Effective Use of Animation for Technical Communication

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ABSTRACT - *Animation can be an extremely effective and efficient means for communicating technical information to both technical and non-technical audiences. This presentation will showcase examples of animations that are highly effective, and those that are less effective. Selected animations will be dissected to examine what makes them particularly effective. The authors will also engage the audience in discussion about modeling accuracy, animation technique, and story flow.*

I. Introduction

Animation tools are available as a part of most commercial solid modeling software today. These tools allow users to create animations that demonstrate the assembly and/or operation of a mechanical device. The use of animation has recently evolved into a highly desirable means for the presentation of technical information for the following reasons:

1. It offers unparalleled clarity in the explanation of assembly and operation of devices.
2. It offers an excellent means of presentation of technical information to non-technical audiences.
3. If engineers, instead of artists or technicians, are permitted to create the animations, errors in proper depiction of parts, processes, and operations will be reduced.

Animations usually comprise three fundamental types of change (Lowe, 2003):

- Transformations, which encompass changes to properties like size, shape, color and texture of objects within the animation
- Translations, which address position changes of objects within the animation
- Transitions, which involve the appearance or disappearance of objects in the animation

Following basic guidelines, as outlined by Lieu (2004), can enhance a presentation to make it more interesting and informative. Comprehension of the information presented may also be facilitated through multiple, purposeful representations of the domain (Gilmore & Green, 1984); learners often benefit from the complementary functions of these different types of representations (Ainsworth & Van Belake, 2004). For example, scenes showing a device operating in its intended environment, as shown in Figure 1, may be added to give viewers a better understanding for where and how a device is used. As such, basic animations that are created in solid modelers are often combined with other video and audio files using third party video editors to create well-orchestrated multi-media presentations that are both entertaining and informative

Although typically used to demonstrate the assembly and operation of a mechanical device,

Figure 1. Two frames from the compound bow animation, showing the environment of its usage, which then dissolves to show the bow only.

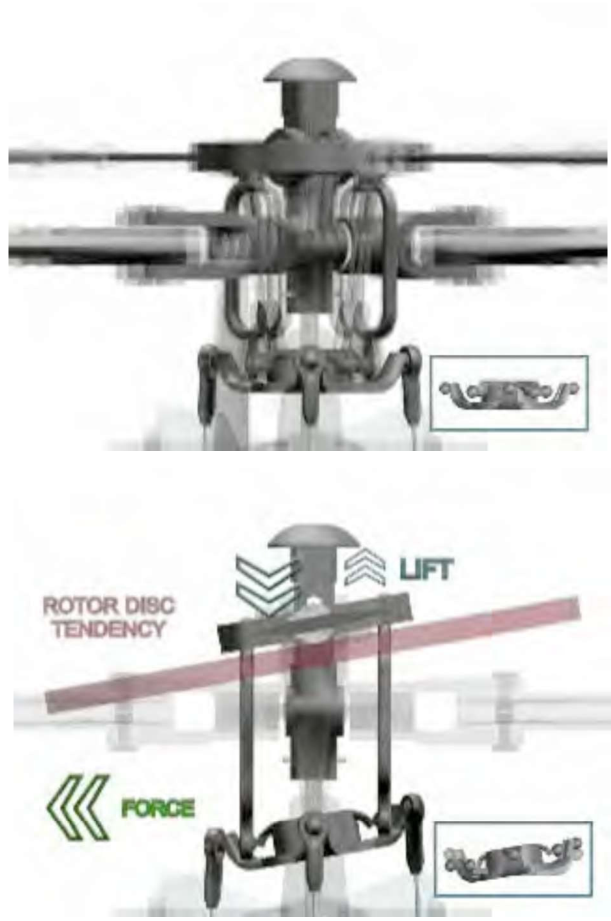

Figure 2. Two frames from the helicopter rotor, showing mechanical relationships and effects of rotor tilt.

animation can be extended to demonstrate working principles that involve processes and reactions that are difficult or impossible to see in the actual device. Such processes include things like gas flow, heat flow, combustion, and molecular motion. This can be done because of animation's ability to create characters, objects, places and events that do not exist in reality. Such objects may not be a formal part of the device, but act as representations for a typically unseen process to enable viewers to visualize and understand the device's function. It is important to note that people often overlook subtle translations and focus on the obvious events in a visual display, even if those events carry less valuable information (Lowe, 1999). However, with animations, such important information can be prominently displayed. This presentation provides a short summary of several clever animation techniques that can be used to greatly enhance the communication of such information, particularly with the working principles and processes of a mechanical device.

