6. Conclusion

Art and technology have always had a close relationship and animation is no exception. The computer in animation should be viewed as just another technical innovation, albeit an important one. Character animation can benefit from this development if care is taken to build practical tools which meet the needs of creative animators. The elastic surface layer model and the LEMAN system represent a step in this direction.

Many people feel there is an inherent conflict between art and technology, but in fact the two are so interrelated that they are often indistinguishable. Every new artistic medium has been based on some technological innovation, and aesthetic goals have often been a driving force for technological advance. This has been true throughout the ages and Leonardo DaVinci, the artist who designed machines and developed new painting techniques, perhaps best symbolizes this principle. At no time has the symbiosis between art and technology been more apparent, however, than in the twentieth century, when explosive changes in technology have precipitated an amazing number of new art forms and artistic mediums. Film, televison, radio, audio recording and electronic music are among them, and none are more astonishing and powerful than the still relatively new medium of animation. Of the many technological innovations that have benefited animation since its invention, the introduction of the computer will perhaps turn out to be the most important. Nonetheless it has been, and continues to be, an evolutionary process whose ultimate realization remains to be seen.

Animation, like film, is ultimately a dynamic two-dimensional medium. However three-dimensional a world it might portray, the final two-dimensional image must conform to the requirements of two-dimensional composition and aesthetics. For this reason, few traditional animated characters fully obey the laws of perspective, and many characters such as Mickey Mouse can almost be described as a hybrid 2D and 3D creature. In addition, the medium of the hand-drawn image is so creative and personal a means of human expression that it is unlikely traditional hand-drawn character animation will ever be completely replaced by computerized 3D animation, although it may make many forms of stop-motion character animation obsolete.

Nonetheless, like other forms of computer animation, 3D character animation is here to stay. Already, there are commercial computer animation systems which have character animation capabilities and several animation production companies regularly produce commercial films using in-house character animation systems. The software and production techniques, however, are far from perfected or standard. In this sense, 3D character animation is at a point somewhat like traditional animation was in the 1920s. We have yet to see a Disney studios of 3D character animation and we have yet to see a full-length feature film based on 3D character animation.

To bring 3D character animation to this level of development and acceptance, two important principles should be kept in mind. First, the needs of the artistic and commercial animator must be given first priority. It is them and not programmers or researchers who will be creating the computer generated films of tomorrow. 3D character animation systems must therefore be regarded as tools in the hands of creative, non-technical people, and they must be flexible and intuitive, with highly interactive user-interfaces. Secondly, we must explore 3D character models that combine a variety of different techniques, in particular, that combine more traditional kinematic, together with newer physically-based techniques. A single, pure modeling method will probably never be successful, simply because of the sheer complexity of character animation. Computer animation researchers must therefore be willing to experiment tirelessly with various hybrid character animation models and interaction techniques to find practical, workable solutions. Fortunately, the current trends in hardware innovation will make these principles more and more possible to realize. Improvements in graphics engine technology make interactive user interfaces more responsive, and increased processor speeds allow more and more powerful physically-based models which can be simulated in real-time.

The elastic surface layer model and the interactive LEMAN system demonstrate the validity of these principles and represent a promising approach to constructing animated three-dimensional characters. By modeling the skin as a separate elastic surface, which is free to slide along its underlying muscle layers while being held to it by attracting connective tissue, we have been able to simulate a rich variety of realistic-looking animation effects with a conceptually simple hybrid model. Since the physical simulation is of an elastic surface only, while the underlying layers are geometrical models, we have been able to execute the model at interactive rates, allowing a three-dimensional, direct manipulation environment for layered character construction and animation.