Computer Aided Design and Drafting in Landscape Architecture

ABSTRACT

Computer Aided Design (CAD) software in landscape architecture have revolutionized landscaping and provide options for computer-generated documentation output which has greatly improved design and drafting. The use of computer aided design software in landscape industry is gradually replacing manual drafting and hand drawings. The software that are commonly used includes AutoCAD, Revit, Sketchup, Pro Landscape, SmartDraw, Realtime Landscaping Pro among many others. AutoCAD and SmartDraw can be used for 2D drafting and designing with huge library of objects available to enhance the drawing. Revit, SketchUp, Pro Landscape and Landscaping Pro offers great platform for 3D modelling to present visualization of the designs. Through these software, designers can work at a faster rate and produces a better quality design thereby increasing productivity. The computer aided modelling in landscape architecture also brought infinite possibilities and creativity that a landscape architect can explore. This paper aims to review the most commonly used CAD software available, their functionality and application in landscape architecture.

Keyword: AutoCAD, CAD software, Landscape architecture, Landscaping, SketchUp

1. INTRODUCTION

Landscape architecture planning and design is interrelated with many other disciplines including urban planning, horticulture, architecture, environmental science, computer science, ecology and art.[1] The integration of all the related fields and disciplines is necessary in the process of landscape designing.[2] In recent times with advancement in information technology and computer sciences, landscape planning and design has witnessed certain technological reforms.[3] This development has transformed the application of computer technology in traditional landscape planning and design wherein drawings have often been unable to meet modernistic demands at times. This has created the development of number of computer software and programs that assist the purpose of planning and design for better efficiency and accuracy.[4] The concept of computer aided designing for landscape architecture is comparatively new. It can simply be explained as the design and drafting of a garden or landscape with the aid of computer software. It is also defined as application of information technology in landscape designing.

Landscape architecture can be defined as the art and practice of designing the outdoor environment, especially that of gardens or parks in such a way that the outdoor space harmonizes with the adjacent buildings and nearby roads. It is the design of outdoor areas, structures and landmarks to achieve aesthetic, environmental, and social-behavioural impact.[5] Landscape

architecture is considered a multi-disciplinary field,[6] integrating different aspects of art, horticulture, architecture, urban design, ecology, engineering, environmental and industrial design. Landscape architects are primarily involved with the design, planning and management of the outdoor spaces around public buildings, private residence, parks, recreational centres, tourist spots and so on. They work on different aspects of the design incorporating the hardscapes and softscapes in the project sites and integrating ecological sustainability at the same time.[7, 8]

The term “landscape architecture” was coined by Gilbert Laing Meason in 1828 and term "landscape architect" was first used professionally by Frederick Law Olmsted in 1863.[9] It was used by professional landscape designers by the 19th century till the establishment of American Society of Landscape Architects (ASLA) in 1899 by Frederick Law Olmsted, Jr. and other landscape architects. The International Federation of Landscape Architects (IFLA) was founded in 1948 at Cambridge, England with its headquarters in Versailles. According to the ASLA, landscape architects work on a variety of professional tasks that includes projects mentioned below.

- Public and private parks including playgrounds.
- Housing and residential areas.
- Botanical gardens and arboretums.
- Industrial parks.
- Highways, bridges and transportation structures.
- Recreational facilities and sporting complexes.
- Ecological designs and tourist destinations.

The two major components of landscape architecture are hardscape and softscape. The term hardscape is used to describe non-plant materials or construction materials. This includes garden enrichment items like outdoor furniture, walkways, pools, lighting, fountain and materials like gravel, stones, concrete etc. The term softscape is used to describe the plant materials. Grasses and herbaceous plants, shrubs, trees etc. makes up the softscape component of landscape garden.

Landscape architecture being an important component of urban planning and architecture and also having a huge impact on the environment has been advocated in different countries. This is considered as one of the solutions in maintaining an ecological balance amidst the growth in population and rise of urbanization where proper planning and strategy is required to utilize the limited space. Manual drafting and drawing for garden designs has been around for ages now, however with the advancement in technology, the use of Cad software is being employed especially by the professionals everywhere. However, with the many lists of CAD software available and within reach, there is very limited literature available on the software available and how they can be fully utilized in landscape architecture.