II. Use of Overlays and Text

The use of text is sometimes discouraged in animation because it requires time to read and comprehend. Also, the use of text may not be effective where language barriers exist. However, if the text is

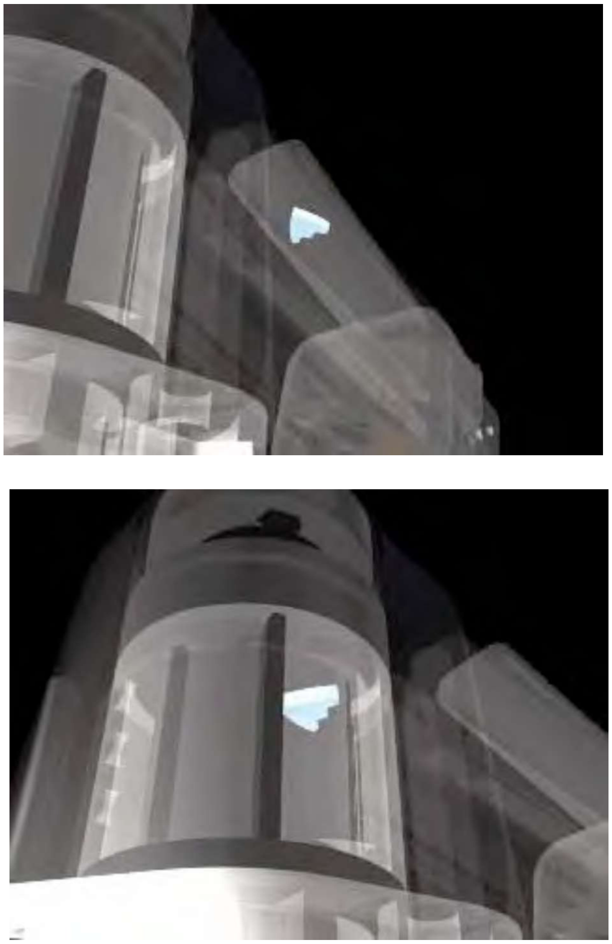

Figure 3. The use of a visible marker to show the direction and affects of airflow in the airwrench animations.

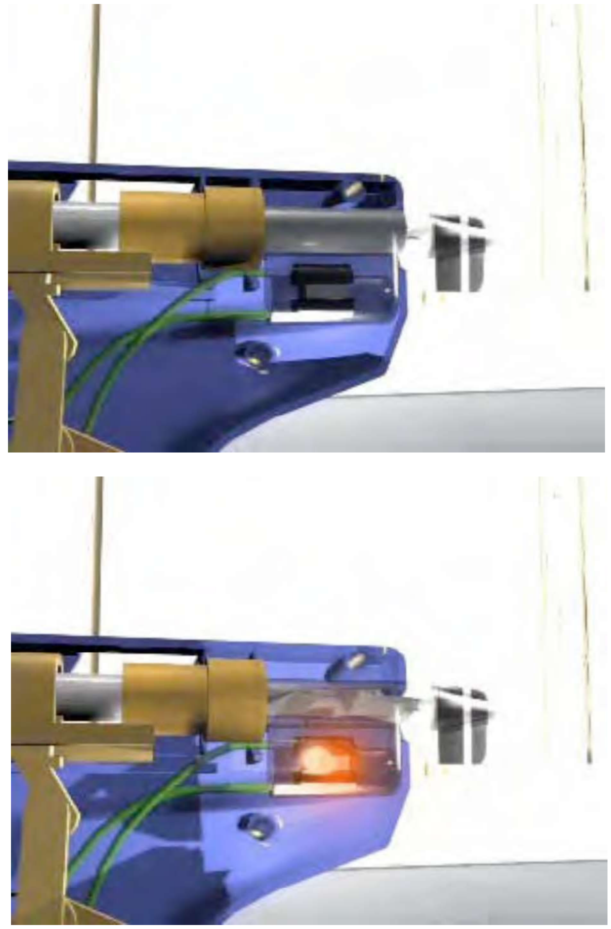

Figure 4. Two frames from the glue gun animation, showing a simulation of temperature rise from the heating element

limited, with just a few words in a choice location, it can save significant animation effort in explaining simple principles. This is especially true if the audience already has some technical skill in the information that is being presented. Figure 2, for example displays two frames from an animation that shows the rotor mechanism from a model helicopter. The mechanism is quite complex, and the resulting changes in airflow and forces are difficult to visualize. However, because the audience in this case was technically trained, they could reasonably predict the affect of tilting the rotor. As such, the animators simply overlaid a simpler 2D animation atop the original animation to show the resulting changes in the rotor forces when the mechanism is aligned in different orientations, thereby cutting excess animation to specifically demonstrate air flow and the mechanism motion. The overlays and text required the use of 3^{rd} party video editing software, as this capability is typically not included in most animators that are found in solid modelers.

