



DICOM Educational Conference Brisbane, Australia

SEPTEMBER 24-25, 2018

ELLIOT SILVER, M.SC.
CHANGE HEALTHCARE

DICOM 3D Printing

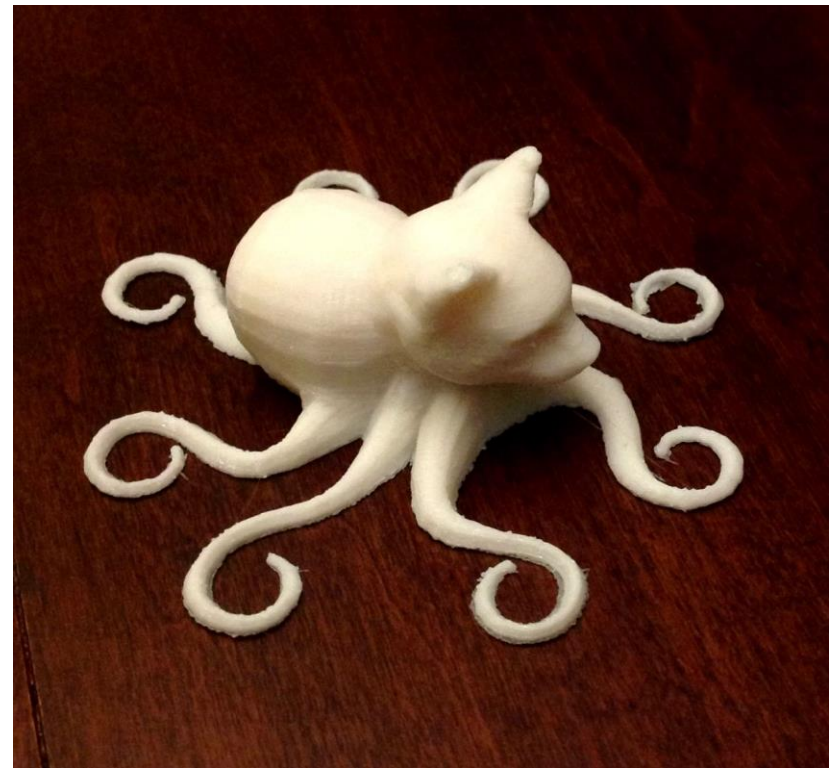
DICOM Educational Conference
September 2018

About Me

- Elliot Silver
 - Sr. Analyst, Standards & Interoperability; Change Healthcare, Imaging & Workflow Solutions
 - Over 12 years in Medical Imaging software product development
 - Co-chair, DICOM WG-20/HL7 II joint workgroup (Integration of Information Systems/Imaging Integration)
 - Contributed to FHIR Imaging resources
 - Past co-chair, IHE IT Infrastructure Technical Committee
 - M.Sc. Computer Science, University of Victoria (Canada); B.Sc. University of Guelph (Canada)

3D Printing

- Many are familiar with home 3D printing



Octocat, Image credit: Allan Noordvyk

3D Printing

- Many are familiar with home 3D printing
- Other fields are seeing benefits of 3D printed components
 - Low volume components
 - Mass customization
 - Tooling & Prototyping

3D-printed titanium parts could save Boeing up to \$3 million per plane

The first common 3D-printed buildings might be army barracks
– The Verge, 11 April 2017
– Fast Company, 14 September 2018

Volkswagen will use 3D printers to mass produce parts
– CNN, 11 September 2018

How 3D printing could help save us from trade wars
– CNN, 13 August 2018

<https://www.fastcompany.com/3087801/3d-printing-could-help-save-us-from-trade-wars>
<https://www.cnn.com/2018/09/14/3d-printing-3d-printing-could-help-save-us-from-trade-wars/index.html>

3D Printing in Medicine

- “Off-the-shelf” low-volume items
- Custom lab equipment
- Patient-matched devices
 - Medical imaging used in design of custom devices

