East Tennessee State University
Digital Commons @ East Tennessee State University

ETSU Faculty Works | Faculty Works

1-13-2005

Linking Art to Science: Digital Media as a Technology Translation Tool

W. Andrew Clark
East Tennessee State University, clarkw@etsu.edu

Cher L. Cornett
East Tennessee State University, cornettc@etsu.edu

Peter M. Hriso
East Tennessee State University

Follow this and additional works at: https://dc.etsu.edu/etsu-works

 Part of the Entrepreneurial and Small Business Operations Commons, and the Scholarship of Teaching and Learning Commons

Citation Information

Clark, W. Andrew; Cornett, Cher L.; and Hriso, Peter M.. 2005. Linking Art to Science: Digital Media as a Technology Translation Tool. *Proceedings 19th Annual USASBE National Conference*, Palm Springs, CA. https://drive.google.com/file/d/0B9pflhVOKMWBMk44eHJVWEhVX2M/view?usp=sharing

This Conference Proceeding is brought to you for free and open access by the Faculty Works at Digital Commons @ East Tennessee State University. It has been accepted for inclusion in ETSU Faculty Works by an authorized administrator of Digital Commons @ East Tennessee State University. For more information, please contact digilib@etsu.edu.

Linking Art to Science: Digital Media as a Technology Translation Tool

Copyright Statement
Papers published in USASBE Proceedings are not copyrighted. Authors are free to publish the same material in any form in any venue. This document was originally published by the United States Association for Small Business and Entrepreneurship.

This conference proceeding is available at Digital Commons @ East Tennessee State University: https://dc.etsu.edu/etsu-works/2524

LINKING ART TO SCIENCE: DIGITAL MEDIA AS A TECHNOLOGY TRANSLATION TOOL

W. Andrew Clark, East Tennessee State University, P.O. Box 70552, Johnson City, TN 37614
(423) 439-4164, FAX (423) 439-7750, clarkw@mail.etsu.edu
Cher L. Cornett, East Tennessee State University
Peter M. Hriso, East Tennessee State University

Abstract

Technology translation can be achieved through the blending of the sciences and arts in the form of digital imagery. Digital animation and video can be utilized to portray molecular events where the mechanism of action is known but the process occurs at a sub-microscopic level. There needs to be a strong collaboration between scientific advisors and digital artists when creating the animation such that the artistic interpretation of the molecular event conforms to the known and accepted confines of science. The finished animation may be used for information, education or persuasion as entrepreneurial biotechnical companies attempt to find markets, customers and investors interested in their inventions. Educational institutions with programs in the sciences, arts, digital media and medicine need to promote the interaction of students from these disciplines through cross-functional teams and courses. Solutions to problems developed by these teams tend to be broader and more comprehensive than more homogeneous teams.

Executive Summary

Technology is becoming more complex and difficult to understand as new fields or applications of science and medicine are discovered or invented. There is a need to develop new communication forums that simplify the science to a level that can be understood by individuals wanting to use the technology and/or by entities wanting to invest in the newly developing business venture.

Digital imagery can be used as a tool to help facilitate a type of technology translation through the use of digital animation and video. As new discoveries are made in biotechnical, biochemical, medical and bio-analytical fields of science the mechanism of action of the technologies while known is many times at a sub-microscopic level. In order to visualize what is happening at the cellular level, digital media experts in collaboration with scientific advisors create animations demonstrating the mechanism of action through an artistic interpretation of the science that conforms to known and accepted confines of science. These animations can be used as sales tools, educational pieces or used to help persuade equity partners to invest in their newly formed companies. The key to success for these entrepreneurial biotechnology companies is to assist any interested party, regardless of their scientific background, in understanding why the technology being promoted is unique and marketable.

Institutions with programs of study in science, medicine, technology and digital media need to develop coursework or opportunities for interaction between these diverse fields

of study. Our experience has been that diverse cross-functional student teams generate solution sets to problems that are more comprehensive and diverse than teams comprised of members from a more homogeneous background. As the technology revolution continues to evolve the need to explain the technology to non-experts will become critical for the success of newly formed entrepreneurial technology-based companies. The combination of arts and sciences through digital imagery is one technique to help facilitate this technology translation.

