

# 3D DIGITAL GRAPHICS IN LANDSCAPE ARCHITECTURE PROFESSIONAL PRACTICE: CURRENT CONDITIONS IN A NUTSHELL

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## 1 ABSTRACT

*3D digital graphics and representation have been a critical part in landscape architecture professional practice. However, few studies have been conducted to document how 3D digital graphics are currently being used. Some important questions are largely unknown. For example, who are the primary users of 3D digital graphics programs, and what are the most popular 3D software packages, and why. A better understanding of these questions is not only important to practitioners, but also to educators and software developers. This study tackles the above questions through a national online survey of landscape architecture firms. Five sets of questions were asked, including (1) background of the firm, (2) familiarity with 3D software programs, (3) current status of using 3D programs, (4) interest in using 3D programs in the future, and (5) desirable impact of 3D programs on landscape architecture professional practice. The survey was sent to all the American Society of Landscape Architects' members through SurveyMonkey. More than 400 firms responded (response rate 13%). Results show that currently landscape architecture professionals exhibit limited use of 3D technologies. The main barriers are the steep learning curve and daunting cost for license. However, majority of the respondents expressed the desire to take advantage of 3D modeling and visualization in their work. The reported main benefits of using 3D technologies include: the ease of communicating with clients and the general public, the ability to create polished and detailed landscape design representations, and time saving in receiving feedback on design and making amendments accordingly, compared to traditional physical models.*

### 1.1 Keywords

3D digital graphics, landscape architecture, professional practice, visualization

## 2 INTRODUCTION

Landscape architects are often charged in tackling interdisciplinary design tasks, where visual communication becomes a key in demonstrating project outcomes to audience groups of all kinds. Development of 3D digital graphics was first led by architecture and industrial design, and then rapidly adopted in landscape architecture. Pervasive arguments for using 3D technologies are that they constantly innovate and may fundamentally change the way that design is perceived and communicated (Lange, 1994, 2001; Tress and Tress, 2009). As a result, an increasing number of landscape architects are applying 3D technologies in order to supplement the traditional 2D methods of design representation.

3D technologies have unique capabilities in creating visualizations that convey complex design ideas to the clients in a meaningful way. Moreover, current 3D technologies allow landscape architects to integrate various data sets and analyses (e.g. hydrology, visual impact assessment) into their work (Hanna, 1999). With the growth of environmental consciousness since the 1970s and the migration of public agencies' data into digital formats, landscape architects are held accountable for using best available information to inform their design and fulfill environmental stewardship (Hanna, 1999).

Despite these encouraging aspects, some early studies found that the high cost and time commitment in learning have prevented designers from using 3D technologies (Paar, 2006). However, little research has been conducted on the current status of using 3D technologies in the realm of landscape architecture. Moreover, little is known about practitioners' perceptions on whether 3D technologies are suitable for their work. The objective of this study is to reveal the current applications of 3D software use in landscape architecture profession practice in the United States. Through conducting a national online survey, we identified patterns of who are using 3D technologies, what tasks 3D technologies are used for, and practitioners' needs and suggestions for future improvements.

## 3 MATERIALS AND METHOD

This study used online survey method for data collection. Survey questions were mostly closed-ended. Room was provided where participants can share additional thoughts on their evaluations of 3D programs' efficacy and opinions on the applicability of these programs to their work. Five sets of questions were asked, including (1) background of the firm, (2) familiarity with 3D software programs, (3) current status of using 3D programs, (4) interest in using 3D programs in the future, and (5) desirable impact of 3D programs on landscape architecture professional practice.

Because this research involves human subject, our survey instrument was reviewed and approved by Utah State University's Institutional Review Board (IRB) (Protocol #4405) before data collection started. Survey instrument was then sent out electronically through Survey Monkey (<http://www.surveymonkey.com>). We invited landscape architecture firms registered with the American Society of Landscape Architects (ASLA) to participate in this survey. The ASLA website listed totally 4,789 members (firms and freelance landscape architects). However, only 3,434 members provided valid or have updated their email addresses online. These members were contacted for the study.

