INDIVIDUAL STUDY OF 3D MODELLING SOFTWARE USING INTERACTIVE VIDEO

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ABSTRACT
Technical software gets ever more essential as tools for mechanical engineers. Still, the subject is not much emphasized in our curricula, and we are challenged with making the students familiar with complex software without much teaching and without much time on the schedule. Being more of a skill than knowledge, such tools should ideally be learned with access to good tutors, but capacity is a problem here. For years we have fought with this dilemma, until we found what we think is a solution: A video-based, interactive teaching and tutoring system for our chosen 3D modelling software. The paper presents the reasoning behind this, it presents the solution as it has been developed, and also summarizes the experiences gained after a year and a half of use.

Keywords: Teaching, self-tuition, computer software

1 INTRODUCTION

Mastering a CAD system for mechanical engineers gets ever more important. Learning such a system in the early phases of a mechanical engineering education and developing competence and skills over the course of the study, is therefore a must. As more and more companies rely on big, complex 3D modelling software, we find that skills and understanding of such systems is demanded by companies when they hire fresh engineering masters. And for students to reach an appropriate level of competence, they need to start learning and using such systems early in the study. We also find that industry is less and less willing to spend time and resources on internal training of new employees, most certainly an effect of the ever increasing competition in most businesses.

So giving students competence and skills in such systems is a necessity. The problem is that this is not considered scientifically important by the university, so there is no room for special courses in these systems in the curriculum – a change from the 1990s, when they were considered new technology and therefore scientifically interesting. Today they are considered more of a skill than scientific knowledge. But skills are time consuming to develop, and contrary to knowledge can only be accumulated by practice, and not by reading. Today's 3D systems are big and complex, and require quite an effort to learn [1]. Still, in our study program where we introduce it to students in the very first semester, we only have it as a partial course together with machine drawing and freehand sketching.

A discussion of the problems of teaching these systems is done by Łukaszewicz [2] [3].

The students are mechanical engineering students, and their level of computer knowledge varies a lot. None of them have learned any programming – which would have helped them understand certain concepts, but most have experience as users of software, although not the type of software we are concerned with.

This is clearly a problem. A topic which requires practice and which is complex enough to require much available tutor capacity has little room in the curriculum and there is therefore not enough time in the students' schedule to get the necessary practice [2].

2 A NEW TEACHING PARADIGM

The CAD system we have chosen to base our teaching on, is Unigraphics NX from Siemens AG, and has been so for some years. For most of that period, we have had a printed tutorial (tailor made by the department for this use) for the students, complete with exercises and practice assignments. Students have had the opportunity to use computers at school, or to install the software on their own PCs so

they can work at home. We have also recommended a textbook, but this has only been of use to the students who have reached a certain level of knowledge and skills, and few have bought it.

2.1 Tutorial

There is nothing wrong with the printed tutorial. The problem, however, is that students who are novices to computer usage, have problems getting going. They simply do not reach a level where the tutorial is helpful for them. This could probably be alleviated by making the tutorial much more detailed, but that again would make it long and tedious to more experienced users. Part of the problem is that what a tutor can show in 10 seconds, takes a lot of lines of description in text.
The problems of tutoring software are discussed in [4].
Another problem is that the software is updated with a new version every year. Usually, changes are minor in most areas, but significant in some. We should, therefore, ideally revise the tutorial every year. That has not been possible for us, so we have postponed it to every second year. That means discrepancies between tutorial and software, again requiring extra tutors to help the students.
Still, the results have not been encouraging. Some students have become very eager, and they have learned a lot and gotten to a more than adequate level, but most have only been able to learn the most basic elements. And the demand for tutors has been higher than we have been able to satisfy.
We have also tried to involve the software provider, and got them to hold courses for the students, but the main issue, tutoring, was not eased by this at all.
So we clearly needed to find a new way of teaching and tutoring CAD software.

2.2 Alternatives

The most obvious alternative to our old method of teaching the CAD software, was the built-in tutorial in the NX-system, called Cast [5]. This was examined, but was found to have a number of properties not compatible with our needs. The major problem was that it covered everything, and it was all in a flat structure. This requires that you know what to look for, something we know that our students would not do. The sheer volume of it was also a problem, making it difficult to navigate around, and it takes up enough disk space that most students have chosen not to include it in their installation of the software on private PCs.
So this was not the solution we were looking for.

