Combining Art and Mathematics in Computer Graphics Education

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Abstract

This paper presents an innovative education program at the University of Gävle, Sweden. The program, Creative Programming, combines traditional methods of teaching computer graphics, with other cross-disciplinary areas such as art, cognition, and film. The uniqueness of the program is represented by the students that are accepted and the teaching environment they are put in. A judicial process is used to screen applicants, with and without portfolios to the program. This is followed by an examination of intellectual capacity, practical examination, and finally an interview. Together, these are used as guidelines to determine if the student is a suitable candidate for the program. The final group selected has varying backgrounds, ranging from the professional artist to the traditional computer scientist. They are then immersed in a lab environment for the whole duration of the education on the campus. The remainder of the education involves a period in industry. The combination of selective students, a lab environment has produced very satisfactory result, and can be used as basis for further developing the education.

Keywords: *Computer Graphics Education, Art, Industry*

1. Introduction

Universities are under pressure to develop new, dynamic education curricula. The area of digital media, for instance, is becoming increasingly important in this world. There is a shortage of people with the required educational background who can design systems in this new medium, in research terms, as well as in visual development and implementation. The interfaces to computers are designed in a much more visual and intuitive manner today, so the skills involved in creating software applications have expanded from traditional programming to include creative skills, such as graphic design, writing interactive narratives and creating story boards. Research also plays a very important role in the design of systems and implementation of new techniques yet to be utilized in current technologies. Universities with traditional education of graduates in computer science must now examine the need for these new multidisciplinary skills. One common solution is the creation of cross-disciplinary degrees such as Computer Science/Media Studies. If we examine the skill set required in developing these new media applications we find that they are essentially different depending on the desired end result. Several applications will require a programming/logical approach as a solution, whereas others will require a creative, visual solution to the problem. If we examine the various types of graduates from a typical University, we will find different skill sets appropriate to this new medium. An arts graduate will have developed skills in written communication, an artist will have an appreciation of aesthetics, psychology graduates appreciate the difficulties of human-computer interaction, and computer science graduates will have an understanding of the technical issues required and how current technologies might not be adequate for the problem at hand.

The Creative Programming program was created in 1995 with the goal of combining the previously mentioned skill sets together in an innovative way. The initial program is an eighteen month program which can be used in conjunction with computer science credits (or similar) to obtain a Bachelors degree. The program looks at both the technical and aesthetic issues involved in the digital media of today. Education is in the form of lectures and practical sessions with skilled instructors from industry or academia. This makes the students up to date with what is happening in industry, as well as understanding what the latest developments in research are. The program helps students to combine existing skills with the technological skills needed in this area, enhancing their knowledge, both technically and analytically.

2. Screening Process

The process of screening applicants is very complex. The work is examined by a jury of experts in the area of digital media, both from academia and from industry. A previous Creative Programming student is also included in the jury to provide a students perspective. The jury reduces all the initial submissions to thirty possible candidates that are then invited for an interview at the University. The criteria used for selection include the portfolio, academic qualifications,

and industry experience. When judging the portfolio, issues of creativity, originality and quality are most important. It is often the case that the portfolios examined are varied in nature, presenting very different kinds of work, in either creativity and originality, but with not necessarily high technical art skill.

The interview generally involves an examination of the applicants intellectual ability, creative ability, skill at handling a computer, and evidence of a creative mind as well as of sociability. One element of the interview stage is the use of Raven's Advanced Progressive Matrices (APM) [1] to indicate the analytical and logical ability of the applicant. The APM is designed to assess a person's intellectual and reasoning ability. It is one of the most well examined tests of general intelligence, it is nonverbal, and has very good psychometric properties, normated against lots of populations with different cultural and educational backgrounds. The advanced version of the test (APM) used here is designed for people of above average intellectual capability. The test-retest reliability is over to 0.93 for age 30 and under. The test is used for evaluating the logical intellectual capacity of those very artistic applicants that are lacking traditional computer science. The social and emotional competence is also judged in the interview, to make sure that an open and dynamic group process is promoted by the students accepted. The creation of this group dynamics is also the rationale for selecting a good mix of gender, age and artistic and computational profiles into the group. With this the most crucial conditions for merging the artist with the programmer are met with.