The survey started on June 21st, 2012. A reminder email was sent out two weeks later, on July 5th. The survey was closed on July 21st. A total of 427 valid responses were received (response rate 13%). Although the response rate is relatively low, it is comparable with other similar online survey studies (Baruch and Holtom, 2008). Also, the initial sample size is large which took into account all the ASLA members in the U.S. Figure 1 shows the geographic locations of the respondents and their frequency of 3D technologies use. A random distribution of participants' locations and their frequency of 3D technologies use also help reduce the bias of using less representative samples. Given these factors, we considered the dataset as acceptable and proceeded with analysis.

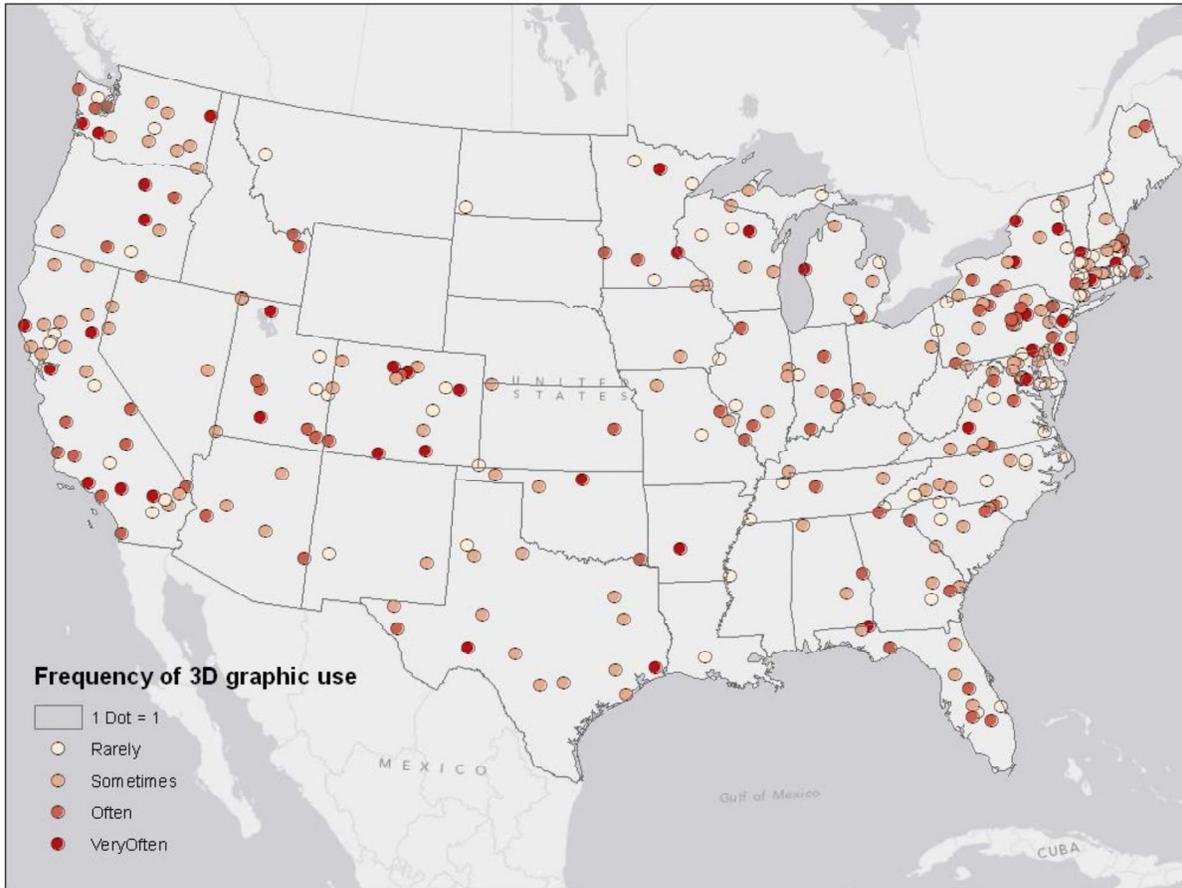


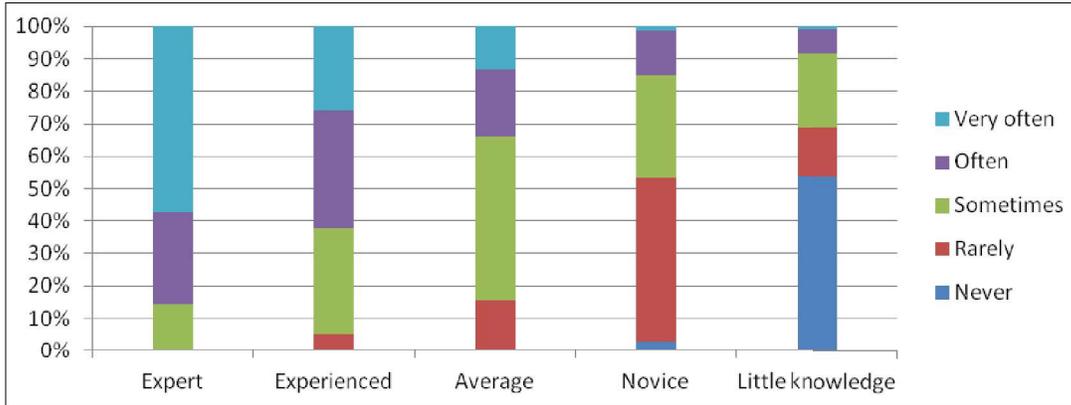
Figure 1. Geographic distribution of participants and frequency of 3D software use

#### 4 RESULTS AND DISCUSSION

##### 4.1 Who are using 3D Technologies in Landscape Architecture?

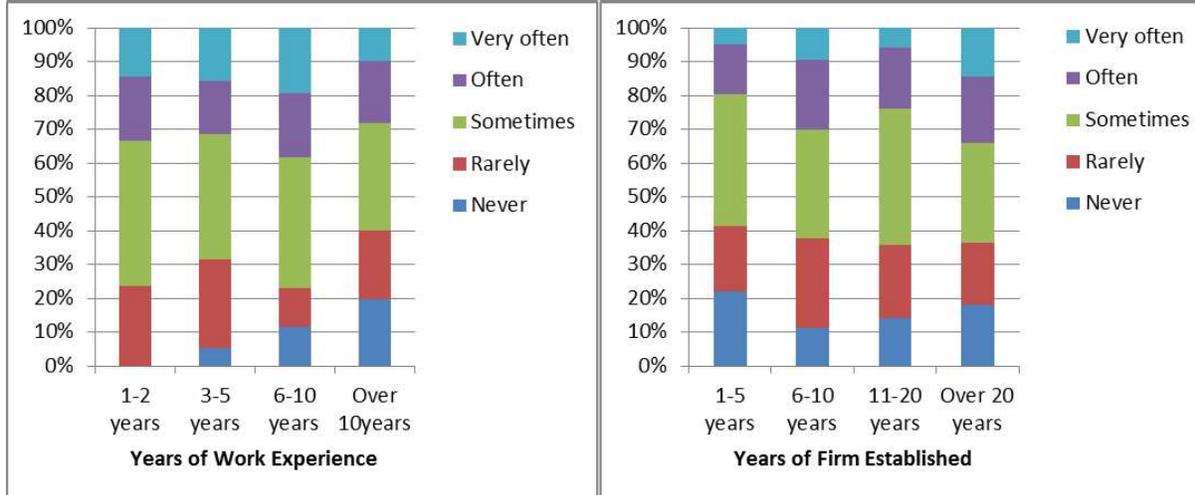
For the question about how frequently professionals use 3D software in their daily work, only 30% of the respondents stated that they often or very often use 3D software during the design process. Only 20% of them considered themselves as experienced/expert 3D software users. Among the eleven 3D software programs examined in the survey, respondents suggested that Google SketchUp, ArcGIS, AutoCAD Civil 3D, 3D Studio Max, and AutoCAD Map 3D are most used.

