

# Multidisciplinary Surgical Training Using a 3D-Printed Facial Surgery Simulator: Breaking Down Surgical Education Silos

## I. Specific Educational Aims:

This project aims **to rigorously validate** a low-cost, high-fidelity, 3D-printed practical facial surgery simulator **to teach** medical students and residents topographical surgical thinking and hands-on skills.

Our **multi-specialty, multi-institutional, Stanford Medicine-led** proposal addresses the **collaboration-based funding priority** by **breaking down surgical specialty training silos to unite around common goals** valuing 3D topographical surgical knowledge and skills.

Further, this proposal explores how this facial surgical simulator may serve as a **sustainable and longitudinal** learning modality for trainees, allowing **for pedagogical tracking of learning progression** across **diverse surgical specialties**. Proving the value of this low-cost simulator across multiple academic institutions may enable a sustainable teaching model for years to come, impacting many more trainees than those involved in this one-year project.

## II. Project Rationale:

An important learning objective of surgical education is the knowledge of how to incise, manipulate, and repair soft tissue in a complex geometric manner. Trainees must develop cognitive and procedural skills to optimize aesthetic and functional outcomes, recognizing how their technique changes the entire surrounding surgical topography.<sup>1</sup> This is especially critical in surgery of the human face, where complex topographical anatomy merges with high-stakes cosmetic and functional real estate. Facial surgery also requires consideration of secondary distortion of critical adjacent regions.<sup>2</sup> Given the risks of poorly performed facial surgery, the hands-on trainee cost of developing these skills on actual patients is high.<sup>3</sup>

Specialties including **trauma/general surgery, plastic surgery, otolaryngology-head and neck surgery, emergency medicine, ophthalmology, and dermatological surgery** all require competency in knowledge and skills for facial surgery. These specialties have yet to collaborate at Stanford in multidisciplinary hands-on education for trainees.

Simulation-based facial surgical training is a particularly attractive opportunity to teach 3D soft tissue surgical thinking and hands-on skills in a low-cost, reproducible, and safe environment. Prior educational initiatives have used animal models, cadaveric specimens, or a variety of synthetic models.<sup>4</sup> Biologically-based models, although having high fidelity, are often expensive and carry biologic risks and environmental costs. Existing synthetic models do not reproduce the complex human facial anatomy to enable high-fidelity surgical training.<sup>5</sup>

Recently, our collaborators at University of Michigan have developed a low-cost, 3D-printed facial surgery simulator designed for high-fidelity training.<sup>5</sup> This simulator faithfully reproduces complex human facial anatomy while providing individual training experiences for every learner. The **3D models can also be easily archived and reassessed** by trainees and educators long after the training is completed. These 3D synthetic models also represent an exciting opportunity to **standardize the measurement of training outcomes** for facial surgical education. While this simulator has been validated with surgical faculty and was designed with trainees in mind, there remains a critical need to validate it with the latter group.

Our proposal hypothesizes that this 3D-printed facial surgery simulator will be a valid, efficient, and longitudinally sustainable educational model to teach 3D soft tissue surgical thinking and hands-on skills to medical students and residents. Furthermore, bringing together multiple specialties for this training represents a crucial multi-disciplinary opportunity in surgical education collaboration.

### III. Approach and IV. Timeline/Plan for Implementation

A. **Production and Shipping Stage Target Timeline: 10/2019–12/2019.** Upon grant approval, our team will fund the production and shipping of the 3D-printed facial surgery simulators from the University of Michigan Department of Biomedical Engineering to Stanford Medicine.

B. **Recruitment Stage Target Timeline: 10/2019–12/2019.** Simultaneously, our team will launch multidisciplinary, multi-institutional recruitment of faculty educators as well as third- and fourth-year medical students and residents from trauma/general surgery, plastic surgery, otolaryngology-head and neck surgery, emergency medicine, ophthalmology, and dermatology from Bay Area training programs (Stanford, UCSF, UC Davis, and Kaiser Oakland). Participation will be voluntary and extra-curricular.

C. **Design and Validation of Assessment Tools Target Timeline: 10/2019–12/2019.** Building on existing literature<sup>6-9</sup>, we will develop knowledge and procedural skills assessment tools to be used during the training camps. Initial content and face validity will be evaluated through expert consensus and practical application during the Stanford Facial Plastic Surgery Course, which includes faculty from national and international institutions and trainees learning facial surgery on cadavers.

D. **Educational Validation Stage Target Timeline: 12/2019–5/2020.** In this period, our team will host multiple “3D Facial Surgery Training Camps” at Stanford Medicine. Each Camp will host approximately 20-30 multidisciplinary trainees with at least 3 volunteer faculty educators. Participants will receive educational materials to prepare before the session. Based on best practices for simulation education<sup>10</sup>, each training day will start and end with trainee knowledge and skills assessments and activity evaluation surveys. Faculty will provide a brief didactic session and then work closely with trainees in guided hands-on tasks. Trainees will be able to bring their own model home for self-learning and/or to their own department didactics for future reference.

E. **Analysis and Publication Stage Target Timeline: 6/2020–7/2020.** Quantitative and qualitative analysis of the results from Parts C and D will be disseminated via conference abstracts and manuscripts for medical/surgical educators.

### IV. Anticipated Work Product

These grant funds will be used to **validate the 3D facial surgery simulator** as a valid, **cost-effective**, and longitudinally **sustainable** educational model to teach topographical surgical thinking and hands-on skills for trainees **across diverse specialties**. Other institutions may then choose to adopt this model for training their medical students and residents. Our approach aims to not only close the **massive learning gaps and costly training opportunities** associated with facial surgery and 3D surgical thinking, but also to unite the **collaborative** training efforts of multiple specialties in educating the next generation of competent surgeons and proceduralists.

### VI. Evaluation Plan

Face validity, construct validity, and content validity as well as overall learner satisfaction of the 3D facial surgery simulator and training camps will be assessed through a combination of pre/post knowledge and procedural skills assessments and learner surveys. Anonymized results will be paired with demographic data including learner age, stage of training, specialty, and relative experience with facial surgery. Skills assessments will be based on OSATS and Global Rating Scales<sup>6,7</sup> and customized for facial surgery considerations<sup>8,9</sup>. All instruments will be validated before training camp use (see Section III, Part C), to ensure that results obtained during the training camps are a direct measure of the performance of this training modality and not biased by the assessment tools. Faculty evaluators will be trained in the use of procedural skills assessment.

### VII. Dissemination of Results

Detailed in Section III Part E, project results will be disseminated via conference abstracts and manuscripts for medical/surgical educators.

## References

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