

AC 2008-152: ENGINEERING AND THE MEDIA: BUILDING A NEW RELATIONSHIP

Tylisha Baber, Michigan State University

At the time this paper was written, Dr. Tylisha Baber was serving as a National Academies Christine Mirzayan Science and Technology Policy Fellow. She earned a B.S. degree in chemical engineering from North Carolina State University and a Ph.D. in chemical engineering from Michigan State University. Tylisha's dissertation focused on the design and implementation of a biomass conversion process for improving the fuel properties of biodiesel. She is currently an adjunct assistant professor in the Department of Mechanical and Chemical Engineering at North Carolina A&T State University.

Norman Fortenberry, National Academy of Engineering

Norman Fortenberry is the founding director of the Center for the Advancement of Scholarship on Engineering Education (CASEE) at the National Academy of Engineering. CASEE is a collaborative effort dedicated to achieving excellence in engineering education--education that is effective, engaged, and efficient. CASEE pursues this goal by promoting research on, innovation in, and diffusion of effective models of engineering education.

Engineering and the Media: Building a New Relationship

Abstract

Today's youth are tightly integrating into their lives the use of digital media such as television, radio, computers, the Internet, and cell phones. Given the affinity of "digital natives" for such technologies, new media presentations as well as educational games that incorporate engineering design and/or analysis simulations may provide a way to bridge the gap between abstract concepts or theoretical knowledge and practical skills. This paper reviews images of engineering presented in videogames and in narrative television series. It also reports on the results of an October 2007 workshop that looked at the viability of using digital media as a means of engaging public audiences.

Background

Today's youth are integrating digital technologies- such as television, computers, the Internet, cell phones- into their daily lives. Studies show that the total amount of media content young people are exposed to each day has increased by more than an hour since 2000, with most of the increase coming from video games and computers^[1]. Given their affinity for digital technologies, educational games that incorporate engineering design and/or analysis simulations may provide a way to bridge the gap between abstract concepts or theoretical knowledge and practical skills. Similarly, engaging narratives on broadcast television, the web, and other new media (e.g., cell phones) may prove avenues by which to increase awareness of engineering as a career field. Many in the engineering community have sought to duplicate the success of *CSI* in building interest in a career field.

Engineering is not Science

In looking at images of engineering in the media, it is important to draw a distinction between engineering and the natural sciences. The natural sciences are broadly concerned with the acquisition of fundamental knowledge through experimental investigation, observation, identification, and theoretical explanation of natural phenomena, with reference to the material and physical world. Physics, chemistry, and biology try to understand, describe, and explain nature through theories, models, laws, and facts about the physical world.

Engineering is the process of altering the location, state, and/or form of matter, energy, or information in service of human desires. Engineering is the application of scientific knowledge to practical ends such as the design of a device, system, or process to solve a problem, meet a need, or improve the original design. The experimental study of engineering involves the use of models and testing devices^[2].

Maintaining cognizance of the distinction between engineering and science is critical to our effort to understand which media images may be legitimately regarded as highlighting engineering. We begin our survey by looking at video games.

Summary of Engineering Video Games

A search of various websites was used to identify engineering-focused video games. Sites searched included the following:

