Computer-Aided Animation in Architecture:
Analysis of Use and the Views of the Profession

Douglas Noble, AIA, Ph.D. and Jason Hsu
Clipper Lab, School of Architecture
204 Watt Hall -- University of Southern California
Los Angeles, CA 90089-0291, USA
dnoble@usc.edu

1.0 Abstract

A traditional way to present three-dimensional representations of architectural design has been through the use of manually drawn perspective drawings. The perspective representation assists in the comprehension of the forms and spaces, but is difficult to manually generate. The computer revolution made perspectives much easier to generate and led to a dramatically increased use of three-dimensional representation as a presentation technique. We are just now seeing substantial uses of animation as a communication and presentation tool in architecture. This paper documents the results of two surveys of the architectural profession that sought to discover the current and near future intentions for the use of computer animation. Our belief is that current levels of computer animation use are low, but that many firms intend to start using animation both as a design and presentation tool.

This paper represents the tabulated results from 82 completed surveys out of 620 requests. While some level of confidence can be obtained from this sample size, we are publishing in the hope of encouraging continued response to the survey. The survey is available on-line at:
http://www.jps.net/jsu54168/arch/survey.html

2.0 Background

The role of computer in architecture has changed considerably in the past few decades. From 1960s through 1980s, CAD programs were the mainstay of computing in architectural practice. Computer drafting substantially replaced hand drawing for construction documents. The computer's role has now expanded to include more capabilities in supporting the early architectural design stages.[1]

Animation is apparently poised to be the next generation of tool for architects for designing and communicating their projects. The most important character of animation is images of motion and time. Moving images can make three dimensional objects easier to visualize. The computer is simply the tool that makes the creation of animation easier[2].

There are many different three-dimensional animation programs, including Softimage/3D[3], LightWave[4], 3D studio MAX[5], and Animation Master.[6] The prices of those programs are vary widely. They range in price from under one thousand dollars to fifteen thousand dollars.

3.0 Hypotheses and Sample Selection

In early 1998 we conducted a survey of the uses of computer animation by architectural firms. We posited a set of 14 related hypotheses.

1. Most architectural firms do not currently use computer animation.
2. Most architectural firms intend to use computer animation in the future.
3. Large architectural firms use computer animation more than smaller architectural firms.
4. Larger firms more likely intend to use computer animation in the future.
5. Computer animations are shown to clients mostly in presentation.
6. Computer animation helps architects to design a project.
7. Computer animation makes projects more understandable.
8. It is easy to design a project with computer animation.
9. Computer animation helps architects to save time in design.
10. Architectural clients ask to see computer animations.
11. Clients understand projects better when architects use animation.
12. Computer animation is an alternative to making physical models
13. Architectural firms do not make physical models when they use computer animation.
14. Computer animation is a good design tool.

The architectural firms selected for the survey are divided in two different groups. One group was chosen from Los Angeles area firms.[7] The other group was selected from a list of architectural firms with home pages on the World Wide Web (WWW). For the local firms, the survey was mailed out to one hundred and twenty firms. We further defined the sample by differentiating between firm sizes. We mailed 40 surveys to each of three groups: small firms (1 to 5 employees), medium-sized firms (6 to 20 employees), and large firms (more than 20 employees). For the WWW selected firms, there were a total of five hundred firms randomly selected.

4.0 Responses

The number of returned surveys from the physical mailing was 46 out of 120, for a 38% reply rate. Comparatively, only 7% of the WWW survey requests received a reply (a total of 36 out of 500 surveys).

In tabulating the results of the survey, we used the Chi-square method with a null hypothesis for determining the confidence level.[8] The chi-square test first calculates a chi-square statistic and then sums the differences of actual values from the expected values. The equation for this function is: $x^2 =$ sum [(Observed Frequency - Expected Frequency)^2 / Expected Frequency]

4.1 Most architectural firms do not currently use computer animation.
From the survey, 35% of Los Angeles local firms are currently using computer animation. Although, this number is higher than we expected, it is still low. Of the WWW respondents, fully 56% said they used animation.

