To provide hands-on training of wisdom tooth surgery, a simulator for oral surgery is being adapted to support the general drilling procedures in the mesio-angular impacted wisdom tooth. In this inter-disciplinary project between Karolinska Institutet, Royal Institute of Technology and Forsslund Systems AB, a multi-modal (vision, audio and haptic) simulator has been constructed and integrated into a course. Haptic feedback is the technology to render the feeling of touch, mediated through a haptic device. In the course a Sensable Desktop device was used, which has a high fidelity compared to Sensable Omni, another commonly used haptic device (figure 3). The simulation described here is built upon previous work by Forsslund et al (2009), where a bone drilling simulator was constructed targeting oral surgery in particular.

Design and implementation has followed a user centered design approach (figure 5) which involved an iterative design process of contextual inquiry, prototype construction and three cooperative evaluation sessions with experienced dentists and surgeons. The simulated procedure is based on an authentic CT-scan of a patient’s jaw (figure 2) which has been segmented to enable different haptic and colour rendering of enamel, dentin and pulp. Based on recorded carving in the simulator, the teacher’s preferred way of removing alveolar bone, separating crown and root and removal of root is embedded in the training case.

![Figure 1. Students practice wisdom tooth extraction supervised by a teacher.](image)

![Figure 2. Patient CT-scan](image)

![Figure 3. Sensable Desktop and Sensable Omni haptic devices.](image)

![Figure 4. Rendering of jaw with shading (left) and without (right).](image)

**Plan the Human Centered Design Process**

1. Understand and specify the context of use
2. Specify user and organizational requirements
3. Produce design solutions
4. Evaluate designs against user requirements

**Results**

An independent study has been conducted by Karolinska Institutet where 60 final year dental students has undergone training in the simulator as part of a mandatory oral surgery course (figure 1). Results from a questionnaire (figure 5) showed that 73% of the students that participated in the spring 2009 course very much agree on that training in the simulator should permanently be included in the course (Rosén et al 2009).

Results from the cooperative evaluation sessions showed important design considerations such as shading and coloring of the teeth, physical hand support and positioning of dental instruments. Shading (figure 3) is an important clue for seeing texture and depth in the rendering, which after speed optimizations will be added to the next version of the simulation (Flodin 2009).

**Conclusions**

The simulator now supports the important steps in the procedure of wisdom tooth surgery, supports training and provides tacit knowledge. The positive results of the course intervention study motivates a controlled validation of the simulator, which will be conducted in a study by KTH and KI starting autumn 2009 where students performance and skill will be evaluated by letting students perform surgical extractions on patients of which half of the students will have practiced with the simulator.

**References**