Introduction

New technology and scientific breakthroughs, especially those in the medical, pharmaceutical and biotechnology fields, have become so complex that the explanation and comprehension of the technology by scientists in a different field of study is difficult and to a non-scientific individual it can be virtually impossible. As companies commercializing these technologies bring products to market there is an urgent need to find new channels of communication that facilitate the translation of highly technical concepts to the common language of the general population. In many cases the new technologies may be the result of disruptive rather than incremental research and the resulting products may significantly alter an existing market or create an entirely new market that has no competition, recognition or boundaries in place. This paper will discuss the use of digital media as an art form to assist in the technology translation process as products move from prototype to commercial availability and in the relevant pedagogical issues that facilitate the linkage of art and science to a common purpose.

Background

Traditional research protocol for Universities and Federal Research Laboratories have been to conduct basic research that contributes to the underlying scientific understanding but leaves the process of conversion of basic research to commercial products to the private sector. Recently, university and federal research laboratories have seen the limitations of licensing technologies to private industry and are favoring the formation of private corporations from technology developed in their own laboratories by allowing professors/researchers needed release time to commercialize their intellectual property. The emergence of regional technology-based business incubators has generated the necessary infrastructure and cost structure needed for emerging high-technology business ventures from Universities and Federal Laboratories. The location of these technology-based business incubators adjacent to universities and federal laboratories provide a diverse consulting base to address the difficulties encountered in technology transfer from the laboratory bench to the commercial realm. In addition, the existence of these incubators in close proximity to the university provides a self-renewing source of embryonic technology-based businesses for our graduate students to interact with through the course of their study in technology driven entrepreneurial innovation (Clark and Czuchry, 2004).

Through involvement with embryonic technology-based businesses formed through technology transfer from universities and/or federal laboratories we have noted several critical observations. The technical complexity of these businesses is increasing over time and this is especially true in the biotechnology based entrepreneurial firms. In most

cases, the technical focus of the business is narrow in scope and theoretical in nature as the science concept moves from the laboratory to the fledgling business. In addition, the founders of the newly formed corporations, in general, are experts in their respective field of study but have limited to no business experience. Many of these businesses gain initial funding through federal SBIR (Small Business Innovation and Research) grants that foster the further development of the technology to a commercial product.

As the technology moves past the SBIR funding phase and a prototype product is formulated, the founders of the company will require substantial capital for continued development of their product and growth of their corporate entity. Funding sources typically come through commercial channels such as venture capital, small business administration loans, angel investors, initial public offerings and other. We have observed difficulty in communication as cutting-edge scientists attempt to translate "science speak" into a language that can be understood by the financial non-science speaking community. The necessity to communicate the significance of the invention to the financial community and their recognition of potential market significance is becoming more difficult as the complexity of technologies is increasing at an exponential rate. The use of cross-functional student consulting teams has proven invaluable as business, technology and digital media students come together to assist these companies in bringing their product to market through market research, marketing strategy development, advertising forms and forums, competitor analysis and other needed information or assistance. This process of using student teams to assist embryonic technology-based businesses domiciled in regional business incubators has been previously reported (Clark and Czuchry, 2004). One significant learning has been the incorporation of digital visual formats as a tool to assist in the translation of complex technology to potential investors or customers through animation and digital imagery.

Digital Media

Students entering our digital media program envision themselves post-graduation as animators employed in studios in the creation of the next "blockbuster" movie or in creating the next generation of interactive videogames. The reality is that opportunities to work in these premier settings is limited, however there are numerous other outlets for creative capabilities in the design of new and innovative uses for digital technology beyond the scope of entertainment industry. Miller (1999) described an incident where 3D animators were given eight days to create a video animation, to be shown to a group of venture capitalists, describing the mechanism of action of a new matrix metalloprotease (MMP) inhibitor, invented by Agouron Pharmaceuticals, for the treatment of non-small-cell lung cancer. The primary author of this 3D animation, Marie Dauenheimer, was quoted in this article stating "A few years ago, we wouldn't have had the computer resources or capability to create something of this ilk that quickly. Yet today we were able to design rather elegant animation that showed the drug traveling through the blood stream, into the epithelial layers and eventually stopping the blood supply to the tumor". In the case of Agouron Pharmaceuticals, the animation was used to describe the molecular process for illustrative purposes, however the use of 3D modeling is becoming more common in designing molecules through structure-based design. This process and was described accurately by Werth (1994) in his description of the process

