Recommendations for procurement of oral surgery simulators for training.

By Jonas Forsslund, MSc Computer Science and Engineering, PhD Human-Computer Interaction, Royal Institute of Technology, Stockholm, Sweden. Updated in June, 2019

Introduction

The application of virtual reality technology for teaching surgical skills have recently gained increasing interest in the dental education community. In comparison with minimally invasive surgery, simulators are still young in the field. Technically they differ in that the scene of operation is open and not relayed by a camera/monitor, and that haptic, the feeling of touch, most likely have much higher impact. Investment in oral surgery simulators is not only an investment for training of students, but also an investment in exciting technology not far from the research laboratories. Much speaks for that the industry, products, training material and best practice will change over time. By purchasing a flexible system, your institution is asserting that you meet the needs of not only today but also for tomorrow.

Difference basic dentistry and surgery

A few differences should guide the choice for a simulator that is mainly for surgery (final year dental school) in comparison with one mainly intended for basic dentistry (first years dental school) skill training:

- While a large part of basic dentistry skills involves training of manual dexterity and fine motor skills, these skills are to a larger extend assumed to be in the possession of the student who learns oral surgery.
- Bone drilling is a large part of oral surgery, but not in basic dentistry. The ability to feel the difference between bone, teeth and enamel is extra important in surgery.
- Real patient cases, with several teeth, bone and nerve are important in surgery, while basic dentistry for most part deal with individual teeth.
- Physical positioning of operator might have bigger importance in surgery.

Physical dimensions

An oral surgery simulator should allow for

- Adjustment of height to allow for different student's height.
- Holding a surgical hook with non-dominant hand.
- Use of surgical draping in a natural way.
- Positioning of the operator/student close to that of a recommended operating position, e.g. the student should stand on the same side as the third molar to be extracted.

Simulate a surgical procedure

An oral surgery simulator should at least allow for simulating the following in each training case:

- Drilling into bone and teeth.
- Haptically distinguish between harder density material (enamel) and softer (dentin)
- Register if student drills into forbidden (neighbouring tooth, nerves) or dangerous areas (too near the lingual side). The areas should be specific to each training case.
- Constrain the student to carry out the procedure in an order of steps determined by the case creator (instructor). For example the right amount of alveolar bone has to be removed in order to continue to divide the tooth.
- Total amount of material removed should be recorded to assess that not excessive amount has been removed.
- If a case requires the use of an elevator, it's correct positioning and use should be incorporated in the simulation, although physically correct simulation of elevator movement is not necessary.
- In addition to the interactive bone and teeth have a context providing graphical model that illustrates the challenge of working in an actual mouth rather than in free space.
- Have relevant x-ray projections and anamnese attached for the student to analyse prior to operation.

Creation of training cases

Each patient is unique, and thus training on different patient cases would give the student a better understanding of how to approach a specific patient. An oral surgery simulator should

- Accept custom created training cases, based on segmented* CT-scans, procedure procession logic and context providing virtual models.
- Have no restrictions in license agreements or technical hinders to use compatible third-party cases, created with or without the endorsement of the simulator manufacturer.
- Have an open document format and/or complete description of how a case simulation is operating. Providing the source code for the simulation engine that accepts cases is one way to provide a complete description.

*) Segmentation is the process of manually or semi-automatically labeling parts of a volumetric image such as a CT-scan to identify different organs or materials.

Library of training cases and ability to distribution of cases

Since training cases can be created by multiple parties, primary by different universities, distribution (for a fee or not) of cases will also be important, especially when simulators become more common. An oral surgery simulator should

- Provide an integrated tool to access cases from an online library (for a fee or not).
- Allow for private distribution of cases made by an independent institution (licence-wise and technically).

Storage and retrieval of training sessions

To allow for assessment by instructor and follow-up training, an oral surgery simulator should:

- Provide a way to store recorded simulation sessions.
- Provide a way to retrieve recorded simulation sessions over a network on another compatible surgery simulator.
- Provide a way for an instructor to review statistics about a recorded simulation through a web-based interface, anywhere in the world.

Possibilities of modifications and upgrades

Since simulators for oral surgery is still a young industry, the technology in various components is likely to improve over the lifespan of an investment. To assert upgradeability, possibility of technological research and local modifications, a manufacturer of an oral surgery simulator should:

- Not restrict, through technology or licenses, modifications of the simulator by customer or third party (warranties may be affected).
- Provide drawings and other detailed descriptions with the shipment of each simulator, for parts/modules made by the manufacturer, and list of components for parts/modules made by third party.
- Not restrict, through technology or licences, the customers right to purchase third party components and modules as mentioned above, for replacement or upgrades, with or without the consent of the manufacturer. (Warranties may be affected).
- Allow for modification of source code by customer or third party in order to improve or alter the simulation engine running on the simulator.
- Allow for distribution of modified source code to the public in order to improve the technology in the simulation community.
- Provide enough documentation or code to allow for independent research in the inner workings of the simulator, especially in the field of haptic feedback research.

Support and maintenance

A manufacturer of an oral surgery simulator should

- Offer to provide a support and maintenance agreement for at least two years.
- Provide software upgrades to the same versions as new customers get, for the fee included in the support and maintenance agreement.
- Assert the possibility of the customer or a third party to continue the manufacturing and development of the oral surgery simulator product and software in the event the manufacturer chooses to discontinue the product or files for bankruptcy.

Note: Jonas Forsslund is partner and CEO of Forsslund Systems AB, a manufacturer of the oral surgery simulator Kobra.