The program is unique in its approach to education and selection of students. It aims to give an opportunity to highly creative and intelligent people to experiment and enhance themselves in the world of digital media by combining their skills from other areas, such as art or programming.

3. Curriculum

After the selection process, fifteen students are invited to participate in the Creative Programming program. The first twelve months of the program the students are in a lab environment at the University. The final six months the students are in industry. The program is taught in competition to the Computer Science program and the Computer Engineering Program at the University. The structure of the curriculum is taught in four terms over two semesters, with the final industry project in the third semester. The first semester concentrates on aesthetics of the image, new media technologies and human computer interaction. The subjects taught in that semester include -

Multimedia Techniques – introduction to the theoretical concepts of multimedia. The practical sessions involve developing multimedia applications, which are both technically and aesthetically challenging. This is taught by Computer Science staff.

Aesthetics – introduction to the important concepts in aesthetics. This looks at both traditional and current theories in aesthetics. This is taught by an expert in art from a department at the University. There is also some interaction from industry art experts.

Multimedia Management – this subject examines how to create complex multimedia applications. This is combined with dealing with real clients and deadlines. The clients are usually from industry or the local community. The lectures involve seminars about topics such as contract writing, copyright issues, management of a team and client handling. These seminars are given by experts from the digital media industry.

Program Design and Cognition – examines the human computer interaction (HCI) issues when designing software. There is a strong cognitive psychology background presented here. The course is taught by lecturers in the Computer Science department.

The second semester of the course concentrates on computer graphics, animation, film aesthetics and future research. The subjects include -

Computer Graphics, Modelling and Animation – this course is actually two courses in one. It examines the theoretical aspects of computer graphics in detail. Even though the majority of students do not have the traditional linear algebra background, the course still delivers complex mathematical concepts. The contents include, but are not limited to, 2D and 3D transformations, lighting, realism, rendering techniques, shading models, colour models, hidden surface algorithms, 2D algorithms, 3D algorithms, radiosity, surface representations, facial animation, facial modelling, volume rendering, virtual reality, future research. The practical sessions are taught by computer animators from the industry. This will often include someone to handle the creative direction of an animation as well as someone to deal with the technical issues. This is to reinforce what the students have been taught in lectures. The lectures and programming oriented practicals are taught by Computer Science staff. The modelling and animation, creative direction aspects are taught by appropriate experts in the industry.

Film Aesthetics – this is a course taught by the Media department at the University. It examines concepts of what is film, the types of film, criticism in film. It is taught by various media professors and improves the students' ability to analyse work. The course also helps the students in designing storyboards and narratives.

Industry Seminars – this course is the last before the students have their industry practice. Approximately ten industry experts are invited to give seminars on how digital media is affecting them. These lecturers have included people from film, government, post-production, computer gaming, research, small companies, large companies and so forth. The main goal is to avoid presenting a narrow view of the digital media industry. The students also have a free project of their choice to deliver.

In all the above courses, the students have access to their own lab of equipment. The lab usually consists of fifteen personal computers, six SGI computers, one scanning machine, two printers, a video editing machine, TV's, video equipment, virtual reality equipment and so forth. This equipment is accessible 24 hours of the day to both staff and students in the program. The benefit of the lab environment is that it acts as a place where the students can learn from each other and to develop.

4. Practice versus Theory

The Creative Programming program examines many issues of what is important in content in today's digital media. This involves highly theoretical lectures in areas such as HCI, modelling and animation, and computer graphics. The general idea is that the theory does not change remarkably, but the tools do. Therefore, it is important to stress the theory more than the tools. This has become obvious in several instances such as the 3D animation industry, where software updates and competition is fierce. The important thing that is stressed in the education is that the tools are irrelevant. With good support of industry we are able to achieve this high standard of education, without compromising the principles of quality with quantity.