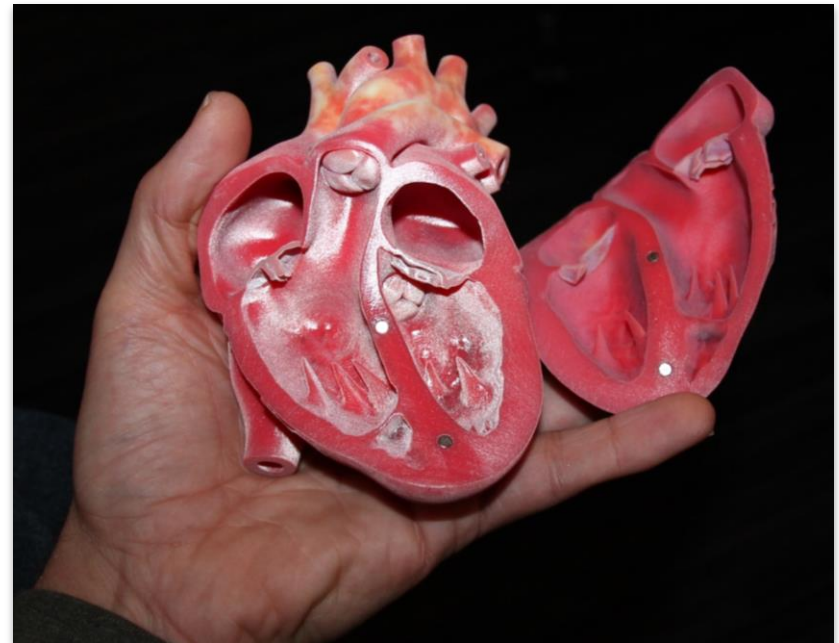


Image credit: Change Healthcare

Uses of 3D Printing and Medical Imaging - Education

- Patient
 - Illustrate condition, diagnosis, or procedure
 - Often as part of obtaining informed consent



Image credit: J. Morris, Mayo Clinic

Uses of 3D Printing and Medical Imaging - Education

- Patient
 - Illustrate condition, diagnosis, or procedure
 - Often as part of obtaining informed consent
- Practitioner
 - Notable/Teaching cases
 - (General education better handled through other means)



Image credit: A. Alexander, Mayo Clinic

Uses of 3D Printing and Medical Imaging - Diagnosis & Planning

- Diagnosis

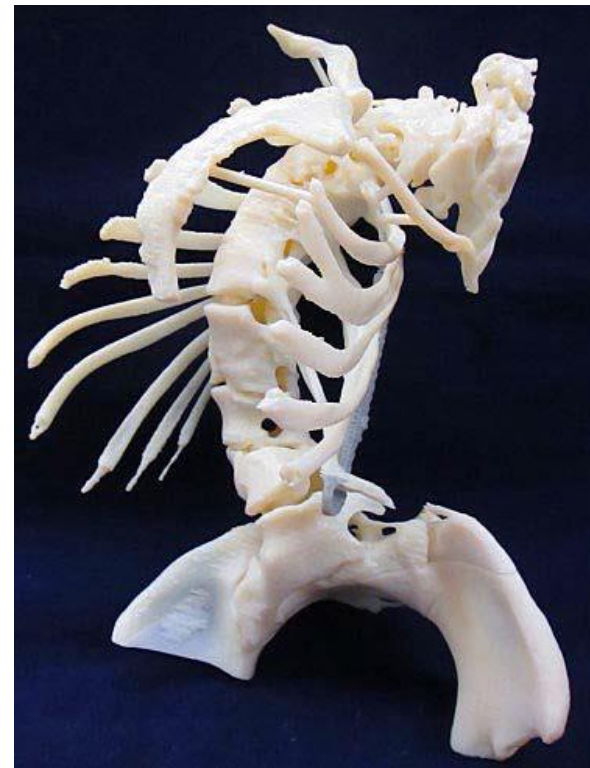


Image credit: J. Morris, Mayo Clinic

Uses of 3D Printing and Medical Imaging - Diagnosis & Planning

- Diagnosis
- Planning
 - Surgical approach
 - Implant sizing and insertion
 - Surgical tool selection



Uses of 3D Printing and Medical Imaging - Diagnosis & Planning

- Diagnosis
- Planning
 - Surgical approach
 - Implant sizing and insertion
 - Surgical tool selection
- Fitting
 - E.g., pre-bending plates



Image credit: J. Morris, Mayo Clinic

Uses of 3D Printing and Medical Imaging - Simulation

- Surgery practice
 - E.g., Insertion of stent in a tortuous vessel
- “Dry run” of complicated cases