III. Air and Gas Flow

Air and gas flow are usually invisible in the operation of most devices. However, the use of artificial "markers" such as small spheres or arrows can help viewers picture this flow. An example of this is shown for the animation of the operation of an

Figure 5. Two frames from the animation of a 4-cylinder engine, showing a simulation of the combustion process.

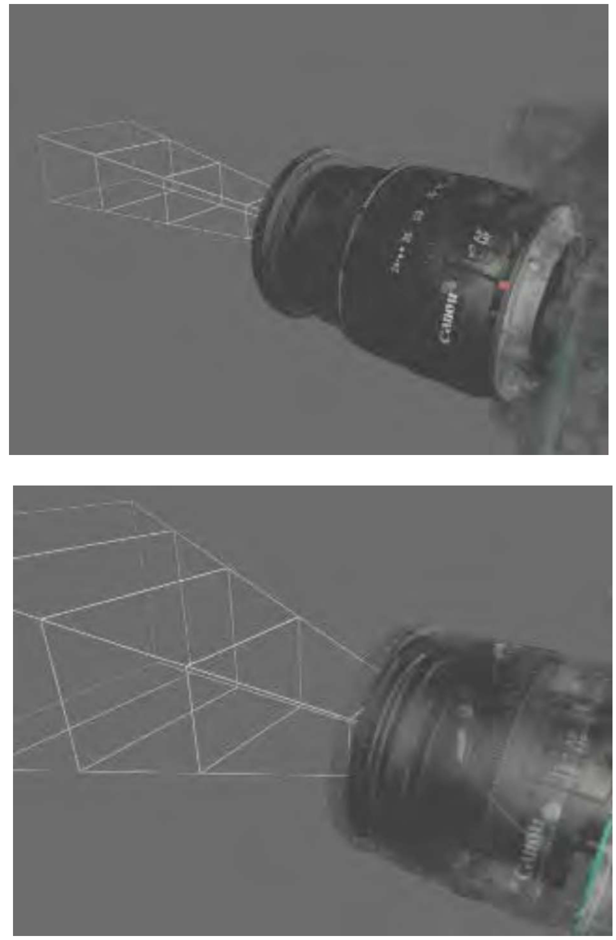

Figure 6. Two frames from the digital camera animation, which show the effect of focal length on the filed of view.

airwrench, in Figure 3. These markers are not a part of the model itself, but are used for visualization purposes only. Flow direction, density and pressure can be simulated with motion, density, and size of the markers. Even the temperature of the gas can be simulated, using the method prescribed in the next section.

IV. Simulation of Temperature

Small temperature changes are not typically visible, but can be important for the operation of a device. In the animation of a glue gun, shown in Figure 4, a temperature rise is indicated by a change in the color (to red, and then perhaps to white) and increased brightness of the heating element. Although the actual temperature rise in the real part is not high enough create a discernable change in color or brightness, such changes are usually associated with an elevation in temperature, and are thus used to convey this information.

V. Combustion

A combustion process can be shown in a variety of ways, depending on the animation tools that are available. As shown in Figure 5, a special tool in an animator that creates the effects of an explosion is the most desirable choice. However, an explosion simulator is not available on most solid modelers.

