CardinalSim

Surgical Preparation & Training with Patient-Specific Virtual Simulations

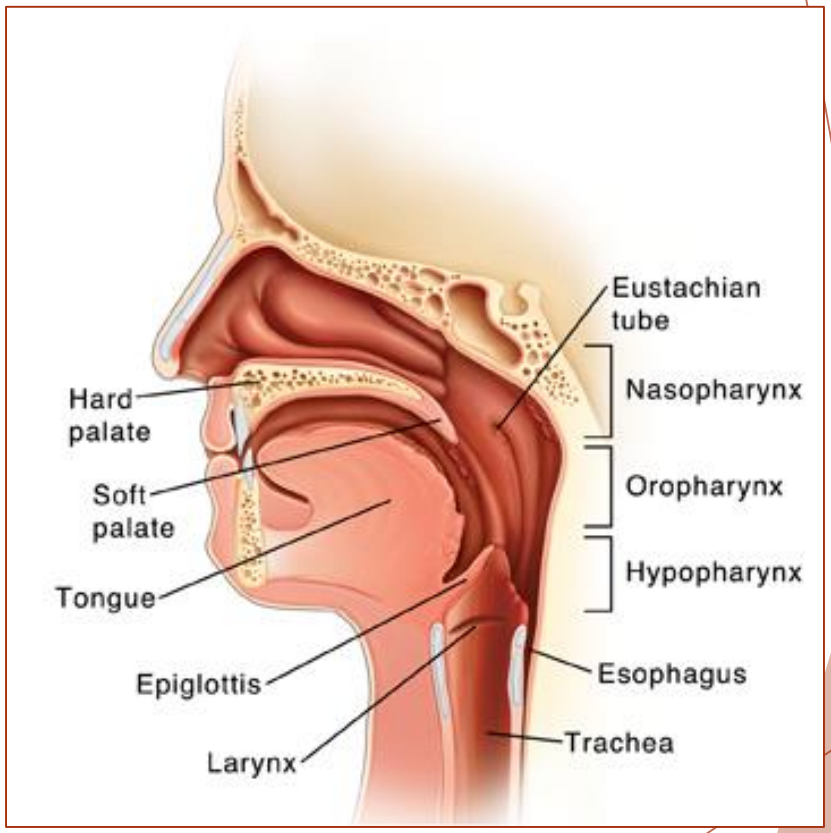
Developed by Stanford University School of Medicine

Executive Summary

- ENT surgeries (ear, nose, and throat) require surgeons to move around a complicated environment composed of minute bone structures & delicate soft tissues
- Failure to appropriately navigate such surroundings can result in surgical complications such as perforation, CSF leak, orbital injury, hemorrhage, facial nerve injury, and others
- CardinalSim has developed a software system that synthesizes CT scans of patients into authentic virtual reconstructions of surgical sites
- Software is already rolled out and easily integrated with widely available hardware such as CT scanners and haptic simulators
- System currently only for ENT surgeries, but applicable to most hard tissue surgeries
- CardinalSim is seeking an entrepreneur to lead software development, device sales, and ENT data sharing collaborations

ENT Procedures and Complications

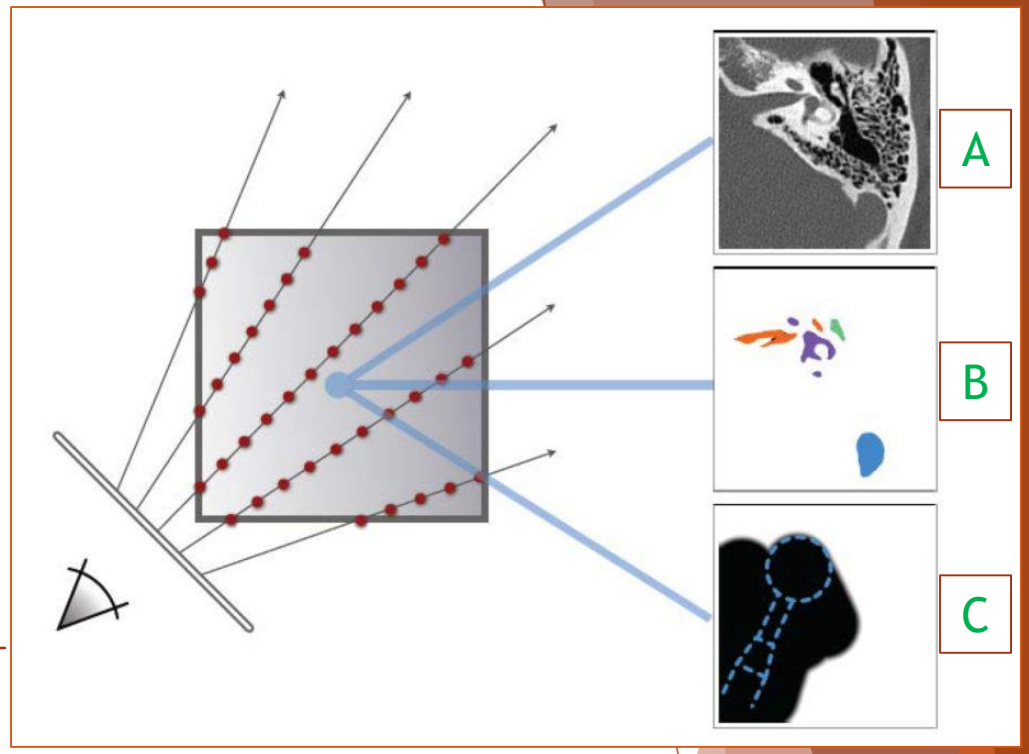
- *Endoscopic sinus surgery*: hemorrhage (0.76%), CSF leak (0.17%), orbital injury (0.07%)
- *Eardrum repair surgeries*: damage to facial nerves (<1%) and bones, permanently altered sense of taste due to nerve damage (<5%)
- *Septoplasty*: septal perforation (2.3%), excessive bleeding (3.3%), ocular complications (0.08%)