2. COMPUTER-AIDED DESIGN (CAD) SOFTWARE FOR LANDSCAPING

Computer-aided design (CAD) software are the software used by landscape architects, to create plan, draft a template for the plan and provide layout of the design before implementing a landscape design. Therefore, it is basically the use of computer-based software that aids in design processes. It provides assistance in analysis, creation, modification or optimization of a design.[10] The introduction of digital technology in landscape design is believed to greatly enhance design efficiency and quality.[11] CAD software is used by engineers and designers for different engineering and construction works. It is used to create two-dimensional (2-D) drawings and figures or curves, solids and surfaces in three-dimensional (3-D) models.[12] There is however comparatively lesser software specifically designed for professional landscape architects[13] since they are mostly intended for engineers and architects. The software tools that are quickly replacing the hand-painted drawings and designs in the recent years and are now being utilized for professional consultations.[14]

i) AutoCAD

AutoCAD software is a computer-aided design (CAD) software developed and marketed by Autodesk, used to create 2D and 3D drawings and is the most widely used software tool by architects and engineers.[14, 15] The use of AutoCAD for landscape designing is very recent and enables user to create, edit, draft, annotate and add blocks using the 2D functions. It has a strong performance and user-friendly interface.[16] The 3D modelling function however is less utilized comparatively since the software is employed for base plan and design concept drawings rather than 3D visualization. A recent survey among 482 ASLA members concluded that AutoCAD is the most prevalent among different CAD software with 82% of respondents using it on a daily or weekly basis.[17]

The software was released in 1982 and is available in different operating systems for windows, macOS, android and iOS. The software can be purchased as one-time purchase or on subscription based to access the full benefits. It also provides a 12 months renewable licence for students and institutions for educational purpose. AutoCAD LT is an entry level CAD package available at a lower cost developed by Autodesk that offers basic design functions without the option for 3D rending and network licensing.

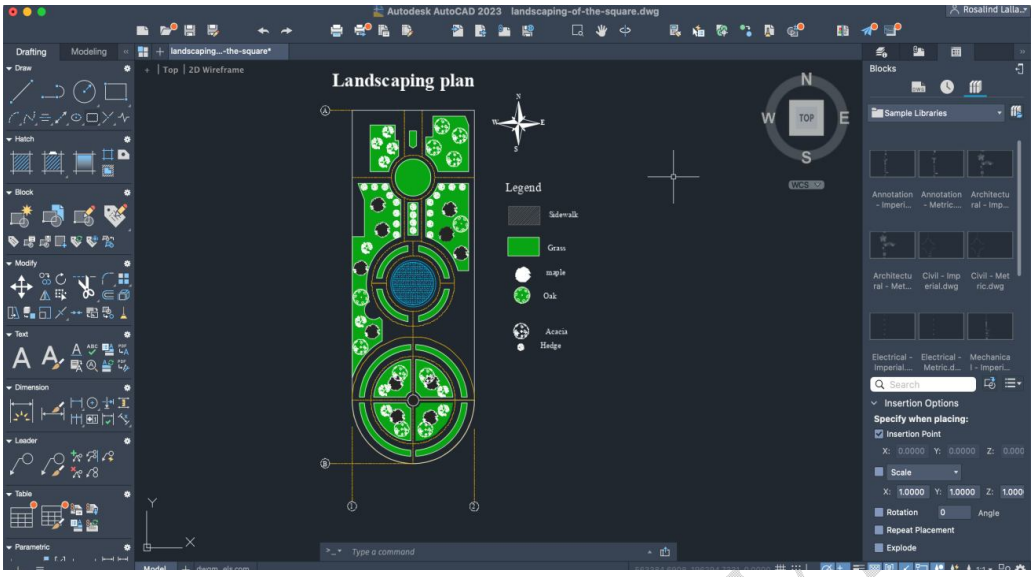

Fig 1: A model of landscaping plan in AutoCAD

Features and principles of AutoCAD[18]

