Review of digital tools for landscape architecture

Arturs Mengots, *Latvia University of Agriculture*

Abstract. The growing use of more complex visualization techniques and digital tools in landscape architectural practice and research poses a set of challenges for Landscape architects. These include: keeping up to date new developments; acquiring new skills; understanding the strengths and weaknesses of new techniques; and knowing when and how to integrate them into the design and planning process. The purpose of this paper is to take a wide literature study review about: the development of the digital tools in landscape architecture design, profession, and planning in general; how digital tools are being used and practiced by taking different aspects into considerations (e.g. types, stages, techniques, strategies, communication methods, and levels of implementations); digital tool potentials and impact on the landscape design, planning and profession in future. Landscape architects introduced digital tools from architecture, civil engineering, military, aviation and other fields and replaced traditional hand powered tools by digital tools. It seems that now more than ever landscape architects have possibilities to research, plan, design, communicate and present small and large landscapes with the various type of digital tools and visualization techniques and no doubt that they will make huge progress in the near future.

Keywords: digital tools, visual communication.

Introduction

Landscape architects had always relied on the use of various tools and techniques for simulations to explore and communicate design and planning ideas. For a hundred years, pencil, markers, pens, and watercolors have been the main tools to make models, sketches, plans, maps, sections, elevations, and perspective drawings for representation [26; 27]. Today hand powered tools have been replaced by computers [26] and digital tools where the traditional techniques supplement with 3D modeling and animation.

Now landscape architects use analogue and digital media to research and design urban areas and the countryside [20]. Several studies have highlighted the importance of using digital tools in planning to improve understanding of projects in landscape planning and urban planning, and to improve communication among designers, clients, and lay citizens [5; 7; 9; 25].

The growing use of more complex visualization techniques and digital tools in landscape architectural practice and research poses a set of challenges for professionals. These include: keeping up to date new developments; acquiring new skills; understanding the strengths and weaknesses of new techniques; and knowing when and how to integrate them into the design and planning process [27].

The purpose of this paper is to take a wide literature study review about: the development of the digital tools in landscape architecture design, profession, and planning in general; how digital tools are being used and practiced by taking different aspects into considerations (e.g. types, stages, techniques, strategies, communication methods, and levels of implementations); digital tool potentials and impact on the landscape design, planning and profession in future.

Development of the digital tools for landscape architecture

The several thousands of years in landscape architecture pencils, pens, markers, and watercolors were the main tools to make plans, sections, sketches, perspective drawings, and physical models [15; 27]. Since the 1950s, people have worked increasingly with computers. However, it wasn't until the 1960s when the first experiments to introduce digital tools from different fields in landscape architecture started [20].

GIS was the first digital tool used by landscape architects beginning in the 1960s [20], even though GIS was developed in the 1950s. Roger Tomlinson and colleagues developed Canada Geographic Information System (CGIS) for Canadian Land Inventory, as a measuring tool and a producer of tabular information, rather than mapping tool [18]. After that, through the 1960's and 1970's, landscape architects were developing analysis methods that would be incorporated into developing software systems. But in this time government and academic institutions developed hardware and data standards.

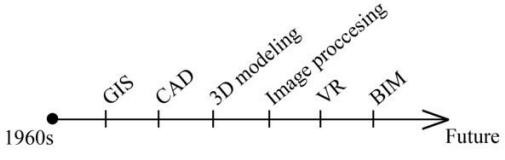

Fig. 1. Timeline of digital tool development in landscape architecture [Source: made by author]

Harvard Researchers created first raster GIS application SYMAP [23] which was used to monitor or analyze natural systems. SYMAP also has been used for mapping viewsheds from particular locations within the landscape. PERSPECTIVE PLOT computer graphic program was the most popular for U.S. Forest Service landscape architects to make perspectives for analyzing landform modifications, siting of structures, timber planning, and road design (Figure 2.) [27]. Ian McHarg set the stage for modern Geographic Information Science in his 1969 book, *Design with Nature* where he outlined the Overlay Method. This method became a standard practice in site suitability analysis and is extremely effective for incorporating natural resource information into planning and design processes. The second great contribution to GIS analysis methods by a landscape architect comes from Carl Steinitz of Harvard University. Steinitz elaborated on the overlay method to produce a model for evaluating landscape change and future impacts of design alternatives [23].

The development of peripheral output devices such as plotters and digitizers together with the ability to store hundreds of maps, symbols, and details for quick recall and presentation, provided the basic foundation that led to the development of Computer Aided Design technology (CAD) [27]. The first steps of CAD industry can be found in 1960, when Ivan Sutherland produced SKETCHPAD and The Electronic Drafting Machine. The use of CAD applications started slowly, because when Digital Graphics division of control Data Corporation launched the first commercial CAD application the price was 500, 000 US dollars and very few units were sold. But some years later when engineers and architects had already used CAD applications also landscape architects were adopting this application [6]. Early CAD packages generated plant symbols at specified locations and scales for planting plans [27].