Use Frequency and Levels of Experience are compared to examine whether experienced users take advantage of 3D software more often than less experienced users (Figure 2). It is obvious that in the expert/experienced groups, more than 50% of the respondents use 3D software often/very often. However, in novice/new user groups, fewer respondents suggested that they use 3D software frequently. The results show that more experienced users would adopt 3D software more often than novice/new users. An interesting finding is that although some respondents did not consider themselves as experienced users, they reported high frequency of 3D software use.



**Figure 2. Frequency of 3D technique use in relation to user's knowledge level**

The history of 3D software application in landscape architecture, both in education and practice, is relative short compared with other related disciplines (e.g., architecture, interior design). It was not until the 1990s that 3D technologies were introduced to landscape architecture (Ervin, 2001). Considering this background, it can be assumed that senior landscape architects would use 3D software less frequently than junior professionals. Figure 3 actually shows that there are 20% of the senior landscape architects seldom or never use 3D techniques. However, when comparing the years of work experience with the frequency of 3D software use, insufficient evidence was found to suggest that there are substantial differences among user groups with varying years of work experience.



**Figure 3. Frequency of 3D software use in relation to user's work experience and years of firm establishment**

Around 84% of the respondents have work experience that is more than ten years, whereas less than 10% of the respondents have less than five years. The low response rate from junior landscape designers (e.g. this 10% of respondents) presents a limitation of this study. This is because recent graduates would have been exposed more extensively than earlier graduates to digital graphics in their education, and therefore they are expected to be leading the use of 3D techniques.

Furthermore, there is a weak correlation between the frequency of 3D technology use and years of firm establishment. Generally speaking, younger firms (1~5 years of history) have relatively higher percentages in the category of rarely or never use 3D software, older firms (more than 20 years) reported higher frequency of adopting 3D software. But again, the evidence is not sufficient to conclude that there is a correlation between the frequency of 3D software use and the firms' year of establishment.

Other factors that were hypothesized to be important for the frequency of 3D software use, did not show huge significance. For example, male and female participants reported similar levels of use frequency. Also, education background does not suggest itself as an important factor that influences the frequency of use.

**4.2 What 3D Software Programs are being used in Landscape Architecture?**

There are many 3D visualization programs currently available. In landscape architecture, the most commonly used 3D software packages include Google SketchUp, ArcGIS, AutoCAD, 3D Studio Max, Maya, and VuE (Table 1). These packages vary in platform, price, and their main applications. Some programs focus more on 3D visualization and representation (e.g. Google SketchUp and Studio Max). Some are very comprehensive and include 3D analysis and visualization functions (e.g. ArcGIS). The number of users reported by the survey was also included in Table 1.

**Table 1. Commonly used 3D software programs in landscape architecture**

	No. of users	Price	Initial Release	Main Applications	Animation	Rendering
3D Studio Max	41	\$3,495	1988	Modeling, animation, lighting, rendering, video game creation, visual 3D effects, post-production video editing	Yes	Yes
AutoCAD Civil 3D	90	\$6,825	2004	Basic 3D modeling	Yes	Basic
AutoCAD Map 3D	41	\$5,245	2005	Basic 3D modeling	Yes	Basic
AutoCAD Plant 3D	6	\$8,922	2009	Basic 3D modeling	Yes	Basic
ArcGIS	69	\$5,000-\$40,000	1999	Modeling, geoprocessing	Yes	Basic
Bryce 3D	1	Free for a limited time	1996	Modeling, animation, lighting, rendering, visual 3D effects	Yes	Yes
Google SketchUp /Pro	303	Free/\$495	2000	Computer aided design	Yes	Yes
Maya	6	\$3,495	2007	Modeling, animation, lighting, rendering, video game Creation, visual 3D effects, post-production video editing	Yes	Yes
Rhinoceros 3D	0	\$995	1998	Modeling, computer aided design	Yes	Yes
Vectorwork	34	\$1,441-\$2,895	1999	Computer aided design	Yes	Yes
Vue	41	\$1,495	2005	Landscape modeling, animation and rendering	Yes	Yes