4.2 Most architectural firms intend to use computer animation in the future.
72% of Los Angeles architectural firms and 94% of WWW firms intend to use computer animation in the future.

4.3 Large architectural firms use computer animation more than smaller architectural firms
Of the 82 firms that responded to the survey, only 16 firms reported that they currently use animation. A substantial portion of the group using animation were large firms (10 out of the 16 total). Using the Chi-Square test, we can state with a confidence rate of 98% that large firms are more likely to use animation.

	Small Firms	Medium Firms	Large Firms
Expected	5.3	5.3	5.3
Actual	1.0	5.0	10.0

Confidence level = 98%

Larger architectural firms with more equipment and able to justify higher overhead costs may be the explanation of this result. In addition, larger firms often get more complex projects and they need to use computer animation to study the spaces they are designing and presenting to their clients(figure 8). One of the comments from the survey was that "…The use of rendering programs which realistically render light on the surface is very informative to the process. Some programs can produce photometry effects of actual light fixtures allowing the designer to show the client the actual lighting design."[10]

4.4 Larger firms more likely intend to use computer animation in the future
Most respondents claimed they will use computer animation in the future. The survey found that only 40% of small firms intend use computer animation. The future use in medium-sized firms is 79% and the large firms is 76%. However, it is worth noting that location of the predicted growth of computer animation is very much larger in the medium-sized firms.

	Current	Intended	Difference
Small firms	10%	40% 30%	
Medium firms	26%	79%	53%
Large firms	59%	76%	17%

4.5 Computer animations are shown to clients mostly in presentation
With this question, the result is substantially different from expected. Only 26% of LA's firms and 23% of the WWW firms use computer animation as presentation tool. Architectural firms using computer animation seem to use it not merely for presentation purposes.

Computer animations are shown to clients mostly in presentation
                                        Los Angeles Firms WWW Firms

Never	2	5%	3	10%
During Schematic Design	15	35%	7	23%
During Design Development	10	23%	7	23%
Final Design Presentation	11	26%	7	23%
Construction Documents	2	5%	1	3%
Other		3	7%	6	19%
TOTAL		43		31	

This is confirmed by one of the comments from a respondent: "Computer animation definitely helps architects visualize and develop their design to a degree that is not possible with traditional media and tools... The power of the computer is in because that options can be tried tested thrown out and re-tried..." Gladden and Associates Architects Productions.[11]

4.6 Computer animation helps architects to design a project
We asked respondents to rate the helpfulness of animation on a 5 step scale. The result shows that most architects from the WWW (confidence level = 84%) think computer animation is helpful, but the firms from LA (confidence level = 67%) are not as sure.

Computer animation helps architects to design a project
Los Angeles Firms

	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	0	4	5	4	3

Confidence level = 67%

Computer animation helps architects to design a project

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	1	2	6	4	7

Confidence level = 84%

Why is the result so different between Los Angeles firms and the WWW firms? The first reason may be that using computer animation requires computer skills. Making an animation is easy but making a good animation is not. Architects need time to practice and improve their skills for making computer animation. Also, many architects still used to use traditional tools to design their projects. According to survey respondent Martha L. Rowlett, "to be a computer illustrator, knowing the program is only one aspect you must learn. The processes of photography, scanning, and output methods are all subjects that an illustrator should know and keep up with in the ever-changing world."[12]

4.7 Computer animation makes projects more understandable
Computer animation can be used by architects to "walk through" or "fly around" their building design proposals. This can help the architect visualize the proposal to determine if the scheme matches the intentions. In addition, architects can show time issues by using computer animation to study daylighting, shadowcasting, seasonal changes and even aging of materials. "…Using this tool, we can easily spot design flaw, make the clients understand the design and help us to decide color and materials more quickly." comment from the D. del Rosario Architects.[13] According to survey, architects clearly believe that computer animation helps make projects more understandable. Both samples give confidence levels of 100%.

