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Singapore Healthcare Management 2017

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Singapore Healthcare
Management Congress 2017



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Join us at the premier congress for healthcare management

DELIVERING BENEFITS FOR PATIENTS AND HOSPITALS THROUGH 3D INNOVATIONS

A Clinician's Perspective

Chen Ching Kit

*Medical Director, National Paediatric Heart Transplant and Mechanical Cardiac Support Programme, Singapore
Director, Cardiomyopathy and Heart Function Programme
Senior Consultant, Cardiology Service, Department of Paediatric Subspecialties
Adj Asst Professor of Paediatrics, Yong Loo Lin School of Medicine, National University of Singapore*



KK Women's and
Children's Hospital
SingHealth

SingHealth Academic Healthcare Cluster



Singapore
General Hospital



KK Women's and
Children's Hospital



Sengkang Health



National Cancer
Centre Singapore



National Dental
Centre Singapore



National Heart
Centre Singapore



National
Neuroscience Institute



Singapore National
Eye Centre



Polyclinics
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Bright Vision
Hospital

PATIENTS. AT THE HEART OF ALL WE DO.®

Partner in
Academic Medicine

DUKE UNIVERSITY
GRADUATE MEDICAL SCHOOL SINGAPORE

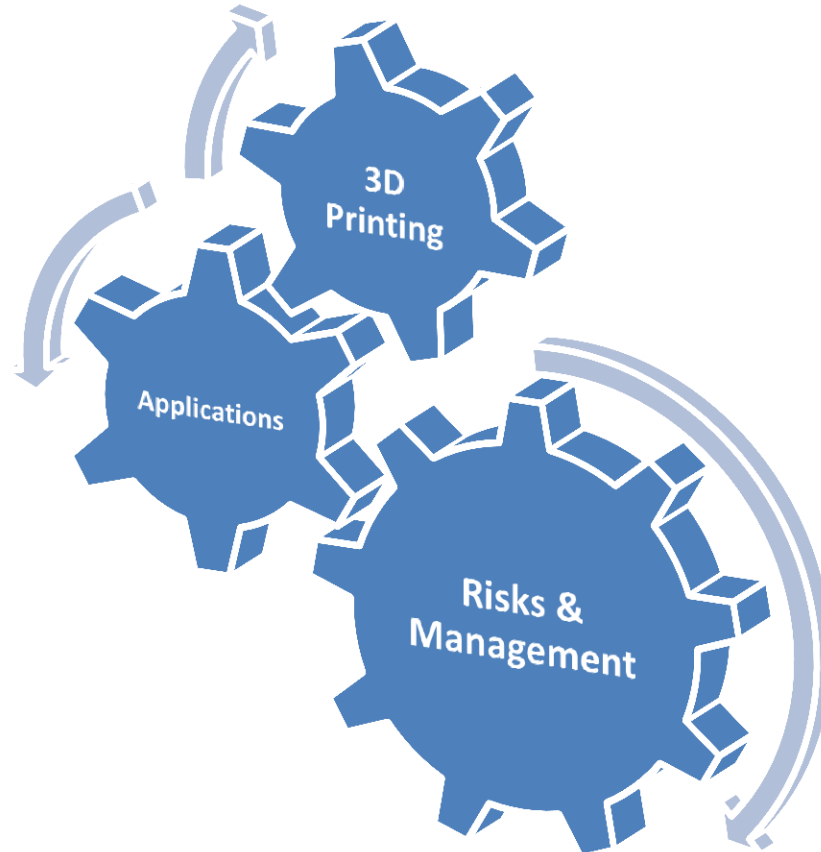


CONFLICT OF INTEREST

- No relevant disclosure



OUTLINE





3D PRINTING

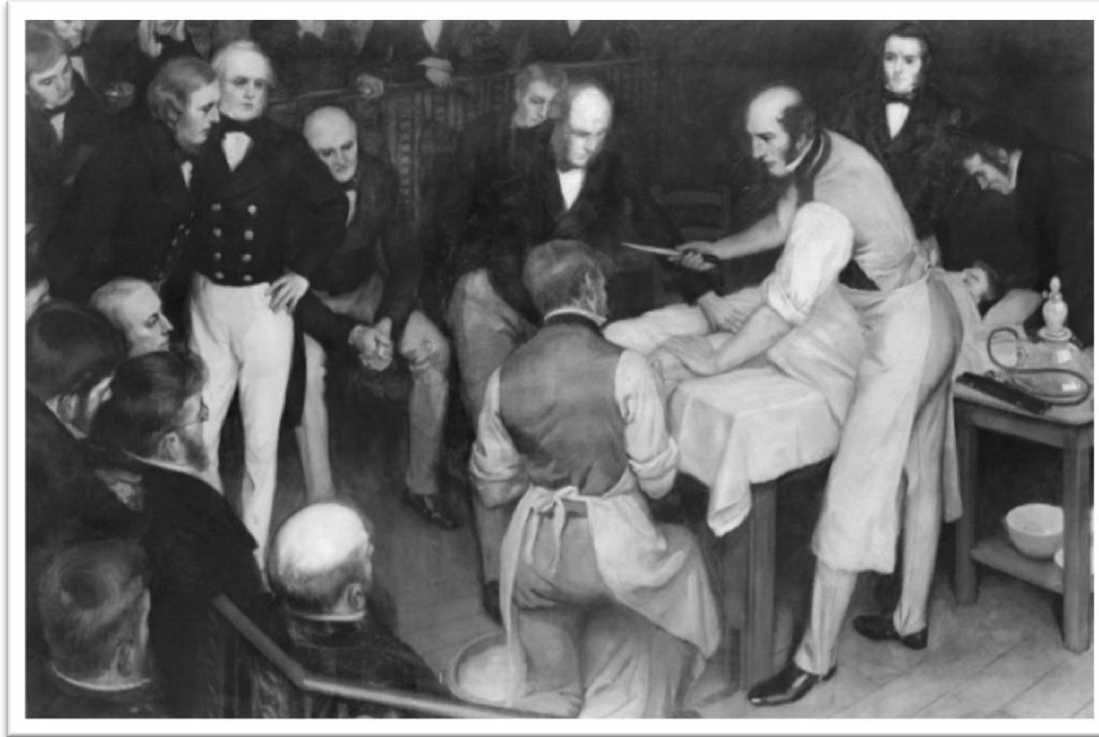
*The Most Disruptive **Innovation** of
the 21st Century*