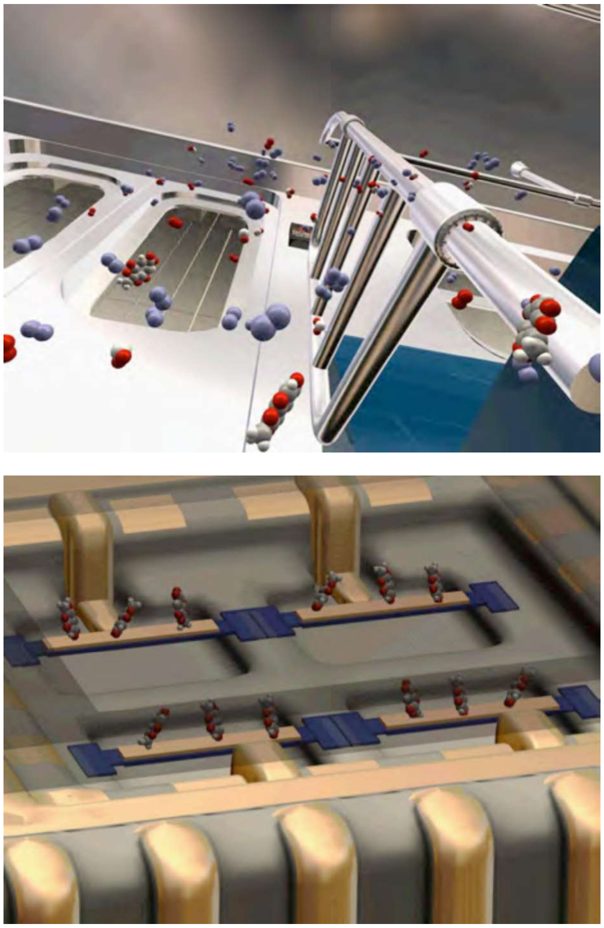

Figure 7. Frames from the "digital nose" animation, showing otherwise invisible molecules in the air and in an electronic device.

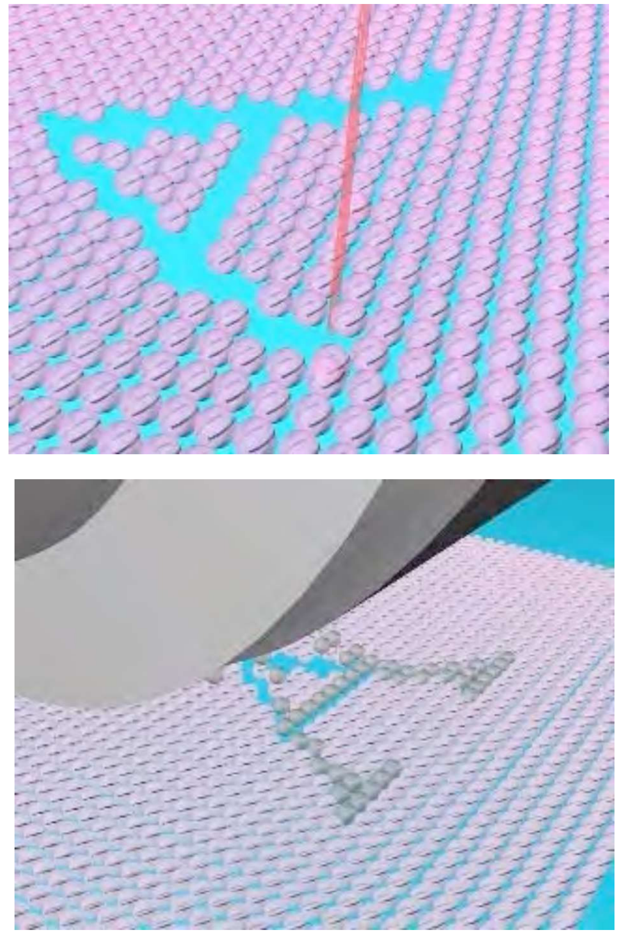

Figure 8. Two frames from the laser printing process, showing the removal of charges from an area with a laser, and the deposition of toner from a drum.

Another method of simulating combustion would be to create a semi-transparent pseudo-object, such as a sphere or cylinder, inside the combustion chamber. The visibility, size, color, and brightness of the pseudo-object can them be altered in the animation to simulate hot, expanding gas.

VI. Optics

The simulation of optical effects is particularly challenging because most solid modelers and animators cannot reproduce the precise effects of optical elements on an image within a scene. An alternate presentation of an optical effect is to show the effect on light rays, instead of the effect on an actual image. This technique is shown in Figure 6, where the effect of changing the focal length on a camera lens is demonstrated. The edges of the field-of-view, in this case, are highlighted to show the extent of a scene that would be captured by the camera.

VII. Molecules

Molecules and molecular motion are important to the function of many devices, especially nano-scale devices. Although normally invisible, molecules can be shown, temporarily and largely out-of-scale to illustrate operating principles. The "digital nose" animation in Figure 7 successfully demonstrates this method in explaining the effects of specific types of molecules on an electronic device. In this animation, different molecule types are used, and distinguished by color and shape. The electronic device is then shown detecting just one specific molecule type. Although the molecules are grossly oversized and unrealistic, this approach does successfully communicate the operating principle of the device, and thus serves the purpose of the animation.