- The software can be accessed both in the web app or the mobile app to create, edit and view drawing in multiple devices.
- The file extension for 2D and 3D drawings created in AutoCAD is .dwg and customized drawing templates with preferred settings can also be saved with the file extension .dwt.
- The Quick Access Toolbar consists of various tools for creating, opening, exporting and saving projects (Fig 1).
- The Ribbon below it contains numerous tools and commands arranged in tabs, which upon clicking includes set of panels with different tool icons. All tool icons are arranged accordingly in the tabs such as draw, modify, block, dimension, text etc.
- The commands for creating and editing can be entered manually by typing in the Command Bar and also lists the order of required steps to execute any given command.
- The inputs for the X-coordinate and Y-coordinate can be entered to specify the drawing coordinates.
- The View Cube is a navigation tool that is displayed when using the 2D or 3D model and can be used to switch between the standard and isometric views by clicking and dragging the icon.
- The compass is displayed below the View Cube and indicates which direction North is defined for the model.
- Blocks are objects that symbolizes a particular element in the drawing. They can be created or pre-made CAD blocks can be downloaded and inserted in the model. Blocks can then be modified by moving, copying or scaling them accordingly.

- The drawings can be saved and shared easily to view or edit them anywhere.

ii) PRO Landscape

PRO Landscape is a cloud-based landscape architecture tool that allows users create computer-aided design (CAD) drawings for different landscape projects. It includes 3D rendering, lighting design, photo imaging and proposal creation which can be used in up to three devices.[19] The product comes with different CAD tools, enabling professionals to transfer materials such as plants, furniture and other garden elements to the design database. The software was developed by Drafix Software Inc.

Features of Pro Landscape

- It gives the ability to import or export CAD files from AutoDesk.
- Pro Landscape allows user in creation of an accurately scaled drawings of landscape plan in any desired size or scale.
- Google earth images or plot plans and survey can be easily imported, facilitate creation of base plan easily and quickly.
- The library has pre-assigned customizable symbols for specific plant species. It also houses large collection of hardscape symbols such as pavers, wall, boulders, landscape statuary, water features etc.
- User can import and export files, or even share them over common formats.
- It also includes an application that can be used to create and modify designs on iPad and android tablets.

iii) Revit (Environment for Revit)

Autodesk Revit is a modelling software tool for architects, engineers and landscape architects that allows them to design a building structure and its components in 3D, it allows annotation of the model with 2D drafting elements, and also helps to access building information.[20] It is one of the best BIM platform that help in designing, documenting, visualizing and delivering architecture, engineering and construction projects .[21] This software has more functions inclined towards building designs and modelling and hence not commonly used by landscape architects.

Environment for Revit is a toolset or plug-in to Revit that allows landscape architects to design within the Revit workspace and provides solutions for all phases of the landscape design workflow. This is because there is a lack of sufficient landscape architecture segment within the AEC industry including Revit, which is a missing feature that is required for landscapers.[22] It was started by a group of landscape architects more than few years ago and was developed by the company Arch-intelligence, a member of Autodesk developer network.

Features of Environment for Revit

- The Environment ribbon within Revit contains more than 40 tools for several features including slopes and grading, walls, fences and planting.
- The tools provide capabilities to create colour analysis of slopes and elevations of topography.
- The new scatter tool allows creation of forest models or place multiple plant types according to the planting proposal.
- It speeds up the workflow by automating many routine operations and improving the graphical representation of the site plan.

iv) Sketchup

Sketchup is a suite of designing products like SketchUp Pro, SketchUp Go and SketchUp Studio for drawing and designing architectural, civil and landscape architecture projects with many functionalities. It became one of the software that plays a key role in the 21st century architectural drawings[23] allowing 3-dimensional drawings to be created, edited and displayed.[24] The program includes functions for drawing layouts, rendering surface in different styles and also facilitates positioning of its models within Google Earth.[25] It is a creative tool to design, develop, document and communicate from the earliest stages of design to the end of construction.

It was developed by Last Software in 1999, acquired by Google in 2006 and was again acquired by Trimble Inc. in 2012.