Computer Aided Design (CAD) and Geographic Information Systems (GIS) software tools have had a significant effect on the visualization of landscape, allowing the creation of 3D landscape models on computers [16]. The earliest effort to place 3D symbols in a landscape image was accomplished in 1969 by Harvard Spatial Analysis Laboratory. Not until 1985 did early pioneers adopt 3D computer tools in landscape architecture [8; 25]

In the 1980s, computer graphics cards and software was emerged which allowed photographs to be captured, stored and manipulated. Elements could be cut from one image and pasted into another one. Unlike the traditional analog photomontage, a digital photomontage can reach a relatively high level of accuracy. This can be achieved by superimposing three-dimensional vector data over

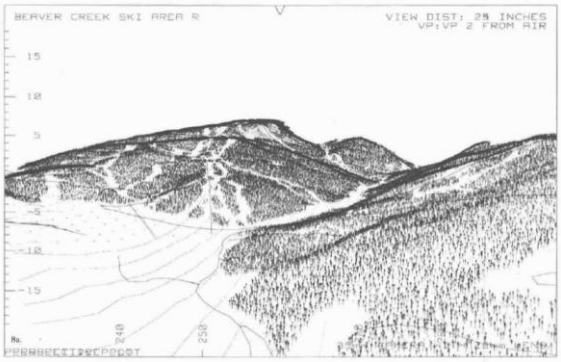

Fig. 2. Cornputer generated perspective graphics in PERSPECTIVE PLOT. Bird's eve view of the Reavcr Creek Ski Area in central Colorado [27]

Fig. 3. An early experiment with CAD and 3D modeling: the design for the 1992 Floride in Zoetermeer, Netherlands is constructed in three dimensions in a digital environment and draped on aerial photograph of existing situation [20]

the two-dimensional image data [15]. Beginnings for the image processing tools can be dated to 1990. Digital photomontages and photo editing comes as a standard tools of landscape architectural education and practice as well as landscape research. They were introduced for the first time in Landscape and Urban Planning to explore Landscape management options in Acadia National Park in response to anticipated landscape change [13].

Transition from the animations and models were first used in flight simulators after the

Second World War, which was the great impact to advancement of virtual reality technology [15]. The birth of VR tool can be traced in the early 1960s, [7] but the full immersion VR environments, initially developed at the Universities of Illinois and Chicago in the early 1990s for astrophysical applications, provide exciting tools for reaching new levels of insight into complex and massive data. Landscape applications of virtual environments (of varied levels of sophistication) have been used to communicate the qualities of a specific plan or design, to provide for interactive manipulation of design elements or to undertake experiments in perception [3]. During the last few decades digital representations of landscape by using VR have

advanced from simplistic, static representations to more or less realistic visualizations, allowing explore landscape space with real time movement experienced at multiple spatial and temporal scales [22]. The latest technologies such as mobile phone augmented reality expands the currently available planning and design toolkit, allowing us to provide people with an augmented view of the real world onsite, where proposed changes can be seen in the context of a fuller ambient array of sensory experiences [13].

One of the newest digital tools in landscape architecture is Building Information Modeling (BIM). This system has been developed for architects and civil engineering, but as of late has come to be in demand for landscape architecture [17]. Now there is no specific BIM software for landscape architects, and this can hinder collaboration with other BIM compliant professionals [1]. However there are few researches about BIM in landscape architecture where they are trying to find the best ways how to made BIM platform for landscape architects. They should not be left out of collaboration with other BIM compliant professionals.

The use of digital tools in landscape architecture

Since the 1960s, the digitalization has been made radical changes in landscape architecture. Landscape architects have been introduced to and adopted many different digital tools from architecture, engineering, military and other fields. Table 1 shows that today landscape architects can use GIS, CAD, Image processing, 3D modeling, VR and BIM tools for different processes, various scales of landscape and to present certain planning scenario for other professionals or public (clients, lay citizens, stakeholders) to improve design process.

Existing GIS tools and methods are more useful for landscape architects in early stage of design to make site analyzes and site plans to capture the results in existing information systems for the future use. GIS tool also offer the needed capabilities for the whole planning cycle. Data capturing for inventory purpose, scientific-based analysis, defining objectives, scenarios and alternative futures and planning measures can be carried out by using GIS to achieve a more sustainable land management. For the implementation and sometimes necessary updates environmental information systems can be developed for specific purpose [21]. GIS tool is a powerful instrument for spatial design at various scales [20]. Results from VR-lab show that as a communication tool GIS is more effective between professionals rather than between professionals and lay citizens [9].