HCI is a very important part of computer graphics, and hence the program involves a heavy cognitive theory section. As we see in Figure 1, simple design tasks are given to the students to help build up an understanding of simple, easy to use interfaces. When educating both programmers and artists in computer graphics, a pragmatic approach is required. We stress the theory aspects of computer graphics, modelling and animation to both students, as these principles generally will remain the same. The practical aspects of the course are performed by industry, and as of such, we do not stress the tools that we use, only how the theory affects the tools. Looking at Figures 2 and 3, we can see some experiments with lighting, reflection maps, and radiosity concepts using the tools available in the labs. This is stressed in the lectures, and the students are encouraged to experiment with the theoretical ideas presented.

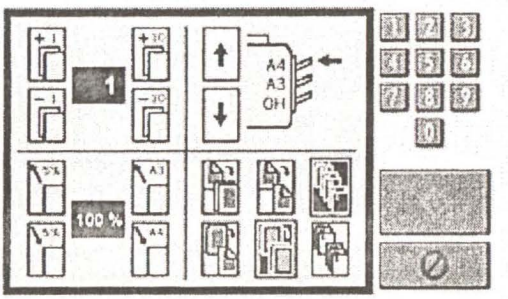

Figure 1. The theoretical concepts of Design and Cognition are used to help students to design simple and language independent interfaces. In this particular example, a new photocopier interface is designed.

Group projects are often encouraged to educate the students about collaboration. There is also plenty of time for students to perform individual projects. During the Computer Graphics, Modelling and Animation course, the students are strongly encouraged to submit their work to various international competitions. These include the Rhythm and Hues student competition, the Alias student competition for instance.

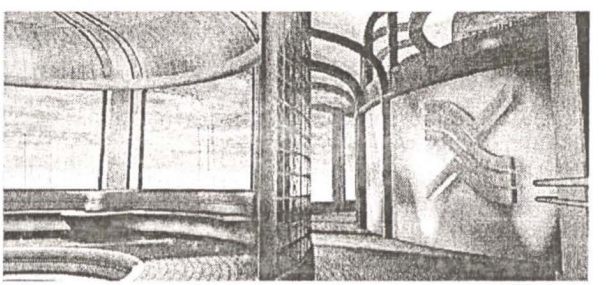

Figure 2: A still from an animation to show the future dental clinic. This is a project with real deadlines and real clients.

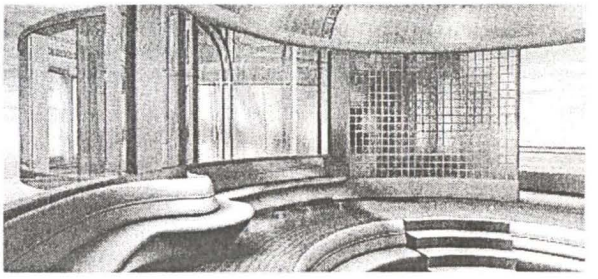

Figure 3: A still from a two minute animation presenting the future dental clinic. This was produced after a highly theoretical lecture on radiosity.

5. Industry Involvement

The final stages of the students' education is spent in industry, where the student specializes in some area. Generally, this has included programming in the gaming industry, 3D industry (animation and modelling), and also the web industry. The process of matching the student to industry is often a complex task. This usually involves various visits by the student to different companies that they like. This is complemented by visits by companies to the lab where they are able to see the student at work. When a successful company has been found, the student then can begin their practice there. Some conditions are stressed by the University about the practice session. These include that the student be guaranteed a computer and desk, that they are working on some project, and that they are given one day a week to prepare a report and presentation. At the end of practice (twenty weeks), the student then presents a major presentation, which is either research related or practice related. To ensure that both the student and the client are satisfied constant communication by the subject controller to both parties is maintained. It is in this process that feedback about both client and student is received. This is important as it allows us to review the selection process for both the student and the company. At the time of writing, we are about to send out our fourth group of students into industry. This process and relationship with industry was discussed in [2]. In Figure 4 we can see the result of one student's work whilst in industry. The student worked in the special effects industry and produced over five productions that were shown on television. Figure 5 and 6 demonstrate how the movement from traditional art to computer generated art can produce very good results. The art work in Figure 5 was in part of course work. The model in Figure 6 was individual free time work that was applied after various theoretical lectures on facial modelling. Figure 7 is a very complex model that has been submitted to the Rhythm and Hues international student competition.

