

Towards **surgeon-authored** VR training: the scene-development cycle

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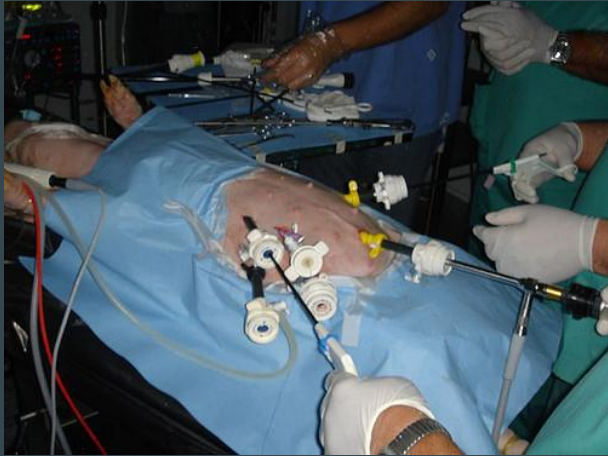
MMVR -- 2016

Outline

- Authoring by Surgeon-Educators
- Distributing the work
- Surgeon-educator interface
- Modeling artist interface

Teaching Minimally Invasive Procedures

Practicing on animals



VR trainer



Box trainer

Advantages of Virtual Reality Simulators

- Practice decision-making
- Objective measurement of performance
- Low-cost, portable
- Customizable ?

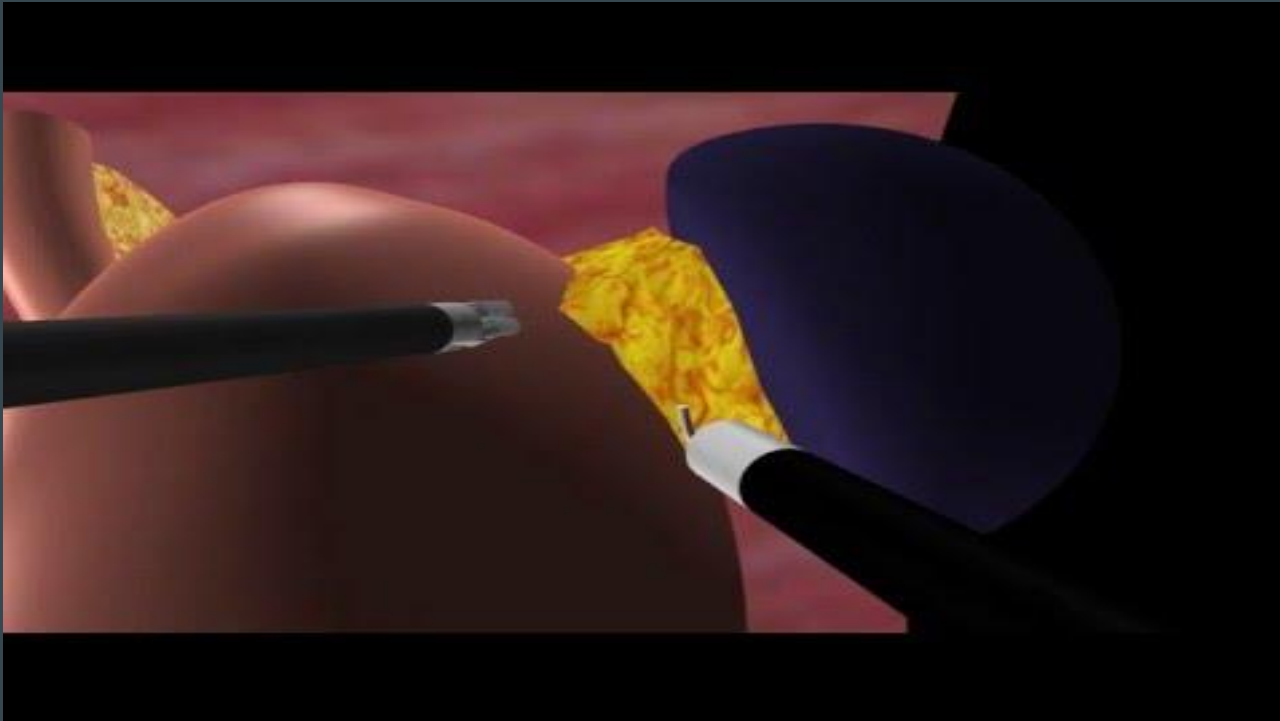


Customizable?