\* The initial release date is based on the first commercial version release date

The most popular 3D software program being used by landscape architects is Google SketchUp. This is likely because of the low learning curve and the low (or minimum) investment on license. In fact, Google SketchUp (non-professional version) is the only one that is free and sets no limitation on the license period. AutoCAD and ArcGIS suites are also popular. For example, for firms that involve large-scale planning work, ArcGIS offers powerful 3D analysis and visualization functions. AutoCAD Civil 3D is also instrumental in stormwater related analysis and cut-and-fill calculations, presented in a 3D manner.

**4.3 What are 3D Software Programs used for in Landscape Architecture?**

Communication plays an important role during the design process and landscape architecture is no exception. Communication becomes particularly critical between designers and clients (Nielsen et al. 2010). In this study, participants were asked to rate the effectiveness of 3D programs in communicating to

different targeted groups. Majority of the respondents agreed that 3D programs are overall effective in communication. To be more specific, the general public, concerned groups, and policy makers were groups to whom 3D programs are most effective for conveying design messages (55.2%, 42.5%, 37.9% respectively, rated as Most Effective) (Figure 4). The above groups are considered to have limited training and knowledge of design (Paar, 2006). Therefore, 3D programs show an advantage in facilitating the design process of engaging layman audience.

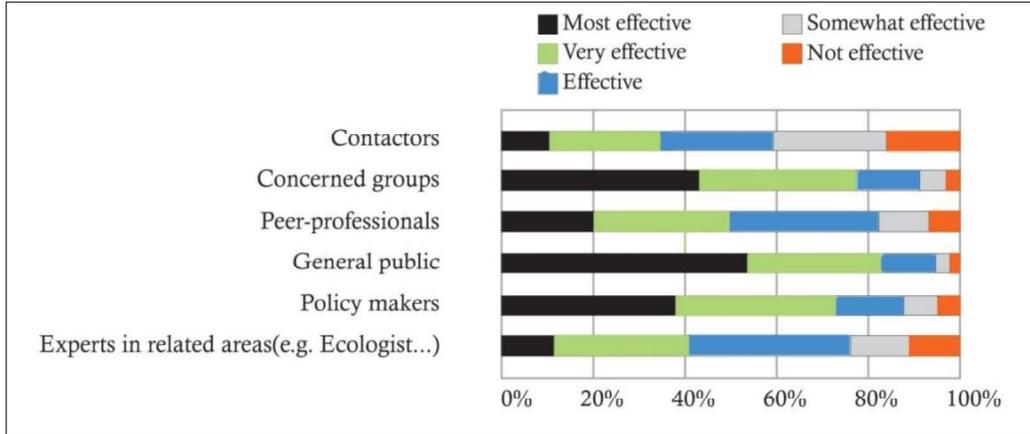


Figure 4. Effectiveness in communication with different groups using 3D software programs

The participants were also asked in respect to how 3D programs were applied in different design phases. Figure 5 shows a fairly even distribution across different design process, with the most extensive use occurs in the project final output. Other phases such as public involvement, planning alternatives, and preliminary draft were reported to have less, but still decent frequencies of use.