used by Vertex Pharmaceutical to custom synthesize a molecule that would have the appropriate structure and conformation to combat the AIDS virus.

Other examples of using digital imagery are evident and can be found in the literature illustrating the utility of computer animation for molecular biology educational purposes (Amerongen, 2000, Skweres, 2004) or assisting in the analysis of medical images (Berlage et al., 1966). In reviewing the websites of new biotechnology pharmaceutical companies there is a prevalent use of digital animation to visually describe the proposed mechanism of action of new pharmaceutical entities at the molecular level. This translation of "science-speak" into easily understood visual imagery can be applied to numerous scientific applications and becomes a significant alternative career path for digital media students. The Digital Media Program, however attracts students who view themselves as artists that are experimenting with the new art medium of electrons and many have little to no interest in business and commercial applications of their skill set. We have undertaken education program steps that seek to bridge the arts and sciences by providing students with technical knowledge, an understanding of aesthetics, and practical experience in digital media. With a core emphasis on learning how to develop and express ideas, solve problems and create digital media content, this program leads students through problem, project and process-based learning experiences that teach them how to define, design and develop digital media content, computer graphics and interactive medias. The program endeavors to bring together students, faculty and industry professionals to realize interdisciplinary initiatives that prepare students for the professional challenges of linking the arts to the sciences. These new 21st century careers include employment utilizing Web media design, 3D visualization (modeling for data, product, architectural, and other needs), interactive design (for education, entertainment and business applications), communication design, digital video production and special effects and animation. Mark Meadows (2003), author of the text, *Pause and Effect, The Art of Interactive Narrative*, gives an excellent example of the utility of digital animation. He states: "The best learning would occur hands on with the physical subject matter. If you're studying a rock, the best way to comprehend a rock is to hold it in your hands, look at it, smell it, weigh it – physical interaction. With 3D where you are using 3D, photorealism and motion, we can approach reality far closer than any other media. In this medium, learning is going to be facilitated." In biotechnology, the process of molecular action although known in many cases, is sub-microscopic and not visible and the use of 3D animation created with scientific direction helps in the understanding of how the body and the molecule interact.

The Process

Our experience of linking digital media and the sciences together is truly in its infancy at our university. Currently students have the opportunity to interact with scientists and create animation that is used to help explain some complex functions in two different manners. For our graduate students, this opportunity is offered in a course entitled "Strategic Experience" which is a culminating experience course for students obtaining a masters degree in business administration, technology and digital media. These students are grouped in consulting teams based on their education, experience and needs and most importantly the consulting teams feature members with diverse educational disciplines.

We have found that by creating cross-functional teams, through bringing many different disciplines together, we create consulting teams that develop solution sets that are broader and more comprehensive than teams with more homogeneous members. We have described the difficulties and positive aspects of managing and directing cross-functional teams in a previous paper (Clark, Johnson and Turner, 2004). When students serve as consultants to emerging businesses at regional technology-based business incubators, they are faced with numerous problems ranging from the need to develop a brand identity, defining their market niche, developing a comprehensive website and communication forum and in finding a way to describe their complex technical process to consumers or individuals that might be interested in investing in their company. In fact, working with these emerging biotechnology companies is a true challenge for our students since many of the companies are dealing with newly emerging or not yet defined market niches.