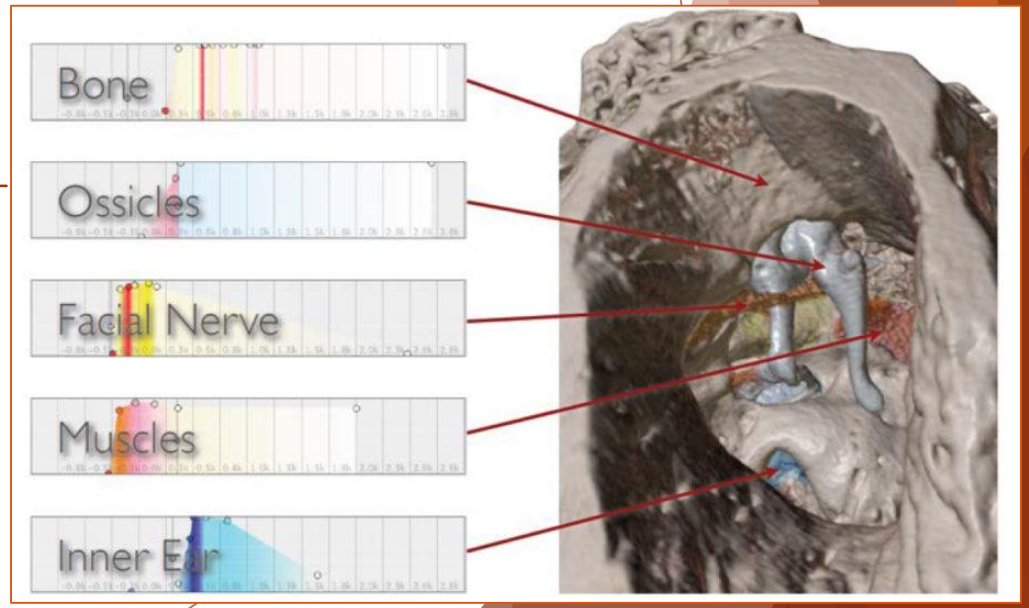


LakelandHealth.org

CardinalSim Technology

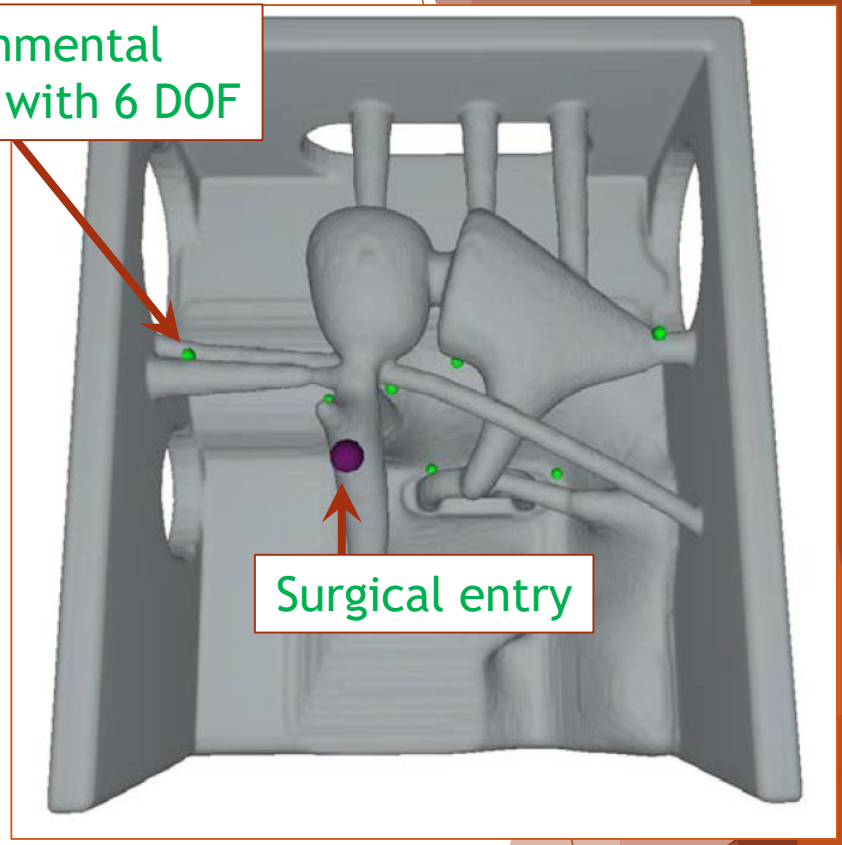
- Uses commercially available Graphic Possessing Units (GPUs)
- Enables application of GPU-accelerated ray casting:
  - **(A)** primary volumetric dataset (usually CT)
  - **(B)** label field volumes indicating which elements are part of which structures
  - **(C)** mask volumes indicate what portion of bone has been surgically removed
- Labels five discrete structures in microCT scans of a human cadaveric temporal bone core
- CT scan data can be synthesized from MRI data