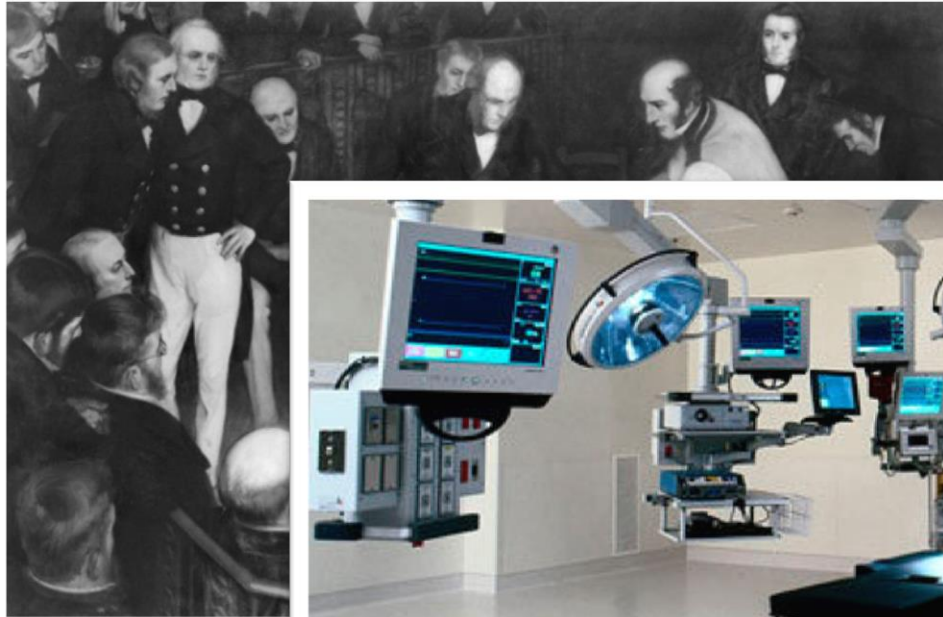


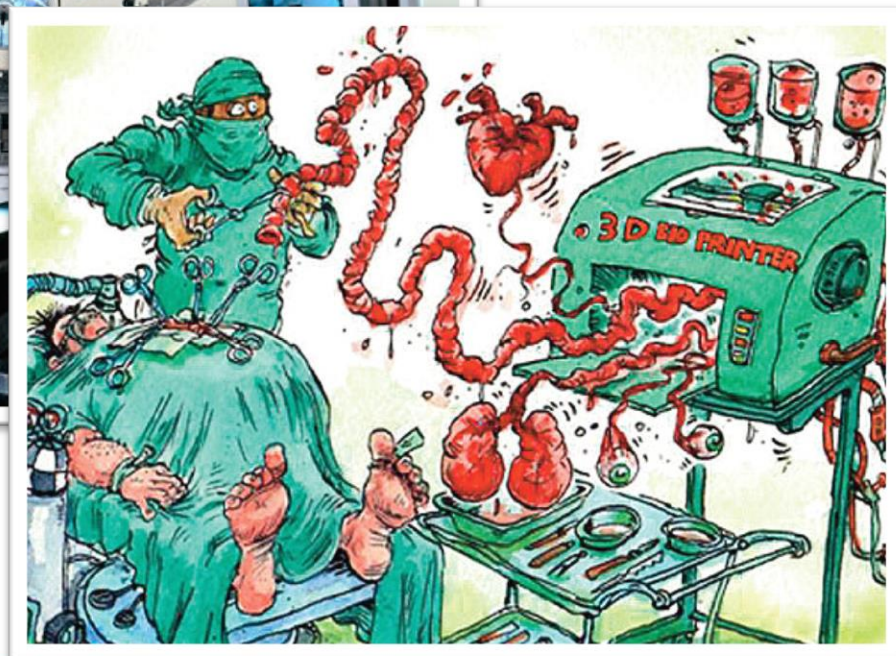
Yuniku.

3D TAILORED EYEWEAR



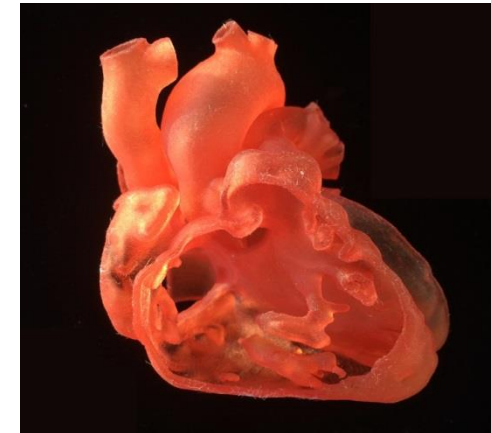
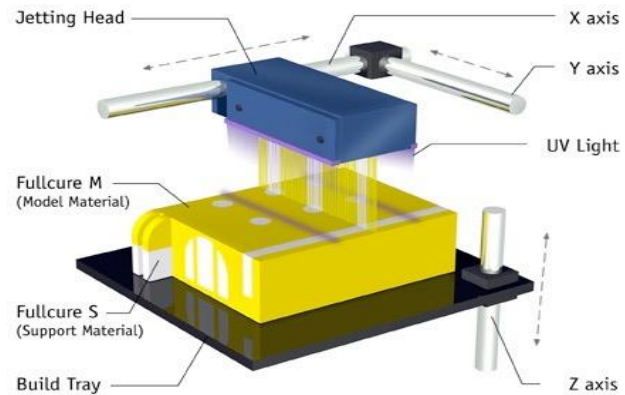
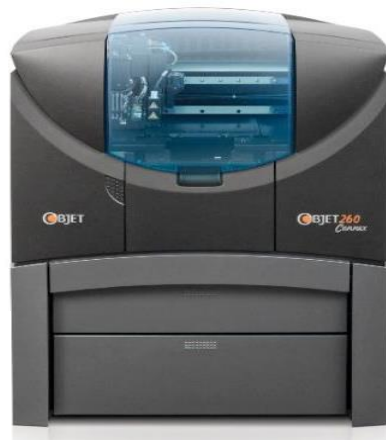