The second opportunity developed to intentionally link the arts and sciences together is through the Honors Program Thesis Project within the digital media department. In this case a student or teams of students work with a scientific mentor with the end result being an animation of a biochemical, physiological or biomedical process that may be combined with an interactive web or CD interface. In each case, the process for developing the animation is similar (Figure 1). The team meets with the scientist (content advisor) to discuss the technical problem that needs to be described through animation. This part of the process may require multiple meetings until the problem is well defined and there is a significant understanding of the technology and how it works. This is not a simple process since animating events that cannot be seen through a microscope requires some artistic interpretation that must conform to the confines of the known science. In the case of cross-functional teams this process can be accelerated since technology students can assist in the translation of "science speak" to the digital media student team members. Once the problem is defined, the team develops a sketches and a storyboard defining how the animation will be developed and what will be emphasized and highlighted in the completed animation. This part of the process may take several more meetings with the scientific advisor as iterations of the animation process are developed and matched to known or perceived mechanism of action at the cellular level. The prototype animation (timing test) or parts of the animation are developed in animatic format and meetings with the team and scientific advisor are again held to confirm the accuracy and authenticity of the artistic interpretation of the biological event. At this point the final voice-overs are added and the finished 3D models created with color, texture and lighting schemes identified. If there is a strong working relationship between the team members and the scientific advisors and the necessary time has been spent to ensure the scientific accuracy of the animation, the final result is an excellent educational, promotional, information and sales tool for the newly emerging technology. This merging of art and science appears to be an excellent new employment opportunity for digital media students/artists who have successfully learned to interact with the scientific community.

Our Experience

Our experience to date in linking science to the arts has been rewarding and enlightening. The use of digital imagery as a translation tool has allowed our classroom to expand to regional technology-based business incubators, federal laboratories and departments on campus where previously we have not had much interaction, such as the medical school and most recently a newly formed linkage to artists located in our community. Examples of projects completed may provide a basis for understanding the utility of digital imagery in the biotechnology field and the wealth of new educational opportunities it provides.

One embryonic biotechnology company wanted assistance in illustrating how unesterified tocopherols and tocotrienols, when formulated into a hydrolipid cream base, would migrate into the skin layers (epidermis, dermis, subdermis) rather than remaining on the skin surface until the ester bond could be broken (requires the presence of an esterase). The significance of the molecules migrating into the dermis layers is that the tocopherols and tocotrienols act to neutralize free radicals that are formed through exposure to UV radiation, environmental toxins and/or other pollutants. Free radicals can serve as a stimulus for cell mutation and the formation of skin cancers. In this case, a digital cartoon was created showing migration of the molecules and the resulting neutralization of the free radical. It allows the company the opportunity to differentiate its product from others using esterified tocopherols and tocotrienols in their formulation and allows for premium pricing in a commodity driven marketplace.

Our graduate students worked with a new startup bio-analytical company that had developed a new piece of laboratory equipment designed to perform two-dimensional gel electrophoresis of blood proteins based on their hydrophobicity and pH. Although our team never had the opportunity to create the actual digital animation of how the proteins would migrate in this two-dimensional field, they did collaborate with scientists at the company to develop a detailed storyboard of how the final animation would be created to show the proteins movement in the gel. The significance of this technology is that it allows scientist to differentiate proteins from normal and abnormal cells. If protein segments identified from abnormal cells are isolated, the amino acid sequence determined and the conformational structure of the protein identified then companies can work to develop new chemical or biological entities to inactivate the expression of that protein from the cellular DNA. In this case, digital animation will give the company a technology translation that will be understood and appreciated by the investment community helping to move the company to the next level.

A third example was a project entitled: “Visualized Surgical Solutions: Female Incontinence,” an interactive walk-through of the surgical procedure for correcting female incontinence. A Professor of Surgery (content provider) and a five-member student team developed an anatomical explanation of the procedure using 3D models of the female pelvis. The project included a series of videos using 3D models to identify the various structural anatomy involved and an interactive, rotatable model of the female pelvis. Also included in the application are a series of video clips of the surgical techniques that could be viewed in pieces, or as a complete video of the entire surgery. This digital imagery used in concert with actual surgical footage provides the physician an excellent platform to describe the process to potential patients. In this case the digital

imagery is used to illustrate a macromolecular process rather than sub-microscopic as discussed in the previous examples.