Features of SketchUp

- Existing data and files such as 2D CAD files and 3D models can be imported.
- An exact terrain imagery of a particular site can be directly obtained by using the SketchUp's Geo-location tool. It will help in specification of longitude and latitude of the imagery directly into the model.
- There are numbers of objects in the SketchUp's 3D warehouse available for download from vegetation and vehicles to people and animals.
- The contour lines can be quickly turned, drape the hardscape elements and also modification of existing terrain. The personalised imagery and date can be imported directly with ease.
- Design vision can be communicated by exporting images and videos that show variations and details using images, animations and videos.

v) SmartDraw

SmartDraw is a wed-based diagramming and designing tool used by professionals and businessmen to make flowcharts and organizational charts. It also allows users to create and edit drawing including landscape projects. It is useful for simple designs of urban landscape with extensive

plant encyclopaedia and several template to assist in landscaping.[26] It was released in the year 1994 by the developer SmartDraw LLC and can be used on subscription basis.

Features of SmartDraw

- The file extension for saving SmartDraw drawings is .sdr whereas the file format for document template with preferred setting is .sdt.
- Smartdraw can be used to add diagrams to Microsoft office software including Word, PowerPoint, Excel and lets users save it on platforms such as OneDrive and Google Drive.
- The projects and documents can be shared from any device.
- For landscape drawings, basic outline can be created which would represent the edge of a garden, the end of the yard or a fence.
- The landscape elements such as shrubbery, trees, and flowers can be added. Symbols for features like lawn, furniture, pools, sheds, gazebos, buildings, and fountains can also be added.

vi) Realtime Landscaping Pro

Realtime Landscaping Pro is a landscape design tool that offers 2D and 3D renderings providing functions for several landscape features and modify models. It provides an effective way of creating a landscape plan using a large collection of plant and non-plant objects in the libraries[27, 28] by utilizing the advanced 3D graphics technology to create a realistic design.

Features of Realtime Landscaping Pro

- There are more than 4000 non-plant items that can be customized, such as furniture, walls, gates, fences and lighting as well as materials such as brick, concrete, wood and stone.
- An extensive library of more than 5000 realistic plants, and thousand more garden accessories are available.
- The realistic lighting, shadows, running water and even moving leaves when viewed in the 3D walkthrough mode which helps to visualize the feel of the finished garden design.
- It is possible to import a photo of the site and make a design over it.
- The finished plan can be shared or printed easily.

vii) Adobe Photoshop

Photoshop is an image processing software developed by Adobe Inc. for both windows and Mac. The software has become the most used platform for digital art and graphic editing and delivers literal representation of concepts and designs.[29] In case of landscape designing, photoshop is employed for post-production and is used to enhance and process images after drafting and designing in other software.[30]

3. INTEGRATION OF CAD SOFTWARE FOR LANDSCAPING

Many CAD software files are compatible and can be shared among them allowing it for easy data importation or exportation when needed. This enables the integration of more than one software to design a landscape project producing a more polished plan enhanced by various functions in different platforms. Studies have shown that integrating different CAD software allows development of products more efficiently. Most professional landscape architects uses AutoCAD for 2D drafting whereas software like Pro Landscape and Revit are mostly used for 3D design modelling[25] as presented in Fig 2. Photoshop is an image editing and graphic designing software that can be used for pro-processing the landscape design. This technique can also help in assisting software which is found to be lacking in certain functions or tools and also improve the object library.

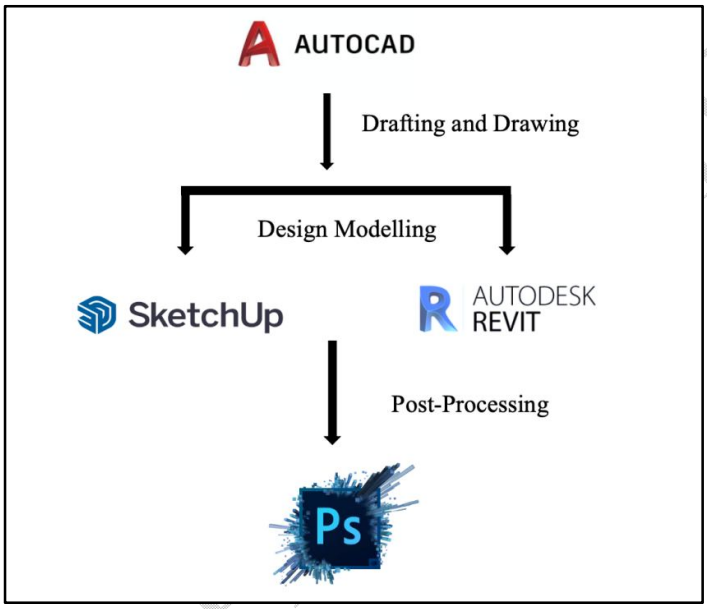

Fig 2: A landscape design step using CAD-SketchUp-Photoshop[25]