Computer animation makes projects more understandable

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	0	0	2	7	7

Confidence level = 100%

Computer animation makes projects more understandable

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	0	0	1	9	10

Confidence level = 100%

4.8 It is easy to design a project with computer animation

Tere is the first time in the survey that the two groups differ very strongly. In this case, the Los Angeles firms believe that using animation is often more difficult than the WWW group believes. The reason again may be that making computer animation needs better computer skills. According to Adam Noble, "producing first-rate professional architectural visualizations requires organization, planning, testing, and patience, so don't get discouraged if at first you do not succeed. Continue to test and experiment, and eventually you will be fluid enough with the software to effectively render and animate architectural spaces."[14]

It is easy to design a project with computer animation

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	4	3	7	2	0

Confidence level = 92%

It is easy to design a project with computer animation

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	1	3	7	7	2

Confidence level = 91%

4.9 Computer animation helps architects to save time in design
With this question the two groups again take opposing views. The Los Angeles group emphatically believing that animation is not a time saver, while the WWW group believes it is.

Computer animation helps architects to save time in design

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	5	6	4	1	0

Confidence level = 92%

Computer animation helps architects to save time in design

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	1	3	7	7	2

Confidence level = 89%

The speed of making computer animation depends on the computer equipment, animation programs themselves, and the person's computer skills. In a follow-up survey, we plan to find out whether hardware, software, or training (skills) is playing a substantial role. Computer equipment tremendously influences the speed of making computer animation. Software can also play a major role. While some software programs have the capability to do both modeling and animation, it may be that good modeling programs have limitations in animation that the users are not aware of. Of course, animation skill may be the most important variable.

4.10 Architectural clients ask to see computer animations
Clients are more likely to ask for computer animation if the projects are more complex. In reviewing the architectural rendering and animation book by Ojeda (1996), you can see that most projects using computer animation are fairly complex projects. Clear examples include the Samsung Cultural Education and Entertainment Center in Korea, the Tokyo International Forum in Japan (both by Rafael Vinoly Architects), and Nanjing East Road Competition in China by Hellmuth, Obata + Kassabaum.

Architectural clients ask to see computer animations

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	5	2	8	0	1

Confidence level = 99%

Architectural clients ask to see computer animations

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	4	2	8	5	1

Confidence level = 92%

4.11 Clients understand projects better when architects use animation
Certainly the firms believe that animation helps clients understand their proposals. A comment from Architectural Resource Corporation[15] provides a good explanation."It helps both the designers and the clients visualize the buildings. It even helps to see if it fits in with the surroundings."

Clients understand projects better when architects use computer animation

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	1	0	4	7	4

Confidence level = 95%

Clients understand projects better when architects use computer animation   WWW Firms

	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	0	0	4	8	8

Confidence level = 100%

4.12 Computer animation is an alternative to making physical models
From the CHI-square test, the confidence levels are not high enough to support this conclusion. The LA's firms' ratio is 79%, and the WWW group is at 80%. Several have argued that computer animation does not replace the physical model.

Computer animation is an alternative to making physical models

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	5	2	6	2	1

Confidence level = 79%

Computer animation is an alternative to making physical models

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	2	1	5	5	7

Confidence level = 80%

4.13 Architectural firms do not make physical models when they use computer animation
The results from the studies are very interesting. Most architects from the group of LA's firms still make the physical models often, however, a larger percentage architects from the group of the WWW firms do not. Although architects from the groups of the Internet may be small parts of whole architects, they actually use computer animation instead of the physical models. It is a sign that computer animation may be an gaining popularity among architects.