2.3 Video

Using video as a tool was an idea that came from a student who had had the paper-based tutorial, and had found it lacking. His initial thought was that a videotaped session could replace introductory lectures only. This would have a number of benefits: The video could focus in on the computer screen and show exactly what was being done, thus providing more detail. Even more benefit would come from the students being able to rerun the video as often as they wanted and when they wanted. In itself, this would probably justify the investment in the video sessions.
The use of video is discussed in [6]. An alternative approach is discussed in [7].
The investment needed was not particularly large. We used the student, a very competent one, to make the videos for us. He worked full-time for about 6 weeks, but went further than we had anticipated. He focused on both lecture type material – introduction to subjects – but also on tutoring. He also designed a web site for the videos, with information about the system, a discussion forum and many other features to supplement the tutorial system [8]. So the effort involved in the basic tutorial system was probably around 3-4 manweeks.

3 RESULTS

The system was developed during summer 2011, and was first used in fall of the same year. We saw immediate benefits of it. After some early capacity problems at the server side – we had to move the system to an external server in order to get the required capacity – it was used by a class of 200 first year students. What we saw, was that not only was it used to replace the printed tutorial, but it was used in tight integration with the modelling software. Typically, a student would have the NX software open in one window on the computer screen, and the video course in another. This meant that when it came to the exercises, it was easy to start the exercise, and switch back to the instruction video whenever a problem was encountered or the student couldn't remember how do perform a certain operation.

The real benefit turned out to be when used interactively in this way. When students work in NX in one window and have the video in another window – and can start and stop the video to follow their own pace – we see students go through the exercises much faster than they used to do. But going through them faster is not the objective; we want them to learn and acquire skills as efficiently as possible.
Measuring and quantifying the results of such a change in instruction methodology, is not easy. And we have not attempted to do that, mostly because we think the uncertainty in the measured quantities would be too large for it to have validity. So the results reported here are qualitative, with an element of subjectivity.

3.1 Efficiency in teaching

The goal was improvements along two distinct axes: Efficiency in teaching and quality and capability of student performance afterwards.
Efficiency in teaching is a measure of good relation between the input (teaching, tutoring, exercise time) and the output (student knowledge and skills). This was very important, since the ratio between the number of students and the number of assistants plus teacher is so high.
The results we have observed along this axis have been good. With the exception of frustrations in connection with capacity limitations in the first week, the need for tutoring has gone down a lot. There has also been reports of students putting in many hours at home, something that was hardly possible earlier.

3.2 Student performance

This is a course with no exam, so we have little quantitative documentation of possible improvements in what the students can and what they are capable of after the course. As mentioned earlier, the 3D modelling course is part of a larger course, and assessment of the total course is through a team project. In this, the teams are expected to show what they have learned, in 3D modelling as well as other subjects.
Filtering out the capability and quality of 3D modelling from this total project hand-in is not easy, so the results so far can only be estimated and will be based on subjective impressions of the overall level of hand-ins this year in comparison to earlier years.
However, we soon got reports from the assistants that this year's students held a higher standard than usual in 3D modelling. And the project reports confirmed this: There was a generally higher standard than in previous years. This is a qualitative judgment which cannot be backed up by data. For our study program, however, this is sufficient to say that the development has been a success.
We are not able to assess the distribution of student competence, so we cannot say if the high standard represents all students, or if the students range from very low to very high competence. The impression that the assistants got from observing them, indicates variation, but not that there are students with very low competence after the coursing. The variation is believed to be approximately the same as in previous years, and is believed to stem from variation in computer competence and experience before the course. This again cannot be confirmed from data.

3.3 Extension of system

After the initial successful experience, other teachers got interested in this way of teaching software competence. That led to a phase 2 of the development: Modules for 3 more courses were developed. This took place during 2012. This is all related to NX, but the new modules cover topics like finite element modelling and calculations and sculptured surface modelling. These new modules will all be tested during 2013. Again, the early results look promising.

4 SELF-TUTORING

The new way of teaching and tutoring the 3D modelling software, can be visualized like this:
The students will start by going to a web-page which serves as a gateway. There they will log on, and start the first information video. This contains information about how to install the NX software for those who have not yet done that.

As soon as the modelling software is installed, they are instructed to open it, and then the video goes through the basics of the software. Principles are explained, and the first modelling techniques are shown. Then comes an example, where the video explains an assignment in detail, and then the video shows how it is done. The screenshots in Figure 1 and 2 illustrate this.