- Rare procedures need more training, but are **low volume**
- Anatomical **variation**
- Master surgeons teach their **unique approach**
- **Non standard** anatomy
(tumor)

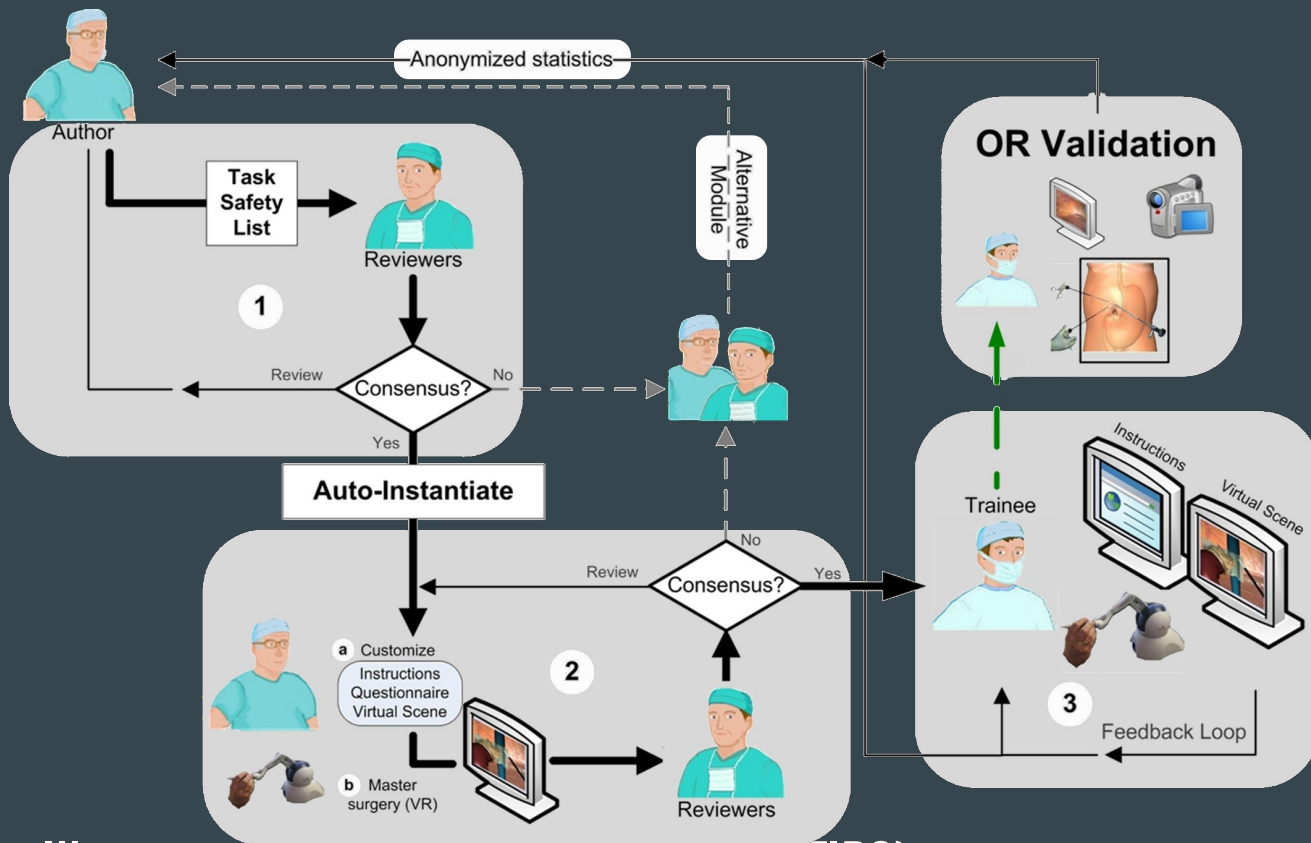
Authoring by Surgeons





Example Authored Simulation :