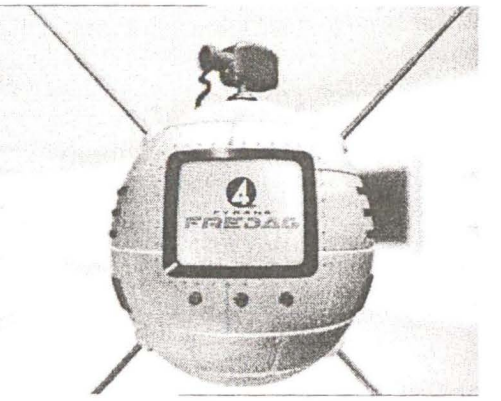

Figure 4: A still from the industry project where a student worked on a commercial that was presented on television.

Figure 5: Traditional artwork.

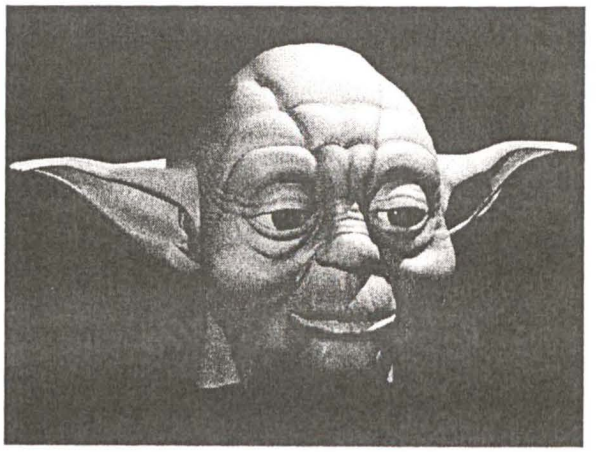

Figure 6: Facial modelling by same student as in figure 5.

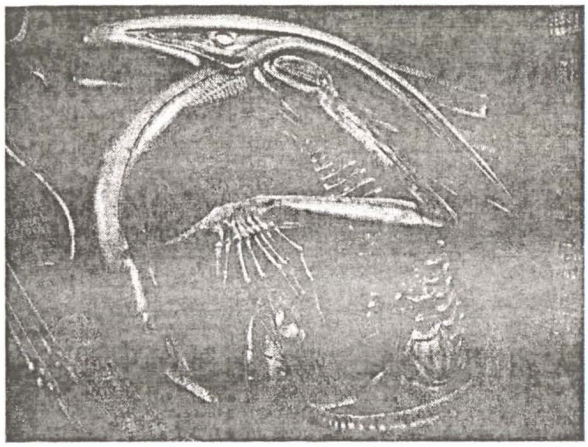

Figure 7: A rendered model with advanced textures.

6. Conclusion

In this paper a new digital media program is described, one that attempts to merge the computer programmer and artist together. The program aims to provide the opportunity for the programmer that has artistic skills to combine them in an education, and for the artist that has never approached a computer, to learn and improve themselves. As APM is a very good predictor of academic success, it can also be used to rise the confidence of this group of applicants in that they will manage the theoretical and technical courses in the program. An examination into the methods used in combining theory of Computer Graphics with practice is also explored. A lab environment is used, where the different cultures of people, experiment with new techniques, and use each other as reference of information, both technical and aesthetic wise. This means, those that are familiar with computer programming, can educate the artists in some aspects, and in return receive aesthetic criticism and tutorage. The education as such, concentrates on theoretical aspects of multimedia, design and cognition, computer graphics, modeling and animation, aesthetics, and media issues. The practical side generally involves reinforcing the theory, but also acts as an avenue for the students to enhance their creativity. Industry involvement is also crucial, and hence the students often find their practical work has a real end purpose.

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References

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