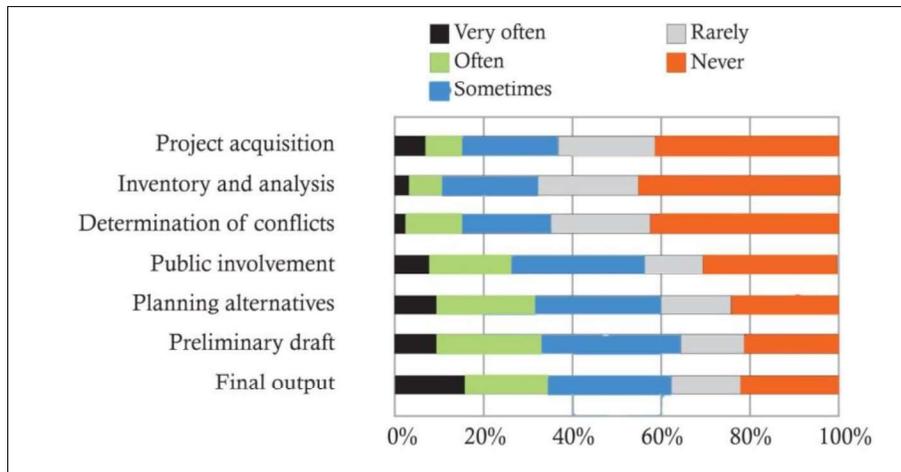


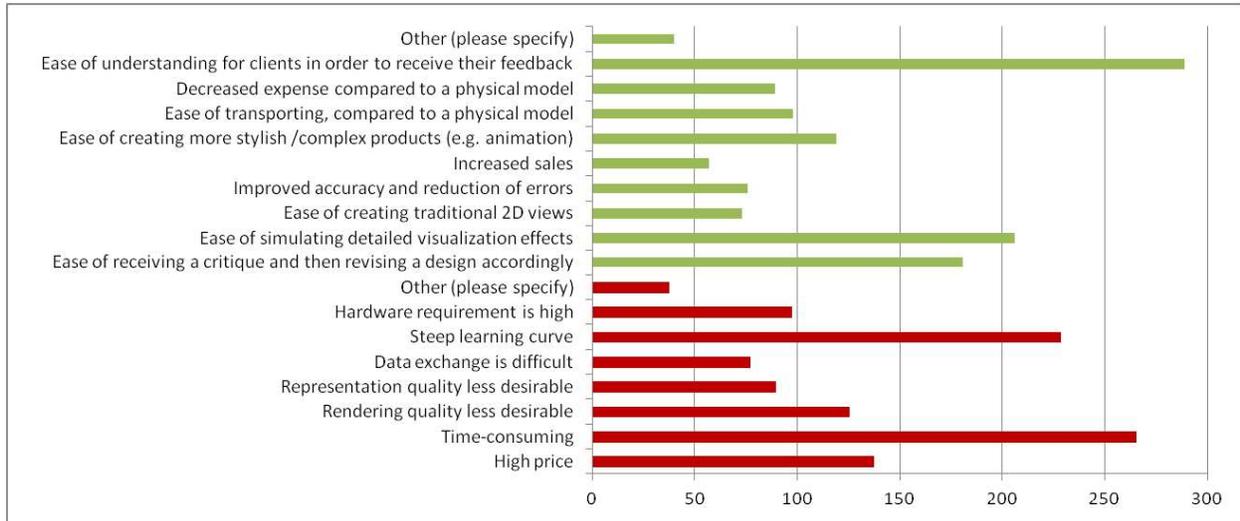
Figure 5. Frequency of 3D software program use in different design phases

The findings have corroborated the perception that 3D programs are mostly successful in performing communication tasks. When communication is addressed to audience groups that have limited knowledge in landscape design (e.g. clients, stakeholders, and policy makers), it is valuable to take advantage of 3D programs for clear and easily comprehensible project presentations (Sheppard and Meitner, 2004).

#### 4.4 Benefits and Challenges of using 3D Technologies in Landscape Architecture

Although the respondents' knowledge level of 3D technologies varies, most of them consider 3D technologies helpful for the profession (Figure 6). The most compelling benefit is a better communication

between designers and clients (reported by 89% of the participants), and as a result increasing clients' satisfaction. It is evident that a healthy designer-client relationship will not only help designers accomplish projects smoothly, but also contribute to long-term client retention. In contrast, traditional 2D communication venues (e.g., plan renderings, 2D line-work plans and maps) have not been fully successful in engaging clients and stakeholders (Kheir, 2001). Based on their experiences, designers can rely on 2D drawings to visualize design proposals in a 3D format; whereas average client may be overwhelmed by sophisticated 2D drawings and experience difficulties in picturing landscape design visions. In this sense, 3D technologies complement traditional 2D design languages and increase the versatility of presentation.