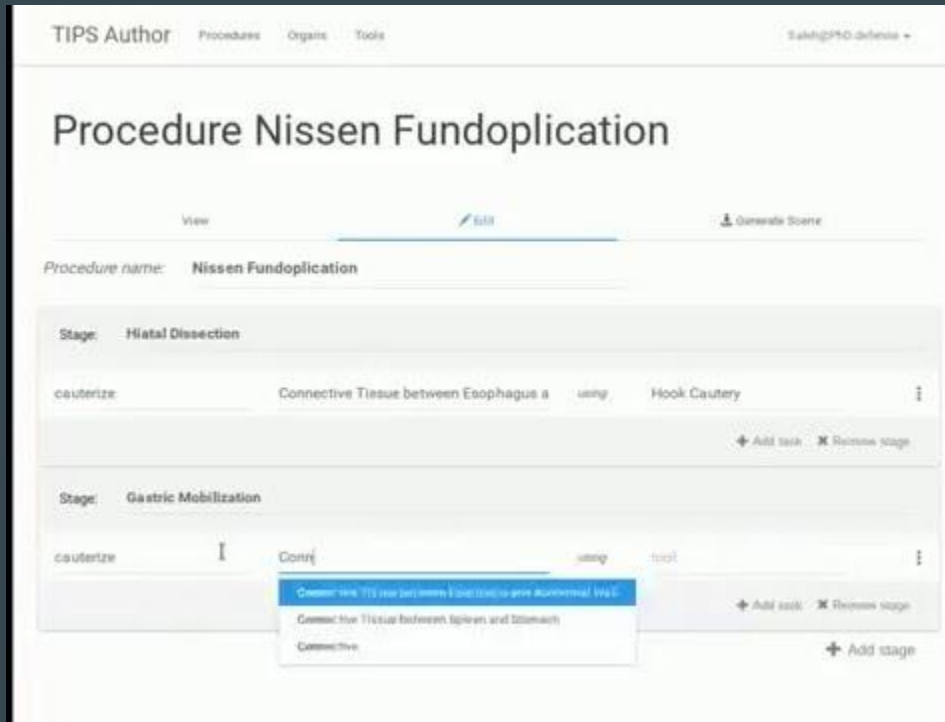
Nissen Fundoplication



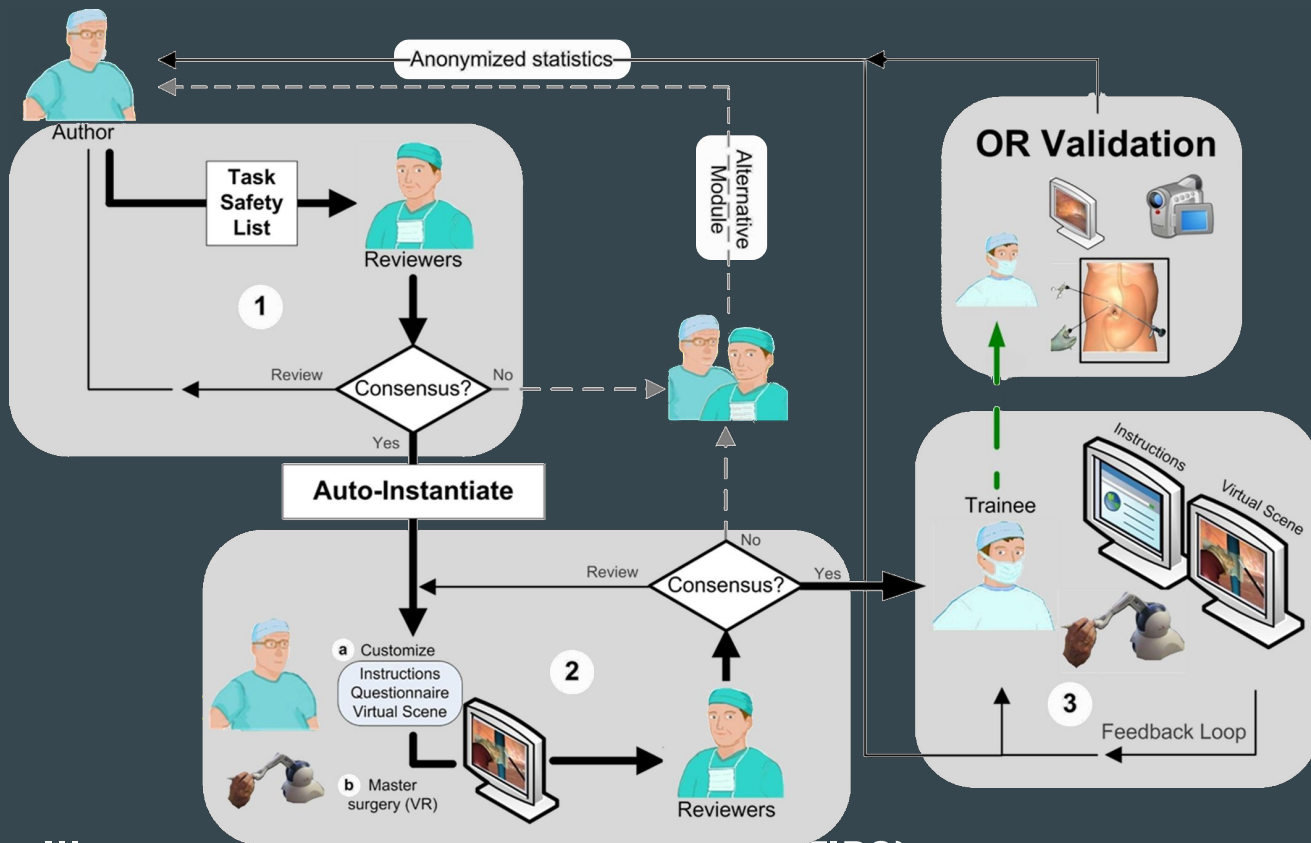
Toolkit for Illustration of procedures in Surgery (TIPS):