RAPID PROTOTYPING – 3D PRINTING

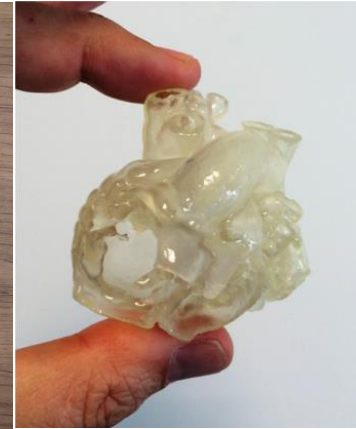
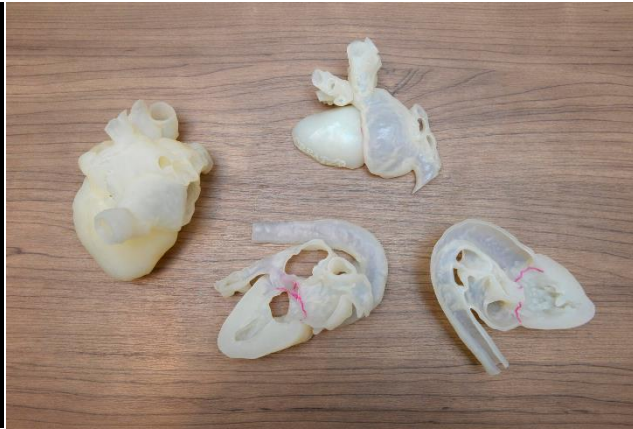
- Additive manufacturing technique – adding successive layers of material
- Inkjet technology
- Photopolymer resin – gives solid vs flexible structure




CUSTOMIZED 3D PRINTED PROSTHESES



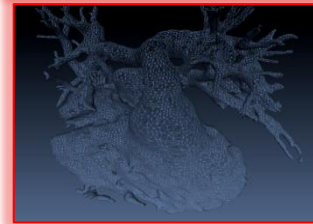
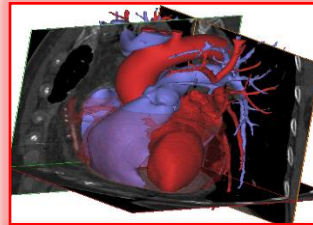
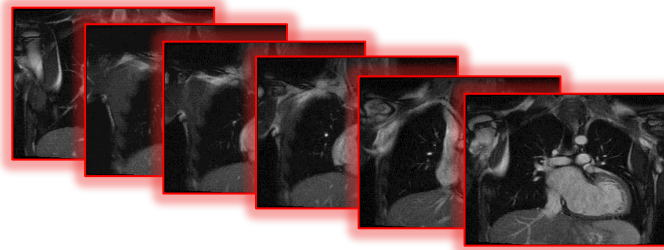
3D PRINTED ANATOMICAL MODELS