Today, landscape architects mostly works with CAD tools in 2D by making site plans, sections and elevations and use the 3D only to get information about altitude conditions. Programs like AutoCAD can be used to create 2D visualization techniques and 3D models. To make 3D models can be complicated for user, because there is often an advanced task and the tools which are available to make changes might not be good enough. CAD tools also provide opportunities to make information rich 3d models, many automated processes and an extensive plant library. In recent years the situation has changed somewhat after SketchUp arrived on the market. This software provides free version and is easily for making 3D models with detailed information. In CAD software users can create site plans sorted information in tables about project from 3D models [6]. In Landscape architecture CAD are used for various type of scale more in early rather than final stages of design to present design proposals and location of each landscape element. As a communication tool it is more useful between professionals rather than between professionals and lay citizens [9].

Design of CAD drawings can be improved by using image processing software. Image-editing software refers to a wide range of applications that are used to manipulate pixels for tasks such, editing illustrations, as adjusting photographs and altering image sizes. Vector-editing illustration software refers to the use of points, lines, and shapes in order to represent imagery [26]. Image processing software are often used to design plans, site analyzes, sections and to create photomontages. Table 1 shows that image editing software is not so strong communication tool but more focus on appearance and effects to present creative ideas. Image editing software where is possibilities to draw or sketch are usable in early stages in design process especially for large scale projects. In these software digital photography, Google Earth and preliminary SketchUp models can be used as sketch bases to create perspectives from scratch and provide true context and perspective from which to launch freehand design exploration. The result is accurate design sketches and tremendous time savings [12].

Today, 3D modeling is becoming an essential tool in many profession fields, such as architecture, engineering, geography and also in landscape architecture. In landscape architecture 3D modeling is used to make more or less realistic three dimension landscape models, to get single rendered images, 360^0 panorama and animations. Single rendered images are most common used form of 3D model representation. Animation rather than 360^0 panorama give a more complete picture of the environment by taking a fly-over or walk-through option [15]. Landscape architects use 3D technologies to their projects in order to supplement their traditional 2D methods- plans, maps, sections,

TABLE 1

The use of digital tools in landscape architecture [Source: made by author]

Digital tools	Processess							Design				Communication	
								Scale		Stage			
	Site plans	Site analyzes	Sections	Photomontages	Renderings	Interactive 3D models	Animations	Large	small	early	Final	Proffesionals	Clients
GIS	x	x						++	++	++	+	++	+
CAD	x	x	x					++	++	++	+	++	+
Image procesing	x	x	x	x				++	++	+	++	+	+
3D modelling					x		x	+	++	+	+	++	++
VR						x		+	++	++	++	++	++
BIM	x	x	x		x		x	++	++	++	++	++	+

Legend: + suitable; ++ very suitable.

through all design process. The challenges that encountered landscape architects to use more often 3D visualizations and animations rather than 2D maps, plans and sections are a steep learning curve, and long time-consumption [25]. Although some of newly launched products such as SketchUp Trimble, AutoDesk Infraworks and Lumion3D provide relatively short learning process and allowing more quickly create project proposals [9; 25]. Gaming type software with LOD technique allows make not only small landscape models but also large city 3D models and import objects from CAD, GIS and three-dimensional modeling software. Three-dimensional games software provides interesting and low budget alternatives to landscape architects [10]. But it is still too time consuming and too expensive for large scale average landscape projects. Results from VR-lab show that as a communication tool 3D modeling is effective between professionals and also between professionals and lay citizens [9].

The rapid development of computer hardware and graphic allowed people from 3D models create interactive 3D landscape models by using VR. Interactive 3D models are more visually complex and interactive, that allows people to freely walk around in virtual spaces by taking any eye level viewpoint they wish to observe [16]. Interactive 3D models can be used to describe the location of the project building in relation to other buildings, to present the size and scale of the project and the use of vegetation. *VR i*mproves 3D understanding of the project and also makes a greater motivation for the project, for public [9]. VR, like 3D modeling, are used more for small scale rather than large scale average landscape project because it is still too time consuming and too expensive. Currently, interactive visualizations of landscape are seen at the end of the design process rather than as a tool for communication between the designer and the stakeholder through all design processes. But there is potential to improve the mental models of each participant through discussion, by collecting together designers, experts and stakeholders in collaborative design workshops [16] and to improve communication between professionals and citizens in design process.