Creation-Validation

Cycle



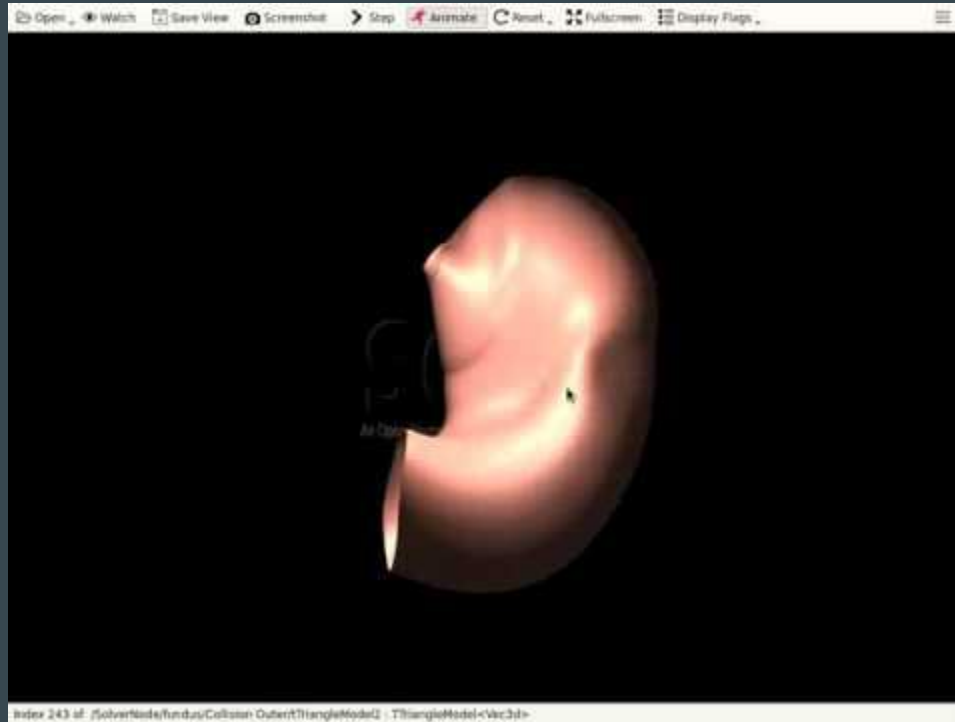
TIPS-Author (a web-application)



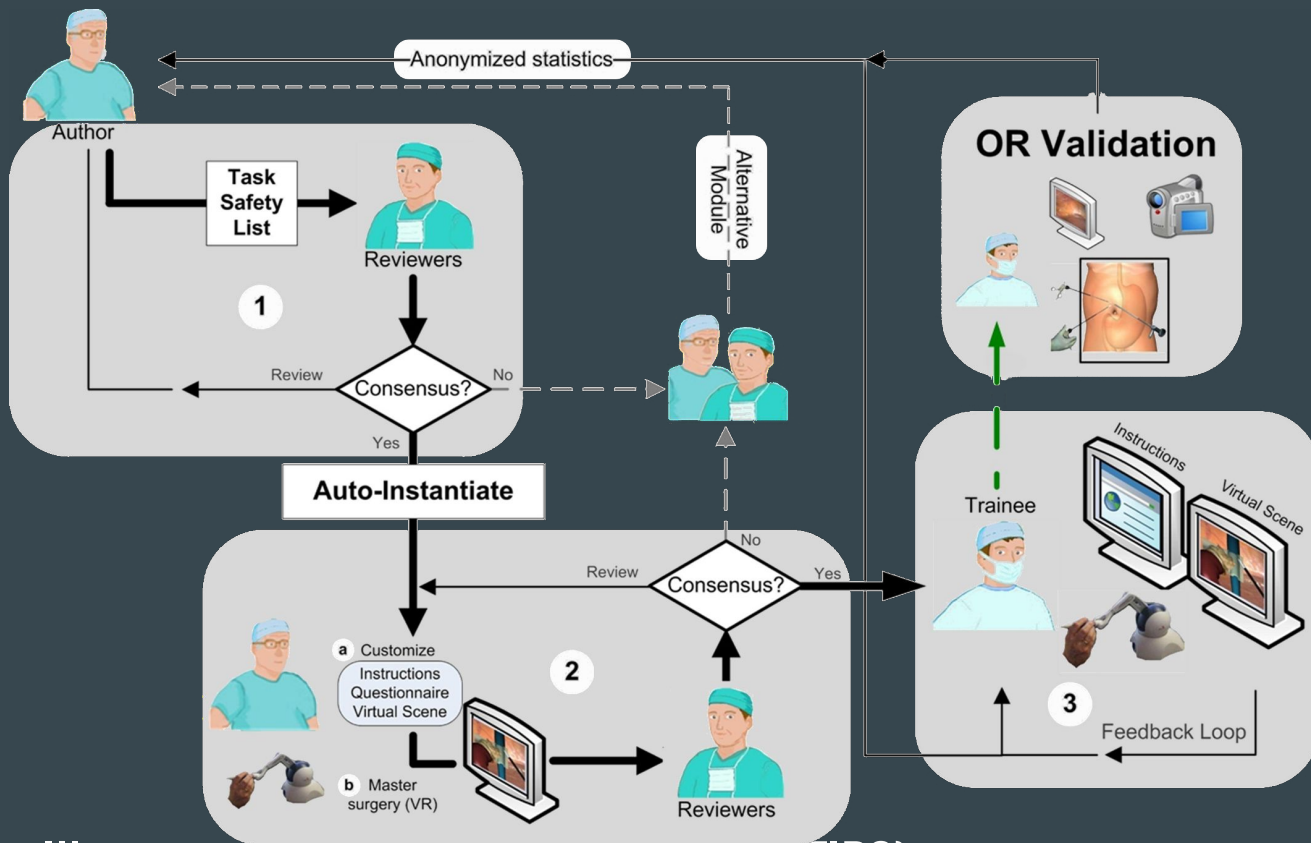
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Modeling and testing a Stomach model using Blender2SOFA