- The website of the John D. and Catherine T. MacArthur Foundation, a private, independent grant-making institution committed to promoting the development of knowledge, nurturing individual creativity, strengthening institutions, helping improve public policy, and providing information to the public, primarily through support for public interest media^[4]. The foundation launched a five-year, \$50 million digital media and learning initiative in 2006 to help determine how digital technologies are changing the way young people learn. Navigating through the MacArthur Foundation website identified several blogs pertaining to the ecology of games. One particular blog provided links to a site for a researcher/developer of epistemic games in engineering– games that address the essential nature of engineering. Of the six epistemic games presented on the researcher’s website^[5], one was screened as the closest game relevant to engineering based on the game’s description.
- The Social Impact Games website^[3] which categorizes games into the following categories: education and learning, public policy, political and social, health and wellness, business, military advertising and branded, commercial-off-the-shelf (COTS), and projected and upcoming. Within each game category are sub-categories. Within the category “education and learning” is the subcategory Engineering. Only one engineering game, Racing Academy, was found on the Social Impact Games website.
- The Learning Federation Project^[6] of the Federation of American Scientists (FAS) works on research and development strategies to harness the potential of emerging information technologies to improve how we teach and learn. In October of 2005, the FAS hosted a Summit on Educational Games. This summit marked the first meeting of individuals from academia, government, private foundations and the software development industry to determine the challenges that need to be addressed to create a strong marketplace for educational games. Although three games were identified on the website^[7], none was determined to have a focus on engineering.
- Finally, a general search of the web was launched using the Google search engine. This approach resulted in the identification of *Time Engineer* as a potential engineering game as well several links to engineering games from the site tryengineering.org.

Further details on the identified engineering games are presented below.

The engineering epistemic game referenced above is contained within the *Digital Zoo*^[8]. The concept of this game is to allow players to work as engineers by designing wire-frame prototypes of ambulatory characters. The full version of *Digital Zoo* was unavailable for assessment. However *Digital Zoo*’s game engine, SodaConstructor was available for review^[9].

SodaConstructor’s spring-mass modeling system allows users to create static and dynamic structures in a virtual design space and test them against the force of gravity. The purpose of the SodaConstructor computational environment is to emulate one particular aspect of engineering design, the design-build-test (DBT) cycle^[10]. DBT is an iterative process through which engineers develop and evaluate design alternatives^[11]. In each iteration of the cycle, engineers design a solution to a specified problem, build a prototype of the proposed design, and then test the prototype to determine its potential effectiveness. The DBT concept has been used in

undergraduate engineering laboratories and in capstone senior design projects^[12, 13]. Based on personal communication^[14] with the game's developer and extensive reading about the game, *Digital Zoo* appears to incorporate core concepts of engineering by applying basic scientific knowledge (the center-of-mass) to the design of ambulatory characters. A preliminary study^[15], indicated that players who attained self-identification as engineers through playing the game did so on the basis of acquiring professional skills such as leadership, management, communication, and strategic planning.

Time Engineers^[16] is a computer game designed to help teach fundamental engineering principles to students in grades 6th - 12th. The students travel to a series of three historic time periods (Ancient Egypt, the Middle Ages, and World War II) to help solve engineering problems. Within the game, students participate in two interactive and open-ended activities per sequence. The purpose of each activity is to develop reasoning and problem-solving skills by introducing one or more engineering principles. In each activity, the student is presented with an engineering task and must select two or three design parameters in order to complete the task. Once the task is completed, an animation simulation is performed to evaluate the specified design choices. Because the game encourages creative thinking, a trial-and-error approach is used in the activities to allow students to adjust variable factors in their attempts to solve problems. The activities use a variety of problem-solving techniques, including optimization, probability, or distribution functions.

Racing Academy is a Multi-User Virtual Environment Experiential Simulator (MUVEES) which allows students to engineer and race virtual models of cars. Unlike most car racing video games, *Racing Academy* is built on real physics and engineering principles. *Racing Academy*'s advanced physics game engine has the capacity to allow users to manipulate over 1,000 parameters of their vehicles, and to compete as entire teams of practitioners within a virtual community of engineers and drivers. The *Racing Academy* project was extended to develop an edition for use in postsecondary education (encompassing what the British refer to as "further education" and "higher education")^[17]. The project, *Racing Academy* JISC Prototype, uses the original prototype of *Racing Academy* but changes the technical content to meet post-secondary requirements with an emphasis on encouraging and motivating engineering and science students and supporting their learning^[18]. *Racing Academy* is available for download on the web from FutureLab^[19].

