Training in Computer Graphics for Entertainment Production: What Future TDs Need to Know

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Abstract

Training grounded in the theory and sound concepts of any discipline is widely recognized as the most appropriate educational practice which serves students well beyond their graduation. But in an increasingly competitive world students can be given a jump-start into a career by focusing their education towards an understanding of the knowledge set they will need for certain types of careers that use that discipline. Computer graphics is an especially rich area within Computer Science or Engineering departments, in that a large number of careers make use of the same basic concepts. However, careers in computer graphic areas almost always require other skills sets of its potential employees, as most are interdisciplinary professions where computer graphics forms but one aspect of the actual job. Examples of this are numerous and range from architecture to CAD/CAM to medical applications. The specific career that I will discuss as an example of training for real world applications has been a highly sought after one for many computer graphic students in the last decade — that of technical director for entertainment applications such as film, television and games. In spite of adequate computer science theory and conceptual training, many graduates are not accepted by this industry because of a lack of understanding of what is expected, and a corresponding lack of additional relevant skills. This paper explores some of these desired skills and serves as a basis for discussion for how educating students towards an understanding of skills necessary for many computer graphic careers can be included in a traditional computer science or engineering program.

Introduction

One of the faster growing segments of the job market for graduating Computer Science (CS) majors over the past six years has been that of the technical director (TD) or software specialist for the entertainment industry. Students to fill these needs within the industry have been in short supply throughout this time. Many companies have had to look overseas or to related industries such as aerospace or other engineering disciplines to find the talent they required during what has been an unprecedented growth period within digital entertainment. This hiring burst of recent CS graduates, at all levels, has brought with it a range of higher salaries, which, in addition to the high-profile nature of the jobs (from screen credits to the glamour of Hollywood), has left a shortage of these same students to populate positions in more traditional fields, such as defense, or CAD/CAM applications.

Traditional Computer Science education, while it provides students with the programming skills they need and the ability to approach advanced problem solving in a logical fashion, does little to prepare them totally for new and distinctive careers such as those in digital entertainment. Even with the best Computer Science education as preparation, studios and production companies have found that there is an additional level of education that these incoming hires often need, no matter what their specific job function within the company.

The types of knowledge lacking in these hires is usually not part of, nor even considered within, a traditional CS program. It consists, in part, of competence in areas of communication and management, artistic expertise, and knowledge of production itself and the way computer tools are used within the various types of production pipelines. Can these areas be folded within a traditional CS curriculum? Should they? That depends. If the task of training students is to prepare them for future jobs, then perhaps consideration should be given to methods with which to prepare them better. Several suggestions on how to accomplish this for the entertainment industry are explored, hopefully sparking a dialog leading to an enhanced computer science education.

The Rapid Rise of Digital Entertainment Jobs

In 1992 James Cameron had a huge box-office success with a sci-fantasy film called *Terminator 2: Judgement Day*. This film was significant in that it could not have been realized without extensive use of computer generated imagery (CGI) to create what was essentially a main character in the film. More importantly, this film was a watershed in a long range economic way — it gave studio executives a level of confidence that this technology could actually be used in film production, without exceeding the economic confines of time or budget. The year before *Terminator 2*'s release (1991) there were approximately 2000 people making their living as digital animators of some sort in the entire industry. A year after T2's success (1993), there were close to 4500! And today there are well over 10,000 digital animators and artists, including technical directors employed in the business.[1] Digital entertainment has become a significant—not to mention exciting—job market for computer science graduates searching for their first job.

This rise in numbers of jobs has been an interesting phenomenon, partly because the job market increased so fast that few schools were ready to meet the challenge of training students for employment in these new jobs. This led to a need for production companies to institute their own internal training programs to help new hires bridge the gap between the skills they had and those they needed to be successful. These programs range between a few days (for someone with previous production experience who only needs to get up to speed on minimal proprietary software) to a full year for recent graduates who have much to learn. The cost of these internal training programs has not been insignificant, but companies simply had no choice. If the dollars spent over the last few years in this area were to be added up the economic impact would be seen to be profound. And since the profit margins, especially for small effects companies who do not own their own content, are often in the single digits, internal training programs are not likely to survive if companies can find any way around them. This is especially likely given the current state of the industry, which includes a number of significant layoffs and company closings, thus putting experienced people out into the job market again in large quantities.

While it is true that the previous demand for more and more hires is currently reversing, it must be realized that the entertainment industry traditionally experiences ups and downs. This cyclic nature of entertainment is another important reason to provide students with as much knowledge as possible while they are in school. Not only will those with more knowledge be the last to be let go in the slow times, they will be preferred hires when the pace picks up over other entry-level hopefuls who would need significant on-the-job training to come up to speed.

What They Need To Know

The jobs of technical director and entertainment software developer are not widely understood. Even within the entertainment industry the same job title can encompass a wealth of different expectations, with an increasing trend towards specialization. For example, a recent recruitment ad for Industrial Light and Magic, a division of Lucasfilm, Ltd., listed the following specialized job titles, all of which might be lumped together under the "TD" category at a smaller company: Digital Matchmovers, Envelopers, CG Commercials Artist, CG Software Engineers, and Senior Level Technical Directors. The general rule is: the smaller the "house" the more hats an employee will wear.

The skill sets necessary to be a successful technical director or software developer in the entertainment industry are also fairly wide range. While any given job may not absolutely require all these skills, knowledge or understanding of them will significantly improve the efficiency with which the job is done, thus maximizing the value of the employee to the company. The following listing of additional skill sets beyond those of traditional computer science programs is drawn from the most common requests and observations received from supervisors during production.