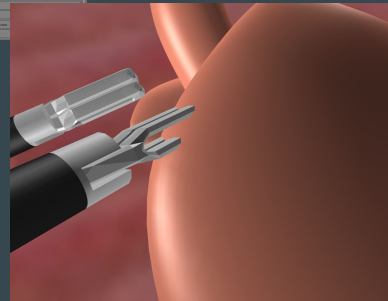
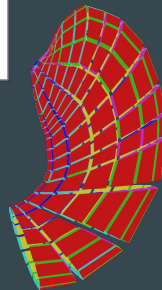
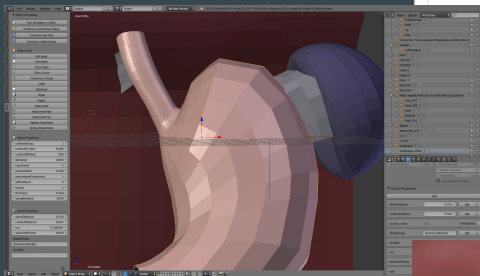
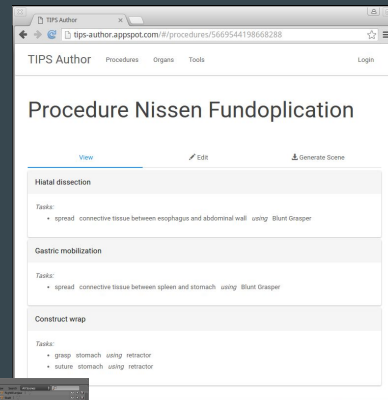
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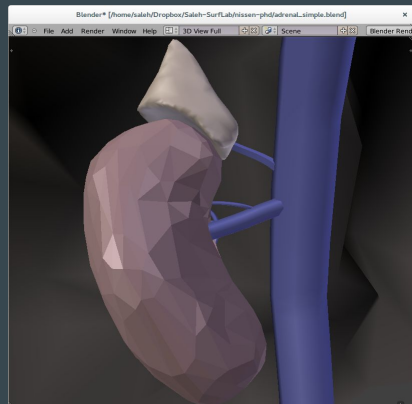
Authoring by Surgeons

- Surgeon-author level
 - Create and share teaching modules
 - Automatically instantiate a simulation
- Modeling-artist level
 - Design the anatomical structures
 - Specify physical behavior
 - Quickly test the designs
- Trainee level
 - VR simulation
 - Haptic interaction with the soft-tissue
- Developer level (sofa)

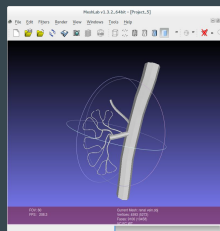
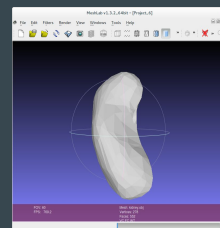
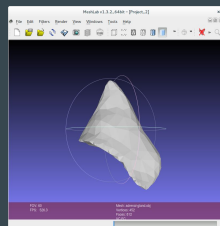


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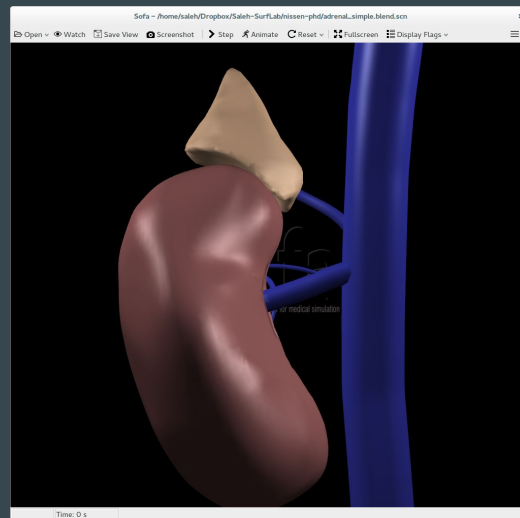
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- Distributing the work
- Surgeon-educator interface
- Modeling artist interface