TryEngineering.org is an accessible virtual resource about engineering and engineering careers for students, parents, teachers and administrators. This educational website contains links to several designing games (originating on the website of the Public Broadcasting Service) that particularly target K-12 audiences. In the *Build a Bridge* game^[20], a description of each of the four bridge types is presented; each description provides historical background, examples of modern-day use, and how the bridge functions. *Design a Parachute*^[21] is an interactive game that provides engineering constraints and specifications in order to design (by adjusting parameters of canopy diameter, band width, and material thickness) an operable parachute within constraints of volume, drag, strength and stability. *Goldburger To Go*^[22] is an in which the player must correctly assembly 13 parts of a production machine in order to deposit a hamburger on a lunch tray.

Given the broad ubiquity of on-line games, relatively few were found that focused particularly on engineering. We next turn our attention to images of engineers and engineering in US domestic non-interactive broadcast media.

Engineers in Television, on Radio, on the Web and at the Movies

Public broadcasting in the US features two engineering-related shows, both of which are more expository or “reality” focused than narrative-driven. First broadcasted in 1999, the award-winning television miniseries *Building Big* was a five-part series on large-scale structures (e.g., bridges, domes, skyscrapers, dams, and tunnels), hosted by renowned author-illustrator David Macaulay. The series explored the history behind some of the world's greatest triumphs of engineering and the ingenuity of the engineers who designed and built them. *Design Squad* is a show targeting children aged 9-13 years old that premiered on PBS during National Engineers Week in February 2007. The purpose of the show is to introduce its audience to the engineering design process. Four boys and four girls ages 14-18 are divided into two separate teams and compete to design, build, and test the best solutions to various engineering challenges.

Commercial outlets such as the Discovery Channel and the History Channel also feature expository shows on engineering. *Extreme Engineering* is a documentary television series on the Discovery Channel which features detailed coverage of ongoing and future engineering projects. Hosted by architect Danny Forster, the series documents the different stages of a project, showing footage of actual work being done, interviews with engineers, and computer-generated graphics illustrating certain aspects of the engineering process. Most episodes examine possible disaster scenarios that could threaten the projects by emphasizing costs, weight, temperatures, and even the risks to human life that an engineering mistake could have. *MythBusters* is an educational television program on the Discovery Channel starring engineering and construction experts Adam Savage and Jamie Hyneman, who use problem analysis and the scientific method to prove or disprove urban legends in popular culture. In each hour-long episode, the hosts combine modern-day science, special effects and technology to determine the validity of two or three popular myths through a series of tests and experiments.

Premiering in October 2006, *Engineering an Empire* is a weekly, one-hour series broadcasted on the History Channel that looks at the history and culture of ancient civilization through the lens of engineering feats. *Modern Marvels* is a documentary television series on the History Channel that tells fascinating stories about ingenuity, invention, and imagination that have produced technological breakthroughs and man-made wonders. *Modern Marvels: Engineering Disasters* is a special sub-series of the show that investigates some of the notable failures of engineering and technology. These episodes describe the circumstances of situations in which designs and construction go awry and result in tragic disasters.

In addition to being featured on reality-based shows, engineers are and have been featured on narrative television. The most recent example is the series *Prison Break*, which tells the story of a man's attempt to free his brother from prison. His knowledge of civil engineering (the character has bachelor's and master's degrees in civil engineering from Loyola University of Chicago) is central to his knowledge of the construction of the prison and how to break his brother out. An older example was provided by *MacGyver*, an action-paced television drama

series that aired for seven seasons, from September 1985 to May 1992. The title character in *MacGyver* was a secret agent who applied engineering knowledge and inventive use of ordinary items to escape life-threatening situations. The clever solutions MacGyver implemented to seemingly intractable problems were a major attraction of the show, which was praised for generating interest in engineering^[23]. The idea of using ordinary household items to jury-rig (made with only the tools and materials that happen to be on hand) devices has become a part of U.S. popular culture by referring to such constructions as “MacGyverisms.” In fact, the American International Press released a book in 2005 of MacGyverisms from the popular television show^[24, 25]. An even earlier example was *My Three Sons*, a situation comedy that chronicled the life of a widowed aeronautical engineer and his three sons living in Bryant Park, IL. Little engineering actually appeared in the show. A web-based show, *Engineering TV*, provides short highlights of leading edge technological devices and (occasionally) the people who create them.