The integration between different software although possible is often created with limited possibilities and functions. Landscape designers need to work on the compatibility between the software and get themselves acquainted with the strong and weak points of each one to make the best use of all the strong points offered by every software. This would assist in creating an accurate and perfect design by applying multiple CAD platforms.[31] The files and objects created using SketchUp can be easily imported and further utilized or processed in Realtime Landscaping software (Fig 3).

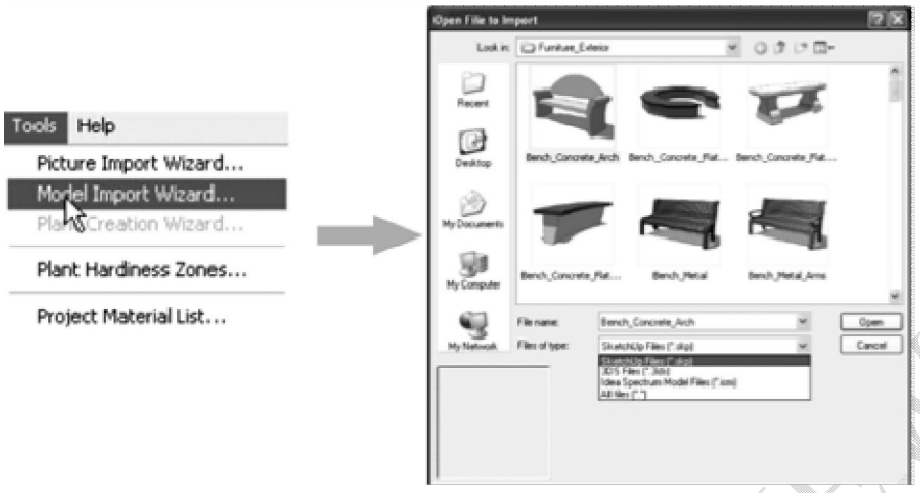

Fig. 3. 3D Sketch UP models imported through Realtime Landscaping[31]

4. ADVANTAGES OF CAD IN DESIGNING AND DRAFTING

There are numerous benefits of using CAD software over the traditional drawings. Productivity and product quality are all improved when using CAD, with reduced process time and lower product costs.[2, 32] The advantages of using these software can be listed as below.

Simplifies work

In the past, landscape architects would draw all their designs by hand or by using old-fashioned drafting techniques which would take a considerable amount of time. When there are alterations and modifications to be done, the entire design have to be drafted and drawn from the start. It takes time and effort whereas the use of CAD can help simply the work and help integrate changes easily with the tools and functions just a click away.

Increases productivity

CAD software allows designers to work smarter and at a faster rate thereby lowering the production cost at the same time which ultimately leads to quicker completion of projects compared to manual operations. This enables production of a high-quality, low-cost products at a faster rate and easily make changes when required. With the implementation of CAD, designers can visualize the plan and test them against the real-world variables. The same file can be easily altered swiftly on point when certain changes needs to be made.

Improves the quality of design

The software offers set of design tools that enables various modes of pre-calculations and control the quality of the final project. This helps in prevention of design flaws that can incur during the process and guarantee enhanced quality.

Improved accuracy

The accuracy that can be achieved by using CAD software cannot be compared to that of manual drawings. It provides various tools to measure the accuracy level and precision of the designs.

Easy to recreate and modify

The designs made can be easily altered when modifications are made. It allows users to create plans and present them in virtual model to see if the design fits the plan and purpose. Any alterations that is required to be made, it can be attained easily using different toolset of the CAD software. When the main plan is completed, the files saved as such could be used again to recreate or modify as per desired without having to restart the drawings.