Blender 3D modeling



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    <OglModel filename="kidney.obj" />
  </Node>
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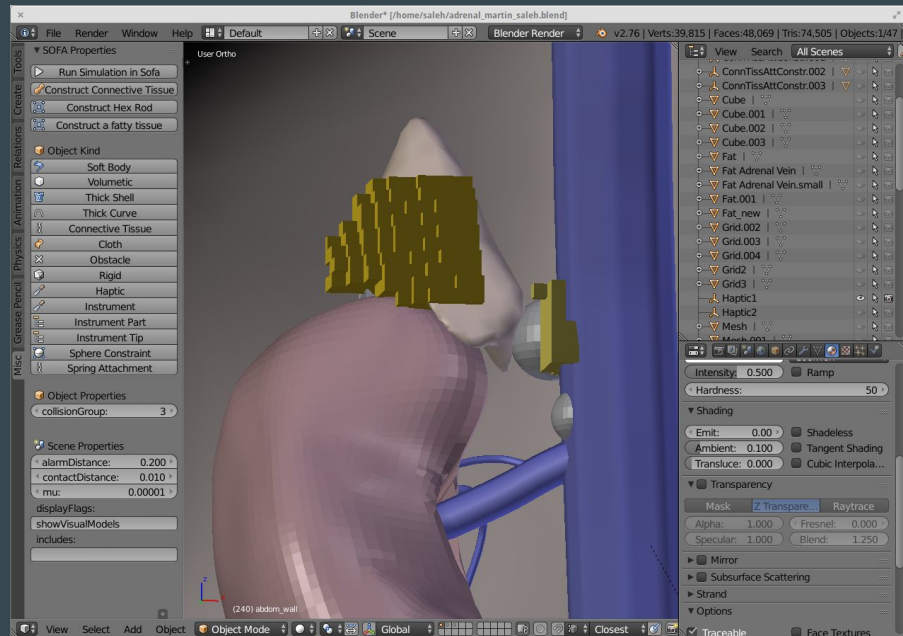


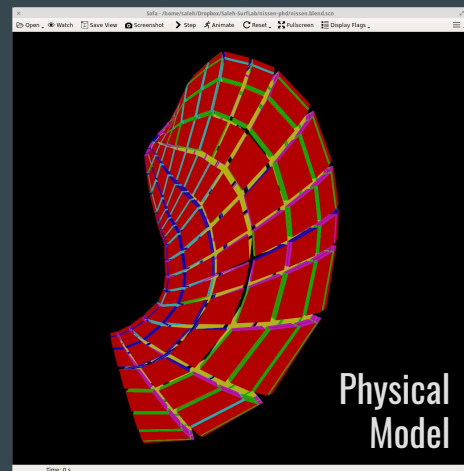
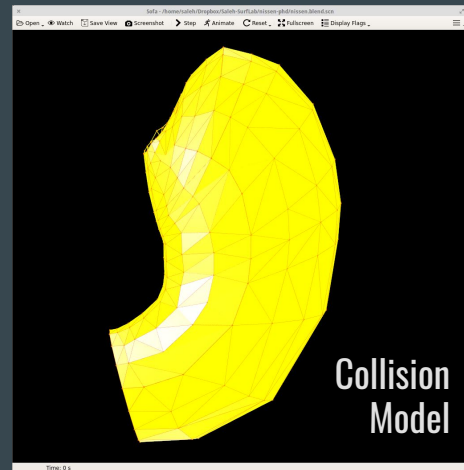
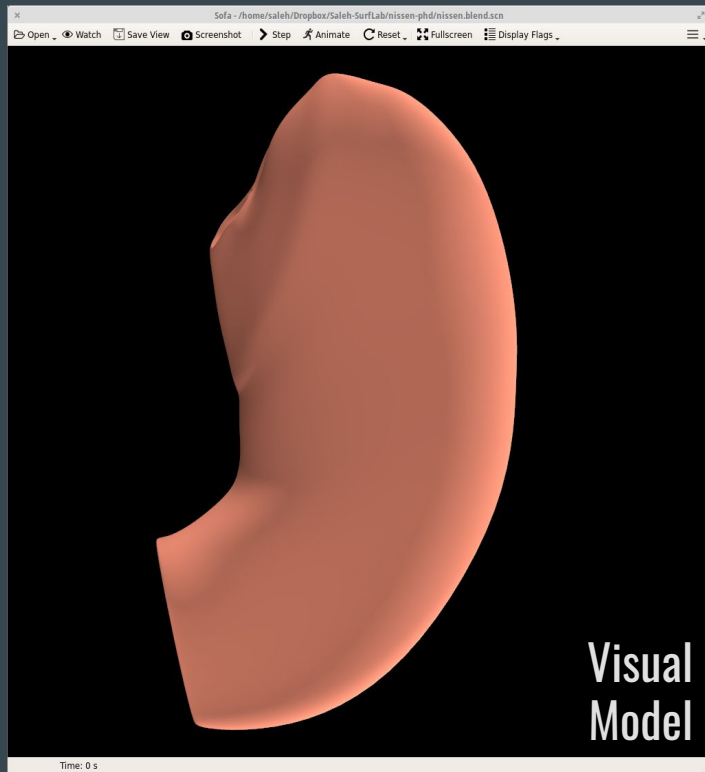
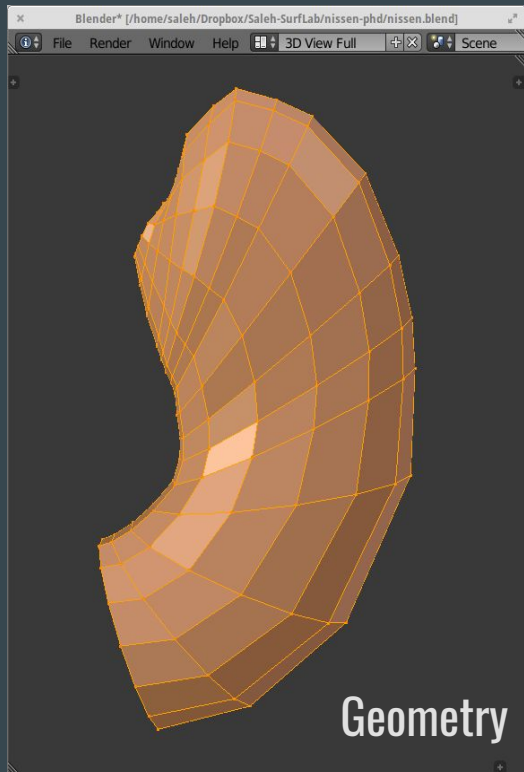
SOFA simulation framework