Communication, Social and Management Skills

This is an extremely important set of competencies and often the ones that have the most bearing on an employee's eventual success or failure. These skills include: how to work with artists, and producers, and directors; understanding the demands and rigors of production schedules and how to work within them; coping with extremely short research and development times; keeping confidentiality; and accepting criticism in a constructive way, by using it as a tool to improve

the quality of the work It is often difficult for new employees to work long hours, not talk about what they are doing with their friends, and realize that the director is always right, even as they redo a shot for the twentieth time at one o'clock in the morning. And technical directors often require strong management skills to lead those working under their direction, including knowing how to inspire a team of people facing the above pressures to push their artistic and creative limits to maximum effect.

Artistic Skills

Aesthetics! The best TDs are those who understand artistic fundamentals and have developed a strong sense of aesthetics. At a minimum, TDs need to know how to value the art skills of those they work with, and collaborate with artists for the best results. But understanding the art themselves is best. A fundamental comprehension of design concepts provides a significant advantage for TDs. Most all TDs would also benefit from knowing color theory, and more color theory. It is difficult to find experts in this who understand the whole color picture, as it is taught so differently within different disciplines, when it is taught at all. CS students need to understand about color psychology, color spaces that artists deal in, and color phenomena as well as gamma and wavelengths. Lighting is another area in which TDs need artistic training. Lighting TDs are in extremely short supply, typically because those who understand how to use the lighting tools, such as Renderman™, do not usually have the co-requisite skills for manipulating light in aesthetic ways.

Learning and Research Skills

In addition, TDs will consistently be called upon to invent something that has never been done before. The best TDs are those who can make ingenious and intuitive leaps that bring unseen visions to life. They need to understand what has gone before and how to put seemingly disparate pieces together. And they will always be expected to keep up their skills, learning or writing new software on very short time frames.

Specific Job Skills

Some specific topics that TDs should know include: scripting and expression writing to create or control images; modeling complex, organic objects and how continuity is kept across such surfaces; enveloping, or developing the final "skin" around an animated character; rigging characters for animation, which is setting up intuitive controls for animators to use; procedural modeling using such tools as particles or implicit surface techniques; detailed shader and texture writing, which creates the final look of an object or character; pixel mathematics, which are used extensively in compositing operations; and working with 2D and 3D spaces and their interactions, especially in techniques such as 3D tracking. It is also imperative for TDs to understand how film works—how it is exposed and scanned into the computer as well as how to correctly output digital images to it. And last but not least, an understanding of the entire production process is extremely helpful. Knowing how and why certain decisions are made for a particular scene before it ever gets to the point where the digital manipulations occur can simplify the TD's task. Add to these areas an understanding of how to decide which tool is best for which job, since CG may not always be the best choice, or when to chose one CG tool over another. For example, modeling an asteroid is easier using simple geometry and a clever shader rather than a model with ten thousand polygons, and blowing up a building might be simpler to achieve with a practical, miniature model than with CGI.

Suggestions on How To Do This

Tying the appropriate computer science knowledge to practical applications is much easier today than it was twenty years ago. However computer science education has not changed to reflect this as much as it might have. CS has a set of core classes that are certified and endorsed by various academic and computer organizations. Contrast this with the multitudes of "Computer Graphics" programs within art, design, communication, architecture, film, tv, or media departments that have been created over the past twenty years. These more artistically-inclined programs have very little in the way of standard or endorsed "core" classes. These programs have benefited, however, from a great deal of advice from studios and entertainment companies, and have modified their programs accordingly, with more or less success. They still, for the most part, lack training in the more technical areas of expertise needed for the optimum success in the entertainment industry. Both types of programs produce students who do not have all they need.

It is tough to create a truly interdisciplinary program within most university or college environments. Not only are there scarce resources which often leads to departments protecting their domains, there really isn't enough time in a typical four year program to implement the total number of classes that would create the ideal graduate for this industry. Nor is there anything remotely like an apprenticeship program for the digital entertainment field (though this is currently being promoted to the State of California). So how can we provide ways for CS students to become more prepared for jobs in this arena, without diluting the core education they need?

One obvious way is to have more input from the entertainment industry. This increased interaction might lead to additional resources such as entertainment-sponsored training materials or innovative elective classes taught on video, the internet or via video conferencing. On-line guest lectures from top TDs at a variety of production companies could be collected and distributed to a number of participating schools. (SIGGRAPH could sponsor this as a Special Project.) Online mentoring or critiquing is another option, where an industry professional nurtures, reviews or critiques student projects using student web pages.

New teaching methods within CS is another possibility, such as special topic classes that are team-taught and co-listed between departments. Dr. Dave Ebert and Dan Bailey are teaching just such a class at UMBC in Spring 1999, called "Art and Science in Computer Animation", with ten art students and ten CS students working on collaborative computer animation projects. There could also be more emphasis on available materials or publications, such as Cinefex magazine, or various special television broadcasts, which would be valuable for those students interested in these careers. This can be done though seminar classes or through career resource departments. There are many points of intersection, especially for advanced or senior level classes that allow students to bring their complementary skills together in production-like projects, thus learning from each other. Even a few such classes or techniques as described above could go a long way towards providing students better preparation for careers in the digital entertainment industry.

[1] "The Visual Effects Industry Needs a New Production Model: Why *Titanic* Is the *2001* of Our Time", by Ray Feeney, Chuck Spaulding, and Kevin Mullican, Millimeter, November 1988, pp. 65-71.