A fourth example was the subject of a two student's Honors project and was entitled "Visualizing the Human Knee." In this project the students used a combination of digital video in addition to animated 3D models of the bones. What is interesting about this particular case is that by using digital video the students were able to take the video and "clean up" and enhance the images giving the surgery a more aesthetic representation of the actual procedure. Patients considering the surgery can view the operation without having to endure the more graphic scenes typically seen in an operating theatre. In this case the students collaborated with a research physician who was the content and scientific advisor.

Our last example also used a content and scientific advisor from the medical school and was entitled "A 3D Visualization of the Sacroiliac Joint." In this case the animation was used to assist in determining how much room for play there actually is in the sacroiliac joint under in vivo conditions. The student worked with scans of the joint to create a negative image (the inverse of the joint—basically a model of the interior surfaces), to be able to visualize how smooth or rough the surface was, and evaluate the effects of the surface topography on actual motion ability of the joint.

Conclusions

The linkage of arts and sciences generates tremendous benefits where digital imagery can be utilized to facilitate imaging of medical, biotechnical, biochemical and bioanalytical processes. Since many of the processes occur at the sub-microscopic level, the use of digital animation, created under the direction of scientists and maintaining scientific integrity within the known and accepted bounds, provides the opportunity for complex molecular events to be understood by the non-scientific community. This technology translation becomes important for emerging new companies promoting these technologies as they seek customers, markets and the influx of capital to support growth. Institutions with strong science, medical and digital media/imaging departments need to intentionally develop projects and coursework promoting the blending of these diverse technologies through cross-functional teams and classes.

Literature Cited

AMERONGEN, H. 2000. The dynamic cell: A new concept for teaching molecular cell biology. Bull Med Libr Assoc., 88(4):405-407.

BERLAGE, T., FOX, T., BRUNST, G., and QUAST, K-J. 1966. Supporting ultrasound diagnosis using an animated 3D model of the heart. Proc. of IEEE Multimedia Computing and Systems, Hiroshima, Japan, June 17 – 21.

CLARK, W.A. and A.J. CZUCHRY. 2004. Technology-based business incubators: Living laboratories for entrepreneurial students. Proc. ASEE Annual Conference and Exposition, June 20-23, Salt Lake City, UT.

CLARK, W.A., A.J. CZUCHRY and J.A. HALES. 2004. University Managed Technology Business Incubators: Asset or Liability? 18th Annual USASBE National Conference Proceedings, Jan 15-18, Dallas, TX.

CLARK, W.A., K.V. JOHNSON and C.A. TURNER. 2004. Cross-functional teams as a teaching tool for enhanced learning. Proc. ASEE Annual Conference and Exposition, June 20-23, Salt Lake City, UT.