Old workflow

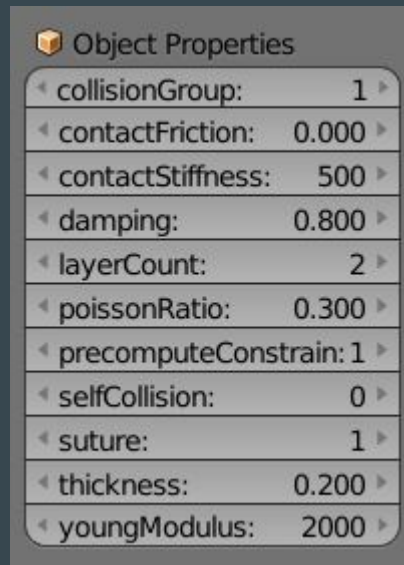
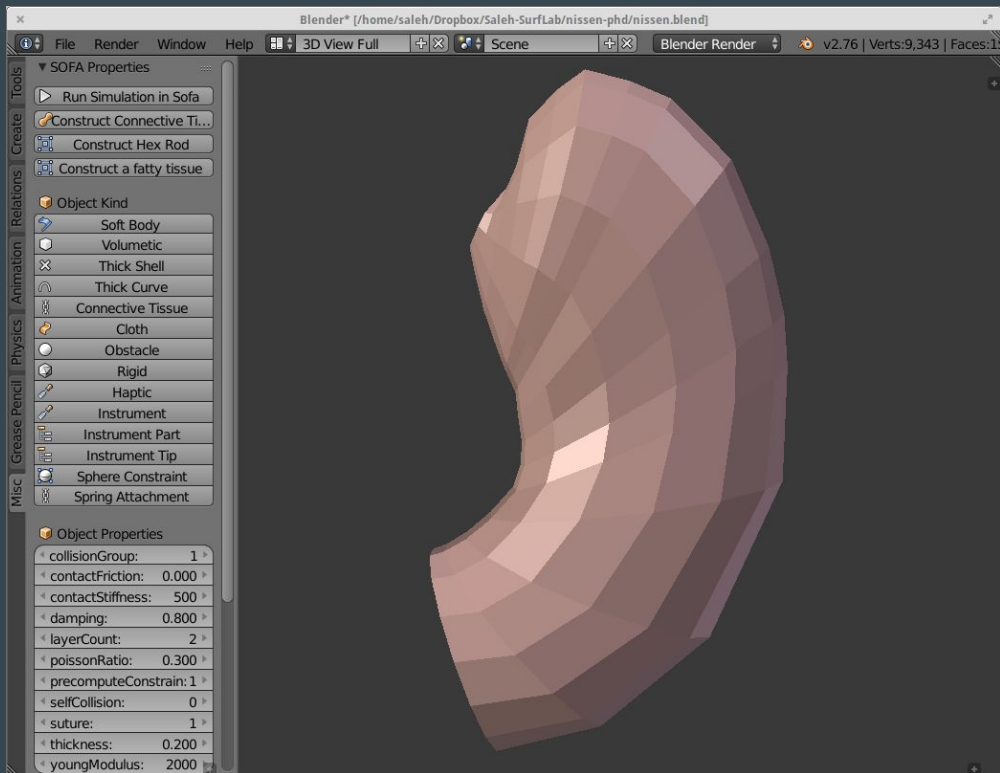
NEW: Modeling-Artist Interface

- Blender interface: model geometry(anatomy)
- Blender2SOFA plug-in: define soft-tissue physics
- Test: auto-instantiated simulation