Image credit: Change Healthcare

Uses of 3D Printing and Medical Imaging - Instruments/Guides

- Instruments
- Guides
 - Needle, e.g., biopsy
 - Cutting
 - Drilling

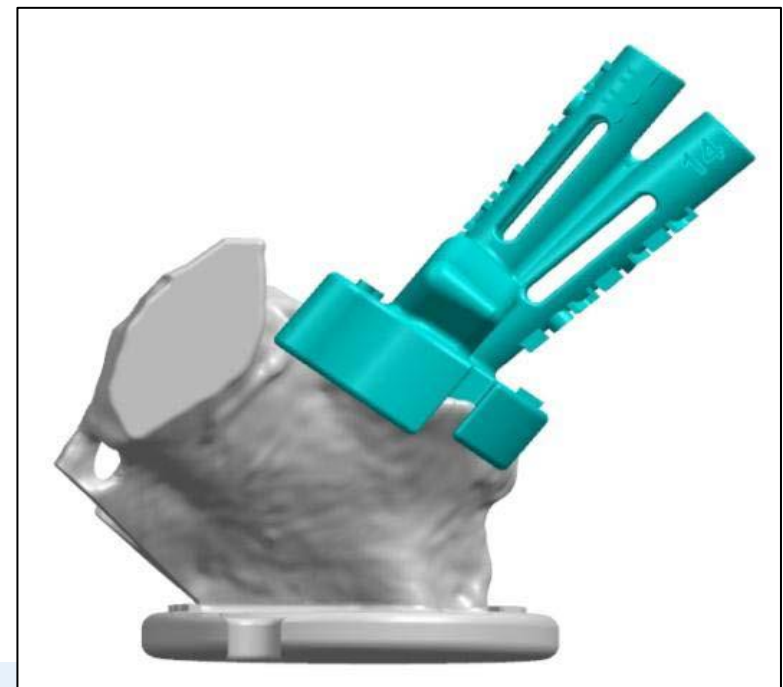


Image credits: J. Morris (right), A. Alexander (below), Mayo Clinic



Uses of 3D Printing and Medical Imaging - Implants/Prosthetics

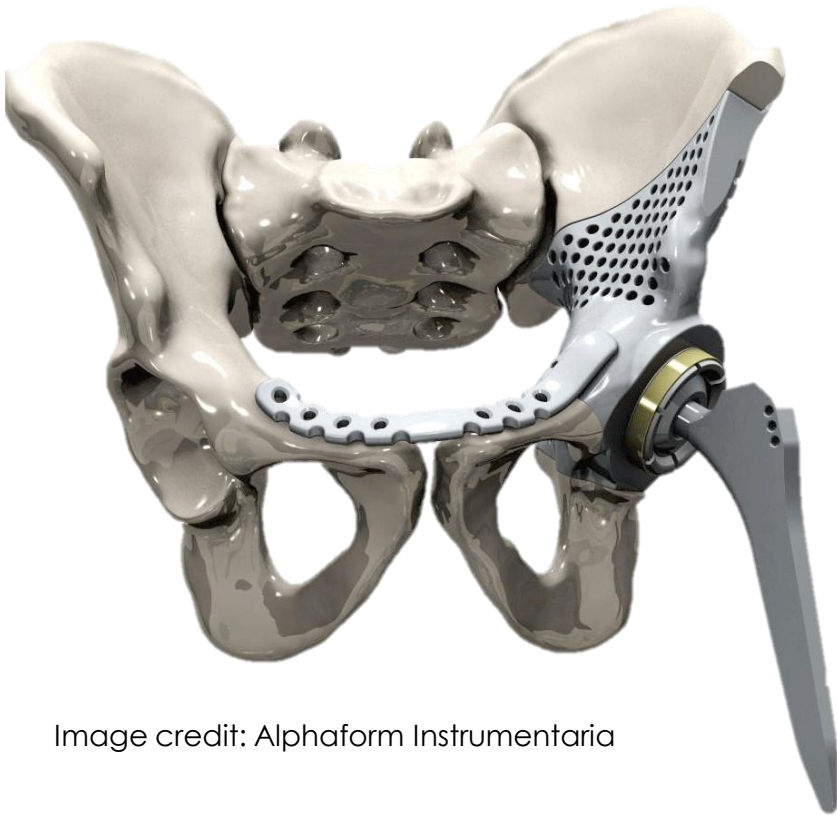


Image credit: Alphaform Instrumentaria

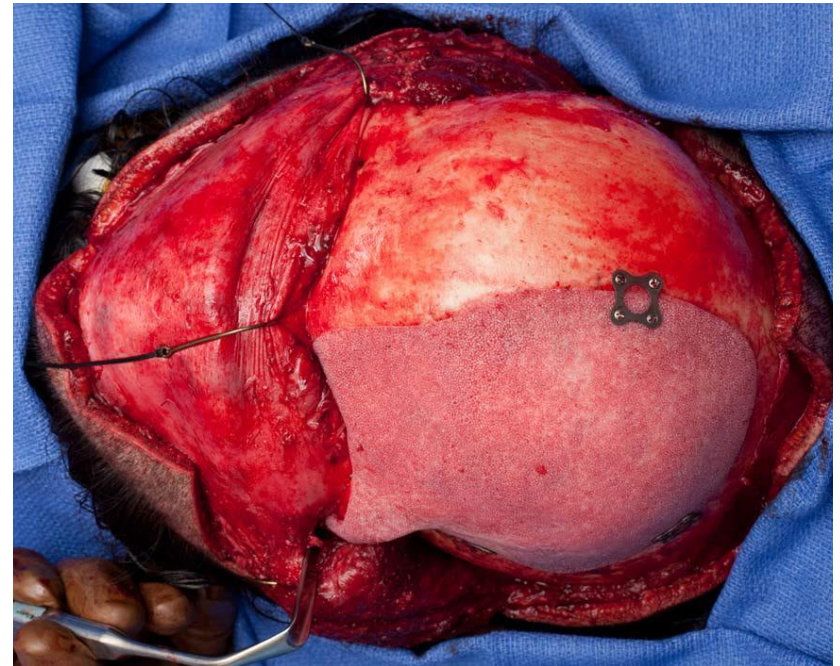


Image credit: J. Morris, Mayo Clinic

Uses of 3D Printing and Medical Imaging - Implants/Prosthetics



Image credit: Yael Maxwell



Image credit: Yong Dawson

3D Printing Workflow

Request	<ul style="list-style-type: none">• Practitioner, e.g. surgeon, determines need for a 3D printed model
Image	<ul style="list-style-type: none">• Relevant, suitable, imaging located or acquired
Consult	<ul style="list-style-type: none">• Technician discusses model requirements and presentation
Segment and model	<ul style="list-style-type: none">• Create model from imaging• Addition of functional features (separations, sockets)• Addition of orientation markings and patient identifiers
Review and Refine	<ul style="list-style-type: none">• Virtual model sent for review• Model improved based on feedback• Add printing supports, determine manufacturing orientation
Print	<ul style="list-style-type: none">• Select materials and colors
Clean-up and QA	<ul style="list-style-type: none">• Remove printing supports, add magnets, etc.• Sterilization

3D Printing is cost effective

- Preparing and printing a 3D model is costly, but...
- ...results in cost reduction through:
 - Reduced operating room time (\$100/min)
 - Reduced materials waste