VIII. Atomic State

On an even smaller scale, even the atomic state of molecules can be simulated. In the laser printing process, for example, a focused laser is used to remove the charges from a photosensitive layer. Toner, from a rotating drum, is then deposited into the areas where the charges are missing, and fused on the layer to form text and graphics. Although normally invisible, the process can be visualized by the simulation shown in Figure 8. The laser is shown displacing the charges, and the toner is then deposited in the displaced areas. Though not realistic, or normally visible, the operating principle is successfully communicated.

IX. Data Transmission

Electronic data transmission is, of course, invisible. Even more challenging to illustrate is the transmission of data over a complex network such as the Internet. The presence of electrical signals can sometimes be presented by showing simulated multi-meter or oscilloscope readings. A much easier, albeit less obvious method, is to show electronic signals and data as simply a sparkling object traveling over the transmission line, as shown in Figure 9. The Internet is so pervasive that it is merely represented by the words "Internet" with no further need to define it.

X. Conclusions

Technical animations provide dynamic and effective means for visually communicating information about the functioning of mechanical devices to both technical and non-technical audiences. They may show the individual components, demonstrate assembly and operation, and even illustrate processes that are usually invisible to human eye but crucial to the device's function. New tools and software programs allow for animators to overlay pictures, thread scenes together, draw atypical imagery, and add text or script, in addition to traditional animation methods. Altogether, these elements can be used to create a compelling and informative animation.

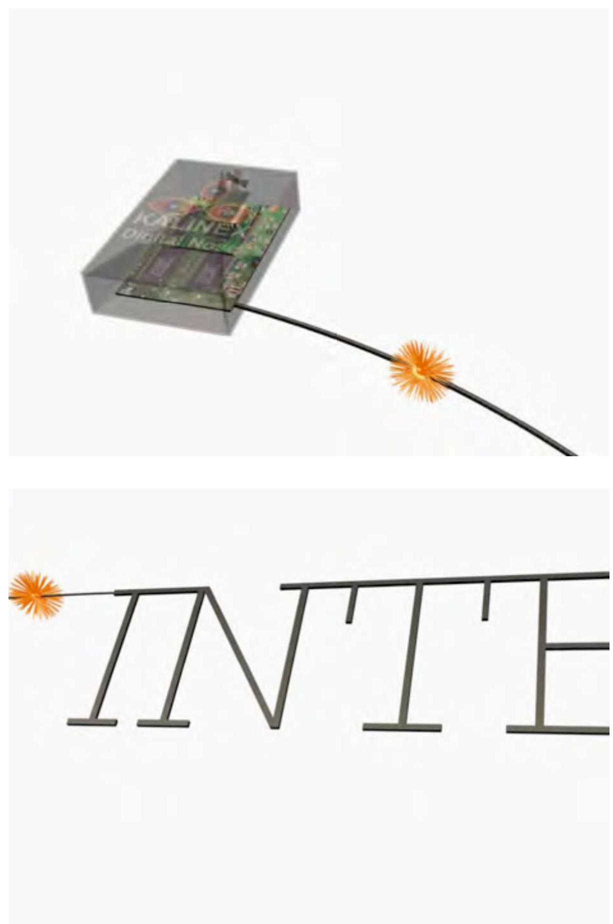

Figure 9. Representation of data leaving an electronic device and arriving on the Internet for transmission.

XI. References

Ainsworth, S & Van Labeke, N. (2004) *Multiple forms of dynamic representation*, Learning and Instruction, Vol. 14, No. 3, pp. 241-255.

Gilmore, D.J. & Green, T.R.G. (1984) *Comprehension and recall of miniature programs,* International Journal of Man-Machine Studies, Vol. 21, No. 1, pp. 31-48.

Lieu, D.K. (2004) *Animation as a Technical Presentation Tool*, ASEE Engineering Design Graphics Journal, Vol. 68, No. 1, pp. 37-42.

Lowe, R.K. (1999) *Extracting information from an animation during complex visual learning,* European Journal of Psychology of Education, Vol. 14, pp. 225-244.

Lowe, R.K. (2003) *Animation and learning: selective processing of information in dynamic graphics,* Learning and Instruction, Vol. 13, pp. 247-262.