**Figure 6. Benefits (green bars) and Challenges (red bars) of using 3D programs in landscape architecture (n=324)**

Another major benefit of 3D visualizations is that they allow the proposed design to be put in the real context (e.g. showing the surrounding landscapes). Because these visual simulations are done by computers (versus physical models), it makes designers' job easier in making design amendments after receiving feedback. These simulations also enable the comparisons of different design alternatives in a speedy manner. Potential design problems that may not be easily identified through 2D drawings may stand out more easily when presented in a 3D format. In addition to 3D visualizations, some software packages (e.g. ArcGIS) can perform suitability analysis and landscape performance evaluation. Other advantages of using 3D programs are also notable, such as the capability of performing time-series analyses through animation and the ease of project collaboration via model sharing.

Challenges also follow. The most noteworthy ones are significant time commitment and steep learning curve, reported as 79.3% and 68.3% by the respondents, respectively. In addition to these two major hurdles, respondents also requested future 3D programs to provide fast, yet photorealistic rendering, increase the compatibility with ArcGIS and other geoprocessing tools, provide more and higher quality symbols, and improve modeling accuracy. Participants also expected future 3D programs to include more features, such as sophisticated lighting design options, rich material and texture libraries, and intricate rendering effect of reflection.

The main technical barrier currently, however, is the programs' lack of ability in building models and delivering high-quality simulations rather quickly. Practitioners have little choice but to omit details in performing model development and visual simulations. Moreover, for a small project it may not worth using 3D technologies because it may likely go beyond the budget limit. On a personal level, another challenge would be the arduous learning process and substantive time commitment. One of the respondents commented that: "I would be interested in using 3D software, but time for learning and money to invest is currently scarce. I am busy enough without it at the moment."

## 5 SUMMARY AND CONCLUSION

This study reveals that landscape architecture practitioners in the United States currently exhibit limited use of 3D software programs. Only 30% of the respondents use 3D programs on a daily basis. Google SketchUp is the most popular 3D software. Other widely used software programs include ArcGIS, AutoCAD Civil 3D, and 3D Studio Max. It is not surprising that the low (or minimum) price and the low learning curve make Google SketchUp a popular option. In respect to when to use 3D programs during the design process, the following phases were reported (from the highest to lowest frequencies): client and public involvement, design alternatives, preliminary draft, and final output.

In addition, respondents emphasized the importance of maintaining core skills (e.g. sketching) of landscape architecture professional practice and design thinking, and put less emphasis on pure graphic production. For example, a few experts from the respondents' statements expressed the concern of overweighting the importance of 3D visualization as a tool. The consensus among the respondents is that the design process appreciates human spontaneity and imagination. Design is a unique representation of human creativity and the current 3D technologies have yet to fully embrace or be able to simulate these activities in real-time.

- "Too many graduates are coming out of school with great graphics and 3D skills, not professional practice skills and the reality check of whether their designs are attainable."
- "While not at all opposed to 3D modeling as a presentation tool, I am of the opinion that design professionals MUST learn to draw, both in 2D and 3D, by hand. It is critical to the creative process!"

This study also shows that communication and collaboration between landscape architects and hardware and software developers is essential to facilitate a wider application of 3D techniques in landscape architecture. In the United States, landscape architecture is a relatively smaller profession compared with civil engineering and architecture (two disciplines that landscape architects mostly collaborate with). As a result, there are not many 3D software programs specifically designed for landscape architecture (Pihlak and Barrett, 2000). Hence, there is a need to keep up the dialogue with software program development and make a pitch to the growth of landscape architecture profession.

Finally, educators in landscape architecture can benefit from this study through incorporating findings into curriculum development and better serve students for the work force. 3D software developers can also use this research to improve digital programs that are better suited for landscape architecture.

## 6 ACKNOWLEDGMENT

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