Three expository radio programs highlight engineering in modern life. John Lienhard’s *Engines of our Ingenuity* is broadcast nationally on public radio. The show discusses inventors, their inventions, and the impact of their inventions on popular culture. William Hammack’s *Engineering and Life* is also broadcast on public radio stations. Hammack offers wide-ranging commentaries on various technologies, the scientific principles that underlie them, and the social contexts that promote or impede their use. Finally, *Engineering Innovation*, a series of short spots produced by the National Academy of Engineering provides an engineering spin on a current issue in the news.

Relatively few engineers engaged in engineering work appear in the movies. A search of the popular website Internet Movie Database <<http://www.imdb.com>> on the keyword “engineer” returned 44 hits, but only a few were commercial movies that featured engineers or engineering work including *Paycheck* (starring Ben Affleck), *Primer* (a Spanish film released in 2005). It is both sad and telling that neither the original (1950) nor the remake (2005) of *Cheaper by the Dozen* appeared in the search. Both films are loosely based (with the remake being a more loose adaptation) on the lives of pioneering efficiency engineers Frank and Lillian Gilbreth and how they used their “time and motion study” techniques to raise their 12 children. Frank Gilbreth was a bricklayer, a building contractor, and management engineer. He was also a member of the American Society of Mechanical Engineers (ASME), the Taylor Society, and a lecturer at Purdue University. Lillian Gilbreth received B.A. and M.A. degrees from the University of California and earned a Ph.D. from Brown University. Like her husband, she too was a member of ASME and a lecturer at Purdue University. After the sudden and tragic death of her husband, Dr. Lillian Gilbreth continued their work and was widely accepted as one of the greatest industrial and management engineers. A more extensive list of movies featuring engineers is available on the web site Engineer as Hero <http://www.tcnj.edu/~rgraham/whatare-movies.html>.

Broadcast media images of engineers and engineering are more prevalent than those presented in web-based games. Nonetheless, such images are still relatively rare, and, with rare exceptions, do not highlight engineers as multi-faceted complex characters. In the text below, we discuss an effort to develop engaging complex narrative images of engineers.

The October 2007 Workshop on “Engineering and the Media”

The Center for the Advancement of Scholarship on Engineering Education (CASEE) hosted a one-half day workshop in October 2007. The workshop brought together fifteen selected representatives of the various electronic media (e.g., film, television, radio, and the web) and marketing experts. This meeting had a goal of identifying a public outreach strategy that would raise awareness of engineering in the public consciousness through a narrative series delivered on current or emerging media (e.g., television, radio, web, immersive environment).

Several key themes were identified as applicable to whatever final format was selected (film, television, radio, web, or game). The product should emphasize (1) narrative versus demonstration as a means to engage the public imagination, (2) engineers as professionals who are also interesting people with unique skills to contribute to the work of the team, and (3) engineering as encompassing design, systems analysis, problem definition and problem solution.

Several options were considered for the story-line to be pursued. It was observed that a common strategy is to focus on a crisis or challenge. A show loosely focused on the National Transportation Safety Board (NTSB) would provide an opportunity to showcase a wide array of engineering disciplines and could easily lend itself to *CSI*-like story lines except that, rather than dead people, there would be failed transportation systems. However, some concern was expressed that this would overwhelmingly associate engineers in the public imagination with fixing failures rather than innovation solutions to human challenges. An alternative strategy would be similar to that the *MacGyver* situations – limited time and resources to solve a pressing problem.