Enables information sharing

The files created in CAD can be shared easily among designers to incorporate different ideas and can be easily modified anywhere. Cloud-based CAD systems allow users at different locations or remote workers to collaborate on projects.

MERITS AND DEMERITS OF CAD SOFTWARE

All technological and digital approaches can have their own merits and demerits. However, selection and comparison between different software can be analysed according to the size and purpose of the project. The major pros and cons of the discussed software[33, 34] can be summarised as below.

Cad software	Merits	Demerits
AutoCAD	It is used as the standard for computer aided designing and has compatibility across different platforms.	It requires powerful hardware or equipment for smooth operation and high performance, which could increase the cost.
Pro Landscape	It has sophisticated 3D rendering tools and has a rich object library in which real images can also be used for better referencing.	The software is expensive and does not provide option for free trial.
Revit	The Revit BIM software assists in creating realistic visualizations and allows to store all information enhancing work productivity.	It is not very user-friendly and does not provide the required function unless the toolset or plug-in 'Environment for Revit' is utilized.
SketchUp	It is a powerful engine with rich modelling tools and customizable palettes.	The features mainly focused on 3d designing and has less features for 2D designing.
SmartDraw	It is user friendly with multiple options	There is no option for 3D graphics.

	of templates and objects. It is also comparatively less expensive.	
Realtime Landscaping Pro	The design cost can be estimated easily which is an important feature for handling especially large project	The software is a windows only package.

Table 1: Merits and Demerits of Cad software

5. STEPS INVOLVED IN LANDSCAPE DESIGNING

The entire process of landscape designing can be divided in two major phases i.e., design and construction. Landscape projects differ with scale and complexity however all follow the similar steps in the design process.[35]

Step 1: Initial consultation and meeting

The initial consultation of the landscape designers with the customer is a very crucial step. There must be onsite meeting and discussion on the purpose and scope of the project, the elements, the budget and principals involved. The vision for the landscape site must be conveyed clearly so that the landscape architect assigned could grasp the idea and intend of the client.

Step 2: Site analysis and preparation of base plan

This step involves site survey and analysis upon which the landscape architect would develop a site inventory and prepare base plan. Inventory for the site involves locating the site, condition of existing elevation, buildings, vegetation, soil, topography and environmental factors. The surrounding area including public utilities and boundary lines needs to be properly studied, photographs can also be taken for references during the design process.

Step 3: Design concept

In this step, the landscape architect formulate an initial design idea based on all the information gathered in the previous stages and creating scaled ground plans and sketches defining the general concept. The overall layout of the planting materials to be used as well as the hardscape elements such as pool, patio, walkway, benches, lights, fences and trellis are incorporated into the design concept. The main objective of this stage is to present an outline or sketch with documents that will help the client to understand an overview of the proposed plan with the possible opportunities and constraints involved. The clients' perceptions and considerations should be taken in each step of the process.

Step 4: Design development / master plan

After revisions of the concept plan are being made with necessary editing and modifications in consultation with the client, the master plan is prepared. In this stage, the landscape architect will develop a more detailed plan including all the features to be added. A plant lists detailed with the information such as common name, botanical name and quantity required based on the design is a

necessity. Coloured photographs of the plants can also be attached for reference. Layout and locations of all other elements are to be mentioned with complete specifications.

In this stage, possible major issues regarding access, topography, services and budget are investigated and presented in proper detail. Design development is considered to be highly detailed with all documents required for design implementation including procurement, construction companies, local pricing and documentation and are to be addressed as per the requirements.

Step 5: Design implementation and construction

Implementation of the design also involves various steps of construction. Necessary procurements are to made and tenders are issued. The construction stage is then carried out in consultations with the landscape architect and the clients simultaneously.

6. CONCLUSION

With the advancement in the field of science and technology, computer-aided landscape design will only become more relevant and convenient. It covers a wide range of development and more perfect landscape planning scheme. To bring about more realistic designs and creativity, one must be acquainted with the basics of computer aided modelling especially those in the related field to fully employ the technology in producing a better work result. Current research is focused on the more advanced concepts of CADs with virtual reality assistance and other documentation programs.

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