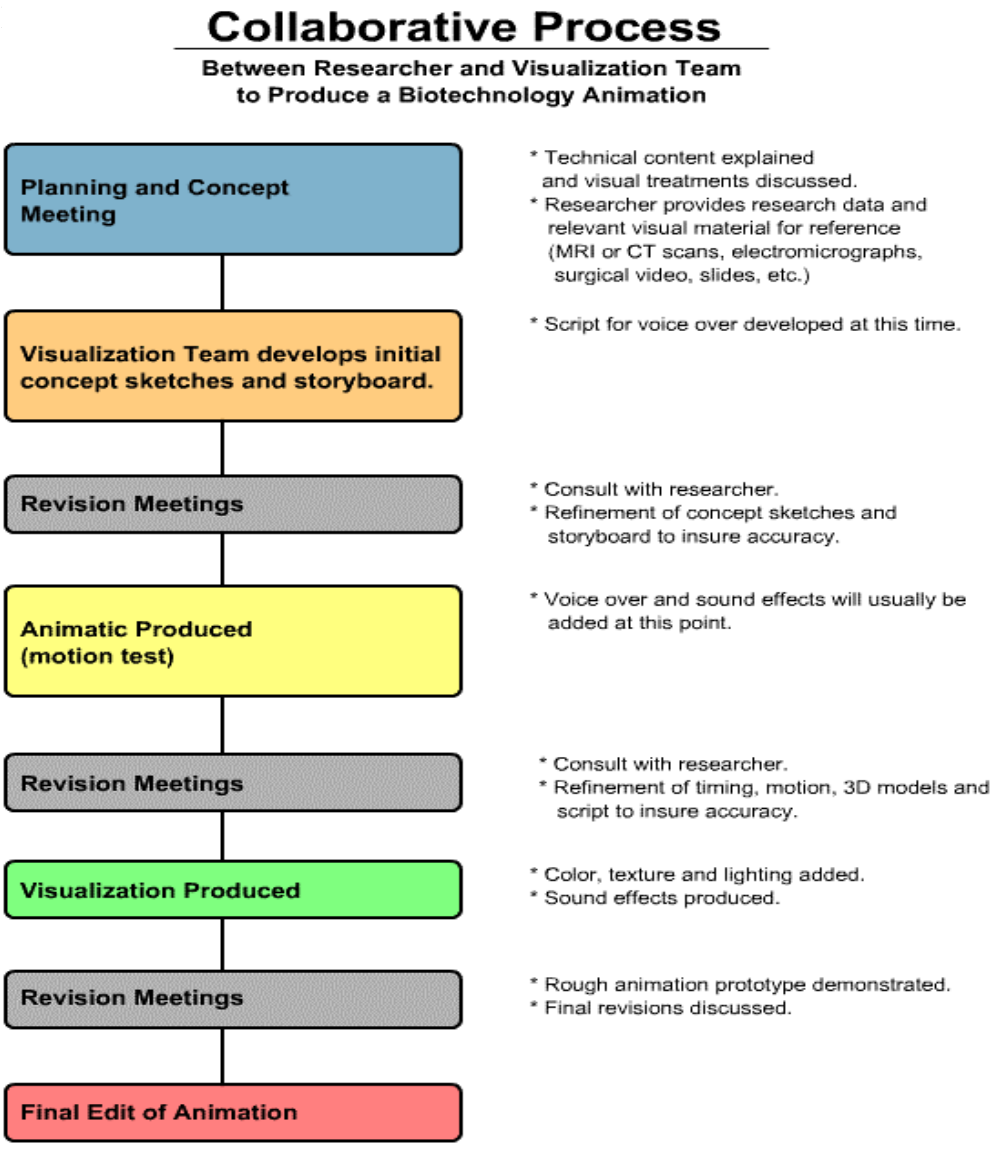
MEADOWS, M.S. 2003. Pause & Effect: The Art of Interactive Narrative. New Riders, Indianapolis, IN.

MILLER, M. 1999. Designing Ways: Computer Animators Illustrate Cancer Research in 3-D Imagery. J. National Cancer Inst., 91(5):409-10.

SKWERES, M. A. (2004, July 20). 3D Animation Takes Off in Education, *VFXWorld,* Retrieved July 28, 2004, from the World Wide Web, http://vfxworld.com/?sa=adv&code=319b255d&atype=articles&id=2165&page=1

WERTH, B. 1994. The Billon dollar Molecule: One Company's Quest for the Perfect Drug. Touchstone, Simon and Schuster, Inc., New York, NY.

Figure 1.


Collaborative Process
Between Researcher and Visualization Team
to Produce a Biotechnology Animation
Planning and Concept Meeting
* Technical content explained and visual treatments discussed.
* Researcher provides research data and relevant visual material for reference (MRI or CT scans, electromicrographs, surgical video, slides, etc.)
Visualization Team develops initial concept sketches and storyboard.
* Script for voice over developed at this time.
Revision Meetings
* Consult with researcher.
* Refinement of concept sketches and storyboard to insure accuracy.
Animatic Produced (motion test)
* Voice over and sound effects will usually be added at this point.
Revision Meetings
* Consult with researcher.
* Refinement of timing, motion, 3D models and script to insure accuracy.
Visualization Produced
* Color, texture and lighting added.
* Sound effects produced.
Revision Meetings
* Rough animation prototype demonstrated.
* Final revisions discussed.
Final Edit of Animation