Firms do not make physical models when they use computer animation

Los Angeles Firms	No	Rarely	Sometimes	Often	Always
Expected	3.2	3.2	3.2	3.2	3.2
Actual	0	1	4	8	3

Confidence level = 98%

Firms do not make physical models when they use computer animation

WWW Firms	No	Rarely	Sometimes	Often	Always
Expected	4	4	4	4	4
Actual	7	0	9	1	2

Confidence level = 100%

4.14 Computer animation is a good design tool
This question was asked in the form of an open-ended comment. The ratio of LA's firms answering yes is 81%, and the ratio of the Internet's firms answering yes is 85%. "Although strictly placed in the same category as physical models, computer animation allows for a much quicker turn around. Therefore, unlike physical models which allow a much improved idea of the model you are experimenting with, computer animation allows for rapid prototyping of different ideas..." according to Bates Smart Architects.[16]

Many architects still believe that computer animation is not yet ready as a tool. "Animations can be very helpful, but they have limitations. It can be (though is not inherently) faster to study design variants via

computer models than with physical ones. This is not always the most helpful strategy.... As a more general answer, I think that frequently animations are less helpful as a design tool then the model they are generated from. ... Animations always anticipate, never react. Once done, an entirely new one has to be made to see something from a slightly different angle." - Zimmer Gunsul Frasca Partnership.[17] Assembly Design seems to agree, "I think in the future it will be a good tool but it is not economical yet especially for the small offices."[18]

5.0 Conclusion

Computer animation seems be a helpful tool in architectural presentation and design. Although most architects reported that they do not currently use computer animation, most architects who have computer animation experiences think this technique helps them. "As a visualization tool, current systems are already effective, although the additional time and energy required …" according to Kanner Architects in Los Angeles.[19] The current role of computer animation is most often as a presentation tool. On the other hand, some architects are trying to use it for designing and documentation. Because of these explorations, and advances in the capabilities of the equipment and software, the role of computer animation will change in the future.

References

[1] Dialogue Architecture + Design + Culture: Yu-tung Liu @ 1996 Dialogue 9, pp. 31-32.

[2] Digital Character Animation: George Maestri @ 1996 by New Riders Publishing, p.2.

[3] The Softimage/3D webpage is: http://www.softimage.com

[4] The LightWave webpage is: http://www.lightwave.com

[5] The 3D Studio MAX webpage is: http://www.ktx.com

[6] The Animation Master webpage is: http://www.hash.com

[7] Local firms were selected because we felt that they were more likely to respond to a survey from a school in their immediate region. Firms were selected randomly (every third listing) from the "Los Angeles AIA Guide to Architecture Firms."

[8] Calculations conducted using built-in formulas in Microsoft Excel and spot-checked by hand.

[9] Hellmuth Obata & Kassabaum INC. 1655 26th Street, Suite 200, Santa Monica, CA 90404

[10] Glavan and Associates Architects Productions, 250 East Broad Street, Columbus, Ohio, USA Web site: http://www.glavan.com

[11] Architectural Rendering 3D Studio Martha L. Rowlett, 1996, New Riders Publishing, p. 200

[12] D. del Rosario Architects, 226 Ortigas Avenue Greenhills, San Juan, Metro Manila, Philippines Web address: http://www.ddra.com

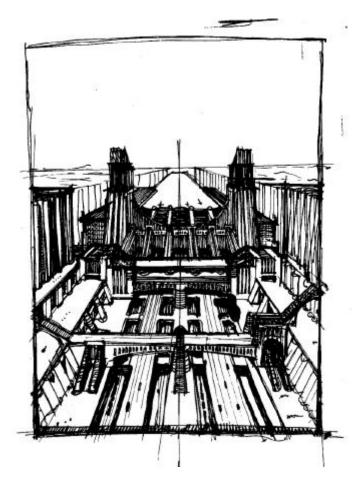[13] Architectural Rendering 3D Studio, Adam Noble, 1996, New Riders Publishing, p. 105.

[14] Architectural Resources Corporation,846 South Main Street, Dayton, Ohio, USA, Web: http://www.architecturalresources.com

[15] Bates Smart Architects, One Clarendon Street, Melbourne, Victoria, Australia, Web: http://www.batessmart.com

[16] Zimmer Gunnsul Frasca Partnership, 333 South Grand Ave, Suite 3600, Los Angeles, CA 90071

[17] Assembly Design, Box 13995, Berkeley, CA, USA, Web: http://www.assemblyarch.com

[18] Kanner Architects, 10924 Le Conte Ave, Los Angeles, CA 90024