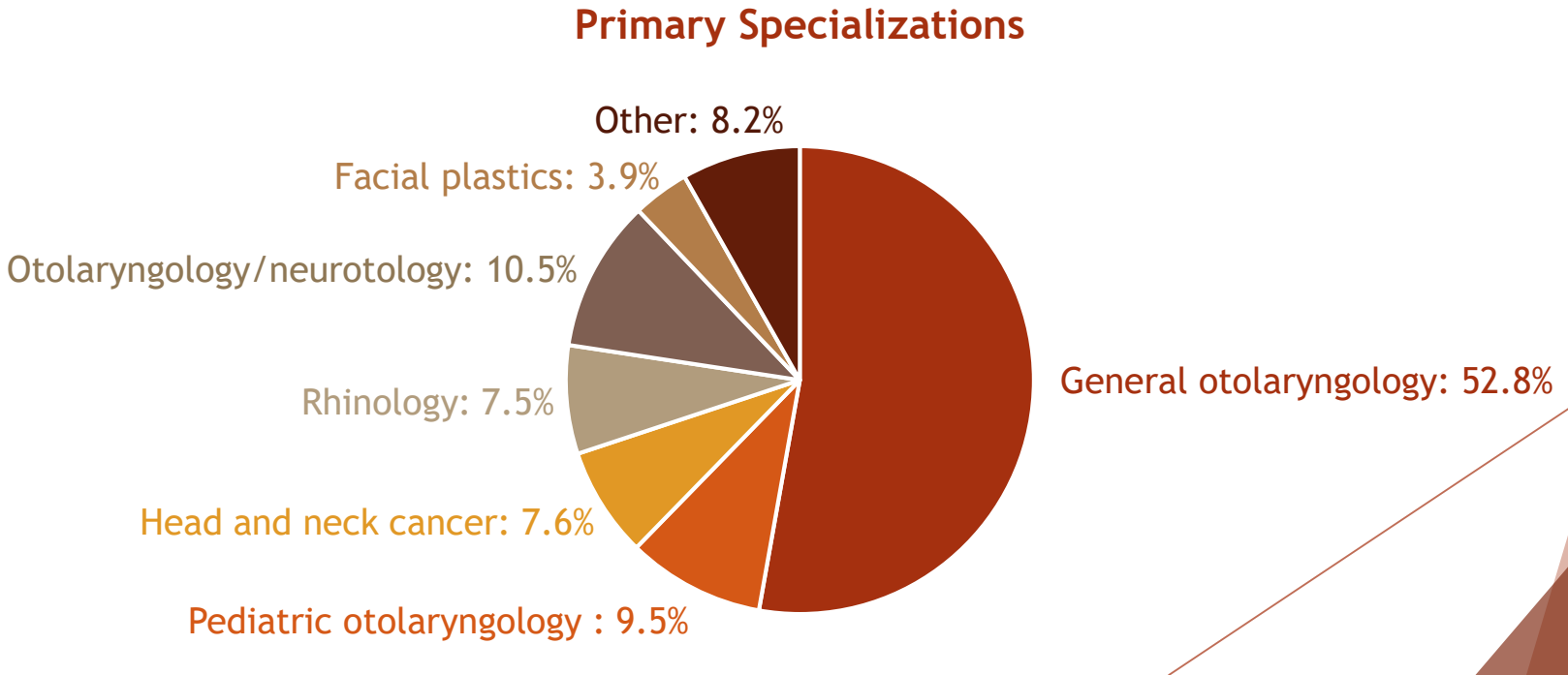
CardinalSim Technology

- Integrates seamlessly with commercially available haptic systems
- Virtual environments are used to measure task completion time and errors made, using different haptic rendering algorithms
  - Works with haptic 1000 Hz update rates
  - Six degrees of freedom (6 DOF) haptic systems
  - Software includes collision detection



How big is the market?

- Global ENT Surgical Devices market was valued at $2.3 billion in 2017
- Estimated to reach $3.52 billion by 2025
- 12,609 otolaryngologists currently practicing in the U.S.
- ~600,000 ambulatory sinonasal procedures in 2006
- ~96,000 cochlear device implants in U.S. as of December 2012



Alternative & Competition

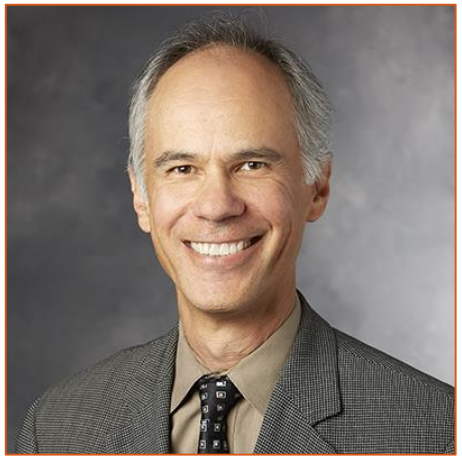
Standard Practice:

- Pre-surgical planning usually involves endoscopic examination and/or CT scan to visualize anatomy

Emerging Technology:

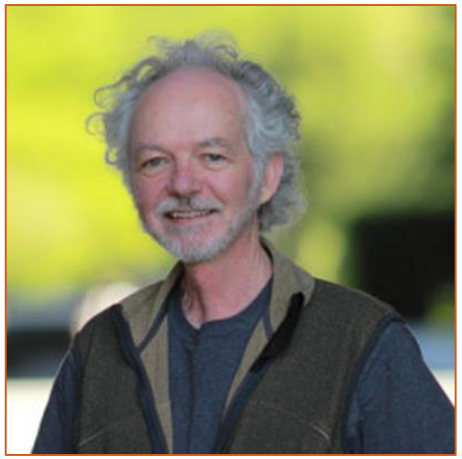
- Endoscopic Sinus Simulator
  - Haptic device developed by Lockheed Martin
  - Being tested for resident training at Montefiore Medical Center
- Fundamental Surgery
  - Subscription-based surgical simulation service
  - Initial focus is orthopedics, plans to move into ENT
- Voxel-Man ENT
  - Simulator for otorhinolaryngology training
  - Use your own CT or CBCT data
  - Based in Germany, devices not currently available in U.S.

Team



Nikolas Blevins, MD

- Larry and Sharon Malcolmson Professor of Otolaryngology at Stanford School of Medicine
- 30+ years in practice
- Best Doctors in America (2003, 2004, 2005)
- 78 publications



Kenneth Salisbury, PhD

- Professor of Computer Science, Surgery, Mechanical Engineering at Stanford University
- Involved in many robotics projects: Stanford-JPL Robot Hand, JPL Force Reflecting Hand Controller, MIT-WAM arm, Black Falcon Surgical Robot.
- Haptic interface tech led to founding of SensAble Technology

Desired Entrepreneur Profile

- Software technology experience -Will lead software development
- Fundraising experience in the MedTech space
- Work with vendors to package software with surgical devices
- Experience with purchasing cycles at major medical centers
- Develop a collaboration with surgeons

Closing

- CardinalSim is a surgical simulation system for preoperative rehearsal of complex procedures
- The market for surgical simulation technology is large and growing
- The CardinalSim team includes surgery and computer science experts with entrepreneurial experience
- CardinalSim is seeking a co-founder to lead software development, device sales, and data sharing collaborations