FY02 Innovations in Teaching with Technology Awards: Iowa Dental Surgical Simulator

Proposal Title: Iowa Dental Surgical Simulator

Investigators: Geb Thomas, Clark Stanford, Lynn Johnson

Org Unit: College of Dentistry

Department(s):

Funding Awarded: $38,000

What do you intend to do?

A project to build and evaluate a surgical simulator that uses force feedback - "haptics" - to teach and assess the tactile skills of dentistry.

The IDSS is a force feedback dental surgical simulator designed to be a regular part of the dental curriculum by providing a more uniform educational experience and superior performance feedback for the students than traditional training methods. The device will help students to learn haptic skills and will help supervising faculty verify that the skills have been adequately mastered. Although the simulator will eventually be used for a wide variety of surgical tools and techniques, initial development has emphasized the clinical assessment of dental margins. Our initial proposal emphasized the simulation and detection of dental caries, but the target task was changed to the assessment of the small gaps between dental crowns and the prepared tooth because: 1) the dental industry has begun to move away from the detection of dental caries with probing, and 2) the dental faculty believe that current techniques for training and assessing crown margin skills could be greatly improved with a simulator capable of quantitative presentation. The crown margin problem involves determining whether the gap between a dental crown and a prepared tooth is less than 25mm or greater than 100mm. Gaps that are too large tend not to bond well and the crown is more likely to fall off. The dimension are too small and awkwardly located so that the dentist must estimate the size of the gap by exploring them with the tip of a sharp tool and estimating the size of the gap.

This important piece of software will give the students a tool that will allow them to improve their ability to interact with other health professionals once they reach the environment where they are daily involved in patient care. It will help them to apply their didactic instruction in a patient care environment. Student satisfaction in the Clinical Pharmacokinetics course will also be improved because we will be teaching the students how to use a tool that will be beneficial to them in many of their upcoming courses and extremely useful in their Clinical Clerkships in their last professional year.
Our current plans have emphasized the collection and validation of the specific force signals experienced by dentists in the laboratory. These measurements will allow us to quantify the realism of the simulator compared to the experience of dentists in the clinical setting. The last step of this project will be to test and evaluate the skills of dental students trained with the simulator. The details of this evaluation have not yet been finalized. It is likely, however, that the evaluation will consist of comparing the performance of students trained with the simulator against students completing traditional training techniques. The participants will be asked to estimate the size of the gap in set of calibrated steel blocks.

Our current approach is to stimulate the pattern of forces perceived at the tool tip rather than to directly simulate the geometry of the crown margin. This approach is much more easily generalized and focuses development attention on the signals directly perceived by the student, which seems appropriate. Once we understand the pattern of forces and the factors that shape them, we will use the phantom device to replay these patterns at the appropriate instant. In order to test this “replay” capability we will need to develop some simple algorithms an add these to the existing model software. We received the new computer earlier this week and will begin software development within the next two weeks.

Although we can use the force patterns already collected by the Iowa Probe in the lab as the basis for the replay, we would like to measure the patterns elicited by dentists when exploring gaps of controlled size. To this end we have begun manufacturing a set of blocks with a wider range of calibrated gaps and submitted the necessary paperwork to the Human Subjects research office to have students and dentists explore the gaps while we record the forces they experience. These data will allow us to see the variation in force elicitation styles and also to ensure that the patterns we measured in the laboratory are similar to those elicited by practicing dentists.

We will then develop software that replays these patterns of forces when the explorer crosses a critical region on a three-dimensional model of a tooth. We will bring this simulation back to the dental school for validation and retesting.

What resources will you need?

- Part-time graduate appointment, 1 semester: $ 7,800
- Grad student fringe: $967
- Computer: $1,092
- Ghost Software: $2,250
- Steel blocks: $100
- Part-time graduate appointment, summer + 1 semester: $12,834
- Experimental set of steel blocks: $400
- 2 undergraduate students ($528.5 hrs at $9/hour summer): $4,757
| Rough estimate of costs | $38,000 |

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