Potential for a cost savings of \$2,700 when using a 3D-printed model for orthopaedic surgical planning. The savings derives from a reduction in surgery times by 38 to 45 minutes per case through preparation on a 3D-printed model of the patient's hip joint.

– UCSD and Rady Children's Hospitals (Journal of Children's Orthopaedics)

<http://www.bonezonepub.com/1717-3d-study-shows-cost-savings>

Challenges with traditional 3D print workflow

- Patient safety
 - Wrong Patient, Wrong Imaging, Laterality errors
 - Model version issues
 - Scale errors
- Complicated workflow
- File handling
 - Model file naming conventions
 - Model file storage requirements
 - Management of source images
- Protection of patient information

DICOM Encapsulated STL SOP Class (Sup. 205)

- STL is a common 3D model file format
- Modeling software can store models in PACS alongside patient imaging
 - Reduces wrong patient, wrong imaging errors
 - Simplifies workflow by eliminating manual movement of images and models
 - Eliminates need for model file naming, file storage conventions, separate storage
- Source images; frame of reference
- Relationship to patient anatomy (e.g. mirrored, modified)
- Scale
- Intended use (education, implant, etc.)
- Previous model, and reason for refinement
- Thumbnail image for quick view
- Burned In Annotation (0028,0301) now covers embossed/engraved PHI
- Recognizable Visual Features (0028,0302) now covers identifying

Other DICOM 3D Manufacturing activity

- Encapsulation of additional model file types (OBJ, X3D, 3MF)
 - Includes materials and color information
- Reference implementation to wrap/unwrap STLs
- Overlap between 3D Printing and Augmented Reality/Virtual reality

**Ask your PACS and Modeling Software vendors about
DICOM 3D Model support!**

Questions?

 ELLIOT.SILVER@MCKESSON.COM

 [@ELLIOT_SILVER](https://twitter.com/ELLIOT_SILVER)