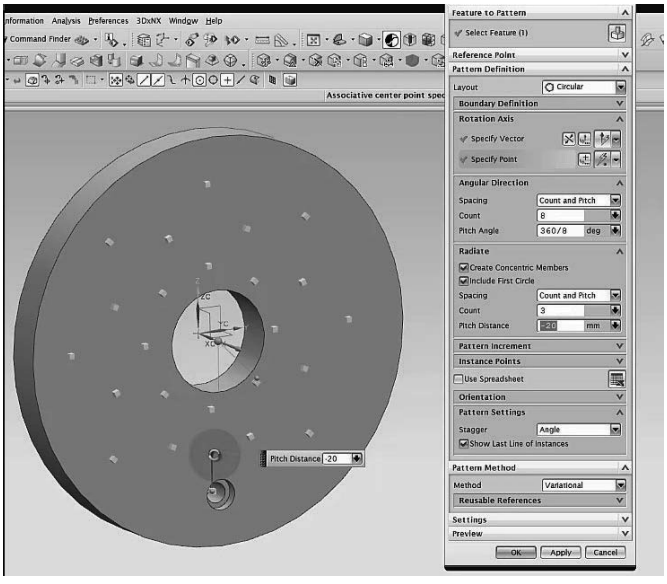

Figure 1. A screenshot showing how the video session shows actual work with the software, and illustrates points with arrows, markers, highlights and spoken explanations (example shows use of pattern feature for duplicating holes)

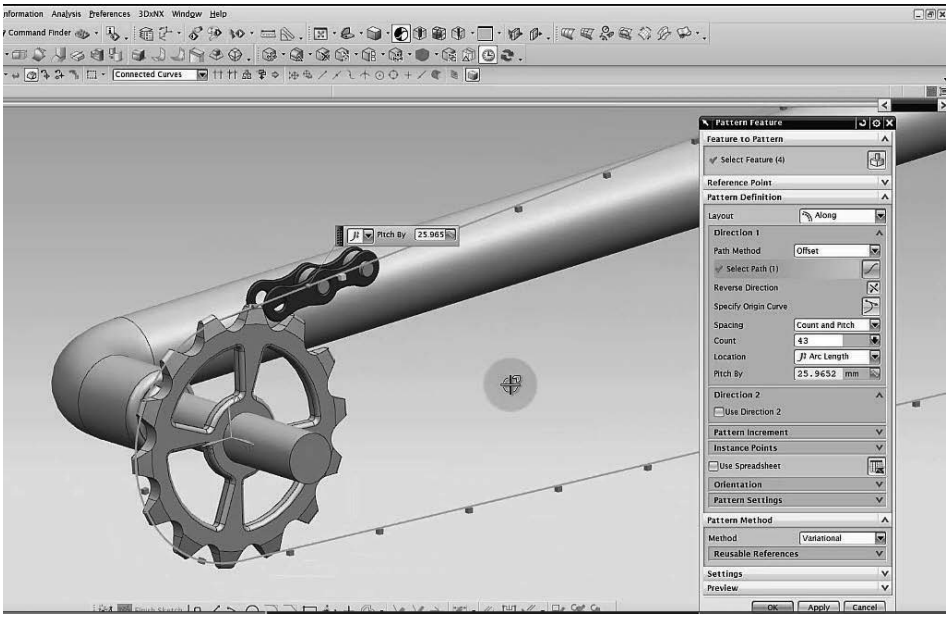

Figure 2. A screenshot showing an actual session, creating a bicycle chain

In addition to these examples, there are exercises for the students to do. These are explained, but the video does not show how to solve it. It should, however, be straight-forward if you have worked through the video session. We also have a system to upload the model files created in these exercises, so that the assistants can look through them and approve them.

5 CONCLUSIONS

A limited development work has led to a new way of teaching the CAD software. This new teaching practice has so far only been used once, but the results are so promising that we expect this to be the way forward for software teaching in the department. The new practice contributes to both quality and efficiency requirements; quality since it seems that students learn more from this than they did from our earlier teaching and efficiency since it reduces the burden on both instructor and assistants. The increase in efficiency also makes it possible for us to handle the increasing number of students in our course.

The problem of keeping pace with the yearly software updates, however, have not been solved by this, and we realize that we face yearly updates of the video course. We will try to find good students to help us do this.

But all in all, this experiment has been so successful, that we are now planning it for other software and other courses as well.

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