With BIM landscape architects should be able to produce animations, detailed plans, walk-through and renderings for presentation. BIM helps in planning to describe both hard landscape elements such as lighting, surface covering, pools, benches, and walk pathways and soft landscape elements such as different plant types, water usage, by allowing develop and organize detailed information for every landscape detail. By using BIM in best practices can lead to efficient and effective collaborative technology and partnering [1] throughout all design stages more between professionals than professionals and lay citizens [9].

Future of digital tools in landscape architecture

This paper shows that digital technologies are becoming more interactive and increasingly important in daily practice for landscape architects. Digital tools are developing at the very high speed and no doubt that they will make huge progress in the nearest future in landscape architecture.

Further developments of digital tools in landscape visualization may improve understanding and engagement of the design proposals for public

Fig. 4. Presentation in VR-lab at NMBU [24]

Fig. 5. Presentation in VR-lab at NMBU [24]

participation, decision- making and information exchange between professionals and public. Today landscape architects in daily design processes use digital tools to produce much more beautiful pictures (visualizations) at the final stages of design for the selling project. But in future there is potential for using digital tools more as a communication tool with various levels of implementations in early stages of design.

There is also potential for the software developers in landscape architecture to make a new, friendly, easily usable, and special suited landscape digital tools especially 3D modeling and BIM tools for today and future landscape architects.

In the future there is a need for updated educational digital tool programs for landscape architecture with the newest tools. Already now, landscape architecture students after graduation had been evaluated based on their skills to use digital tools when they apply for the job.

However, the tendency of developing more and more representations by digital tools can lead to having more "similar" design projects. By using digital tools landscape architects in the future cannot forget about creativity, individuality and own style how to design landscape and present design proposals.

Conclusions

From the 1950s, development of digital tools transformed the work process in different fields, including landscape architecture. Landscape architects introduced digital tools from architecture, civil engineering, military, aviation and other fields and replaced traditional hand powered tools by digital tools.

The digitalization made radical changes in landscape architecture. It seems that now more than ever landscape architects have possibilities to research, plan, design, communicate and present small and large landscapes with the various type of digital tools and visualization techniques to other landscape architects, designers, experts, stakeholders lay citizens and clients.

Digital tools are developing at high speeds and no doubt that they will make huge progress in the near future. There are possibilities in landscape architecture to develop new software to improve communication between landscape architects and clients and provide better collaboration between professional. But in this digital time landscape architects need to avoid similarity. Landscape architects are creative persons and they need to save their creativity, individuality and own style how to design landscape and present proposals by digital tools.

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INFORMATION ABOUT AUTHOR:
Arturs Mengots, Master student (since 2015) at the Latvia University of Agriculture, Faculty of Environment and Civil Engineering, Departament of Landscape Architecture and Planning.
E-mail: artursmengots2@inbox.lv

Kopsavilkums. Daudzus tūkstošus gadu ainavu arhitektūrā un plānošanā zīmuļi, pildspalvas, flomāsteri un akvareļi bija galvenie instrumenti veidot plānus, griezumus, skices un modeļus. Taču šodien tradicionālie ar roku darbināmie instrumenti tiek aizstāti ar digitālajiem rīkiem. Daudz sarežģītāku vizualizāciju tehniku un digitālo rīku augošais pielietojums ainavu arhitektūras praksē un pētniecībā rada virkni izaicinājumu ainavu arhitektiem. Tie ir šādi: sekot līdzi attīstībai; apgūt jaunas prasmes; izprast stiprās un vājās puses jaunajām vizualizēšanas tehnikām; un zināt, kad un kā integrēt tās projektēšanas un plānošanas procesā. Raksta mērķis ir veikt plašu literatūras apkopojumu par: digitālo instrumentu attīstību ainavu arhitektūra dizainā, plānošanā un profesijā kopumā; kā digitālā instrumenti tiek izmantoti, un praktizēti, ņemot dažādus aspektus (piemēram, veidi, posmi, tehnikas, stratēģijas, komunikācijas metodes un implementācijas līmeņi); digitālo instrumentu potenciāls un ietekme uz ainavu projektēšanas, plānošanas un profesijas nākotnē.

Ainavu arhitekti laika gaitā pielāgojuši digitālos instrumentus, kas aizgūti no tādām jomām kā arhitektūras, militāro, aviācijas un citām. Līdz ar to pētījumā secināts, ka mūsdienās ainavu arhitektiem ir iespējas pētīt, plānot, dizainēt, informēt un iepazīstināt ar dažādiem digitālajiem rīkiem un vizualizācijas tehnikām dažāda mēroga ainavas, prezentēt dažādus attīstības scenārijus klientiem, iedzīvotājiem, kā arī citiem profesionāļiem. Straujā digitālo instrumentu, rīku attīstība tuvākajā nākotnē sniegs vēl lielākas iespējas kvalitatīvai ainavas veidošanā un pētīšanā.