DELIVERING BENEFITS FOR
PATIENTS AND HOSPITALS
THROUGH 3D INNOVATIONS

A Clinician's Perspective



Imaging



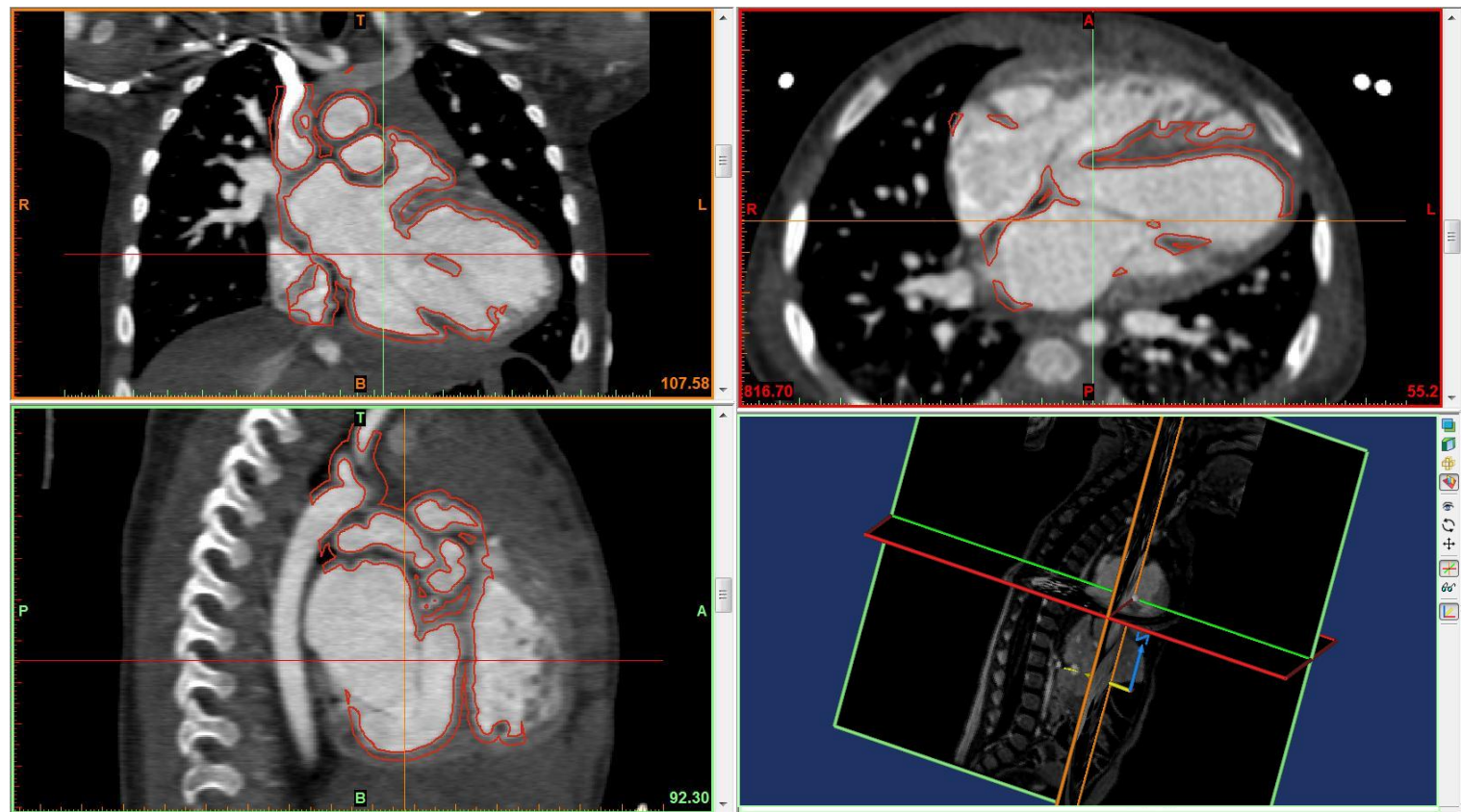
Segmentation

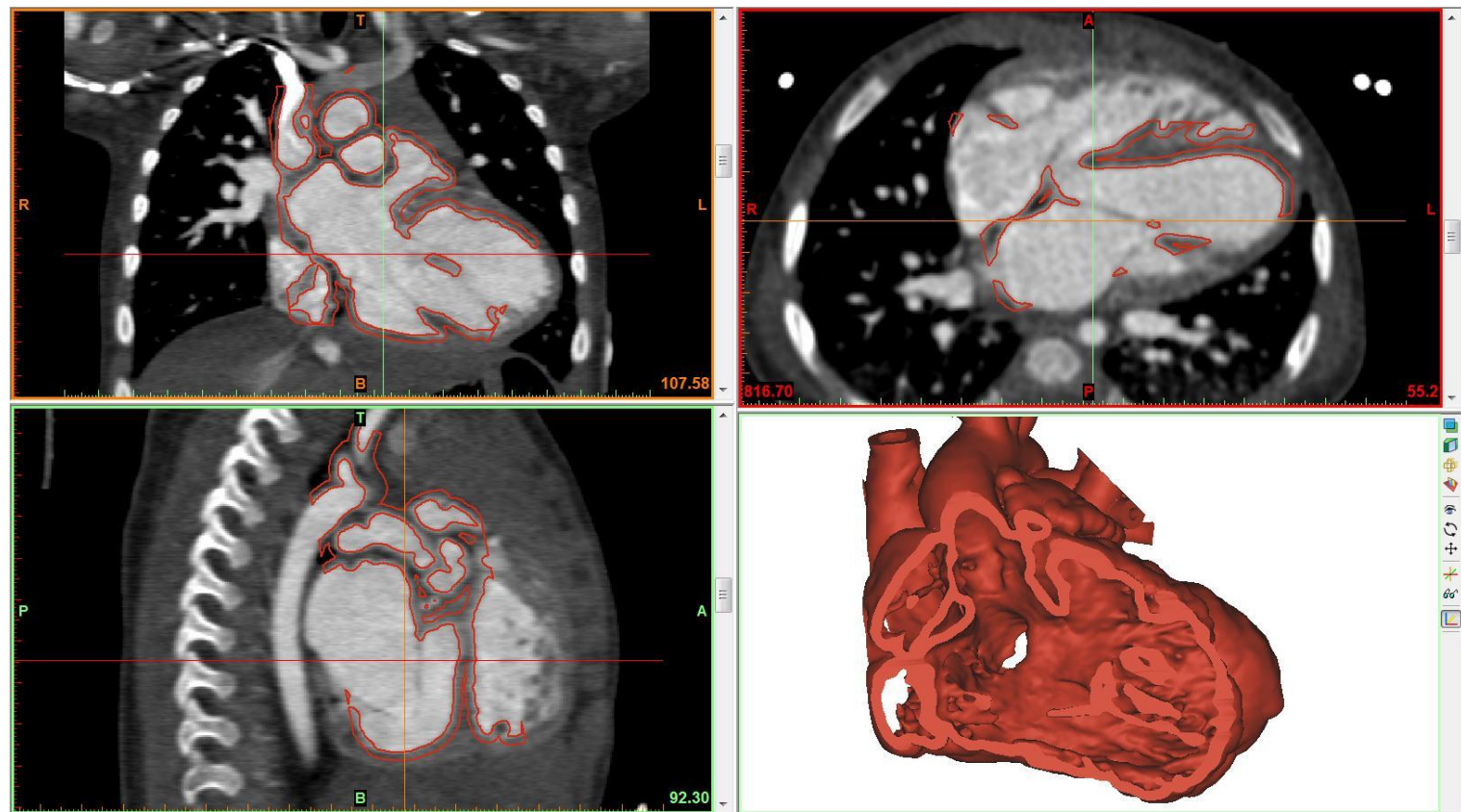


