systems contribute to enhanced planner-customer communication.

CAD systems constitute fundamental building blocks within the architect-developer dialogue. The visual presentation of a landscape makes the plan of the projected site clearer and easier grasped. Its aesthetic impact, its financial issues, and other characteristics may be easier judged. Details may be changed or altered easily, at any time, for improved results.

ArchiCAD version 18 is used to analyse the images due to several advantages it presents. On the one hand, less time and attention is required for the execution of a landscape, for instance. By means of the ArchiCAD version 18 modelling software, a landscape garden was created as a

proposal. A wide range of computer graphics possibilities is efficiently set at the disposal of the architect or planner and that was demonstrated by the application of descriptive geometry and mathematics analysis. Moreover, CAD rapidly produced animated demonstrations of the landscape garden, generated by the computer. The graphical construction stages are all included in an algorithmic mathematical model. Besides, the design application of the computer graphic has a user friendly interface.

4. References

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