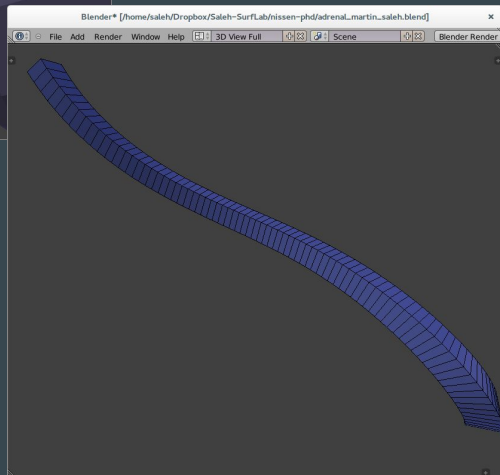
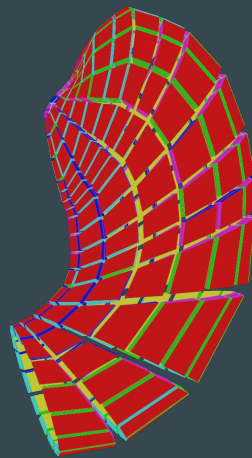
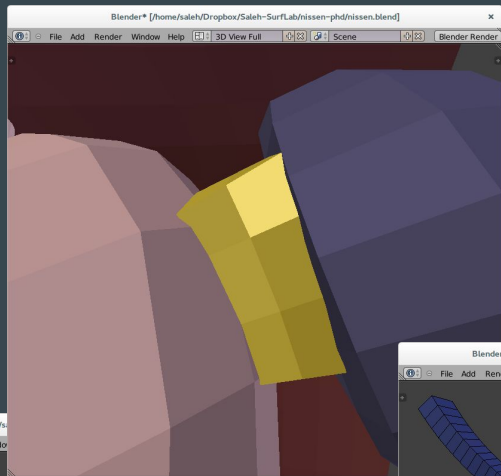
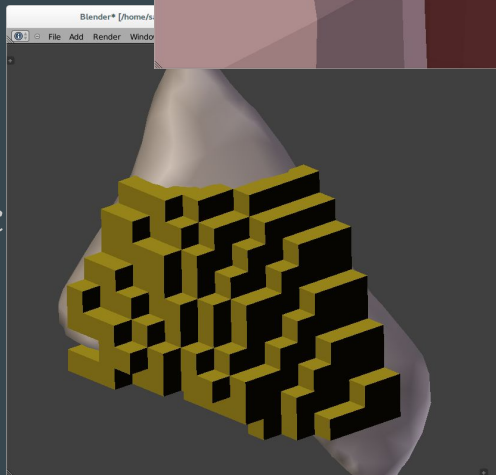
Auto-generation of Visual, Physical and Collision Models



Specifying Physical behavior

Volumetric Object Creation

- Extrude in normal direction to create **thick shells**
- Fill the space between two models to create **connecting tissue**
- Create volumetric models embedding organs in **fat**
- Convert curves into volumetric clamp & cut **vessel models**



Blender2SOFA

features



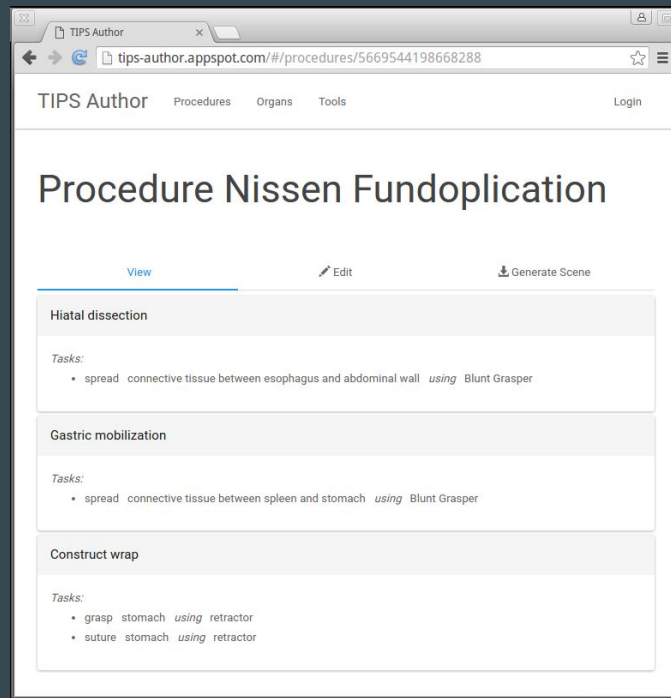
- Specify Physical Behavior
 - Assign physical behaviors to geometry objects
 - Adjust parameters for physical behaviors
- Generate volumetric objects from surface geometry
- Generate visual, collision and physical models from geometry
- Generate attachments between objects
- Generate fixed constraints on deformable objects
- Define surgical instruments with haptic force
- **THANK YOU - QUESTIONS?**

Source Code

- Modifications to SOFA simulation software:
 - Source code: bitbucket.org/surflab/sofa
- Blender2SOFA plugin:
 - Source code: bitbucket.org/surflab/blender2sofa
- TIPS-Author
 - Published: tips-author.appspot.com
 - Source code: bitbucket.org/surflab/tips-author

Surgeon-Educator Interface

- Enable surgeons to deconstruct a surgical procedure
 - Stage: a series of tasks to complete an objective
 - Task: a single action involving
 - Verb
 - Organ
 - Instrument
- Review lists of available organs and tools to use
- Auto-instantiate the simulation from a description



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