Some consideration was given to the characters’ setting. The NTSB scenario would allow for a wide array of settings and locations (similar to *Time Engineers*). Similar flexibility would be achieved by placing the characters within an international design firm that travels to various sites and solves challenges (similar to *Mission Impossible* except that the mission is to save lives through engineering expertise).

Practical implementation issues were also raised. If the project is to be commercially viable, careful consideration must be given to the target audience and how they would be presented to advertisers. (Those in attendance believed the key audiences to be parents of young children and others in the 18-34 age range). Commercial considerations also suggest careful attention to developing a full multimedia strategy that leverages the core product (e.g., television show or video game) with subsidiary products in other media (e.g., core television show but with associated video game, web site, cell phone flash games, etc.). A fundamental task is to distinguish between the “destination” (e.g., television show) and the “paths” to the destination (e.g., promotional web site). Ancillary outlets should be used to showcase subplots, character backstories, and other activities that will build interest. Full consideration should be given to collateral activities that can build interest and leverage (e.g., incorporate social networking sites, or develop a “fantasy engineering league,” consisting of teams that the user/viewer puts together based on characters on show/game, where performance depends on skills of those assembled).

Considerations specific to the individual medium (e.g., television) were also raised. With regard to a television series, it was suggested that cable channels may offer more immediate access and be more able to accept a smaller audience share than would be the case of a show on a broadcast network. One might also seek to integrate engineering topics into existing shows rather than attempt to create entirely new shows. Television also has a history of taking popular subplots and spinning them off into separate shows, which may provide a path towards a show devoted to showcasing engineers.

If a game is the target product, then choices have to be made with respect to the type of game (e.g., epistemic, first-person, strategy, role-playing), the objectives and incentives to be provided, the format and dimensionality of the game (e.g., flash, fully immersive, 1-D, 1.5-D, 2-D, or 3-D).

Next Steps

Based upon input from the workshop as well as on-going synergies, CASEE has decided to pursue a dual track strategy. The long-term goal remains the development of a narrative series and video game. However, since fully developing such products will require a collection of compelling stories, a nearer-term goal is to develop a competition to generate story ideas while also advancing public understanding of engineering. CASEE has chosen to pursue the development of a juried competition targeting (full or part-time) college students in good standing pursuing a (graduate, undergraduate, or associates) degree program, and including at least one engineering student on the production team. The teams will produce a 5-minute (animated or live action) “film” showcasing the work of a diverse (ethnicity, gender, lifestyle, outlook) team of engineers in responding to topical “challenges” posed by nature (e.g., designing emergency shelters in response to a natural disaster, creating a personal portable water purification system, etc.), nations, or people. Examples of such short narrative films have appeared as commercials^[26, 27].

As recommended by the workshop, the show should be grounded in a compelling narrative with accessible characters, but be accurate in its use of engineering principles and analysis. Teams must not only submit a final “film,” but also a marketing plan that leverages spin-off media products (web, cell phones, etc.), cross-marketing initiatives, etc. Scoring is done on the technical accuracy, film quality, and entrepreneurial plan. (The requirement for a marketing plan responds to the workshop recommendation that consideration be given to a multimedia marketing and collateral product development plan.) Each scoring category would contribute equally to the overall composite score. Pursuing this strategy contributes to the long-term goal while also conferring near-term benefits including quickly generating a variety of storylines for pursuit in films and games, raising the visibility of the stories in a forum that allows easy adaptation by anyone viewing the contest submissions and winners, drawing upon the ideas and motivations of current engineering students to speak to future would-be engineers, and involving partner organizations at a lower level of commitment than will be required for the more resource intensive development of a film, television series, or video game. Separate partner organizations would be involved in judging the submissions for their engineering content, film quality, and business plans.

Summary

This paper has summarized images of engineers and engineering in various media (e.g., video games, television, and radio). It has explored the design of new media products to enhance the public's understanding of engineering; and it has identified a near-term strategy to pursue in route to this long term goal.

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