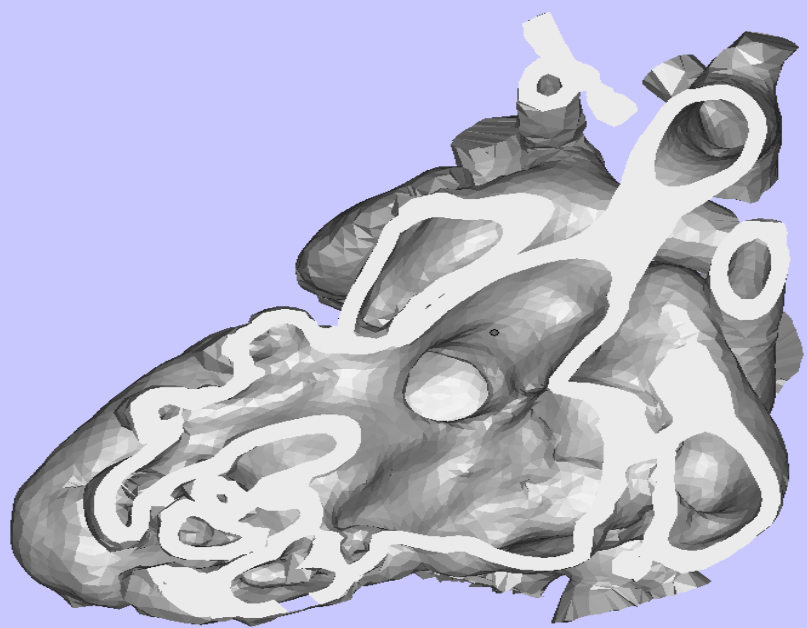
DICOM to STL

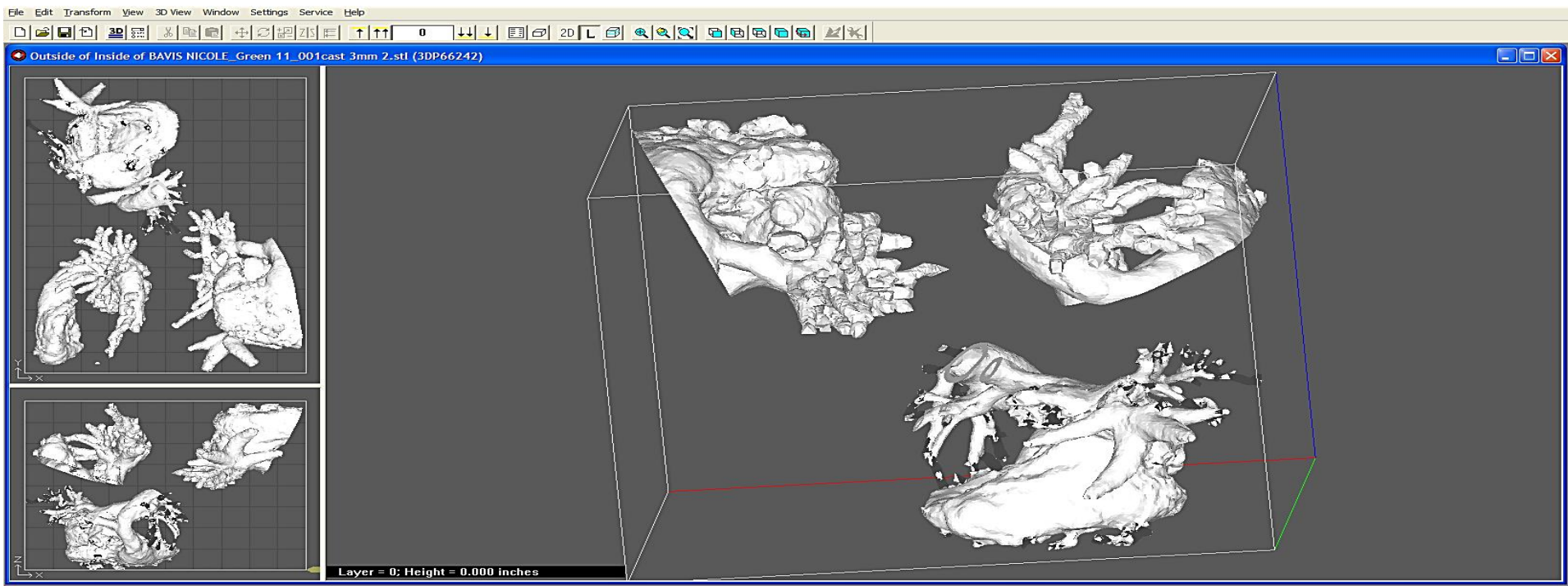


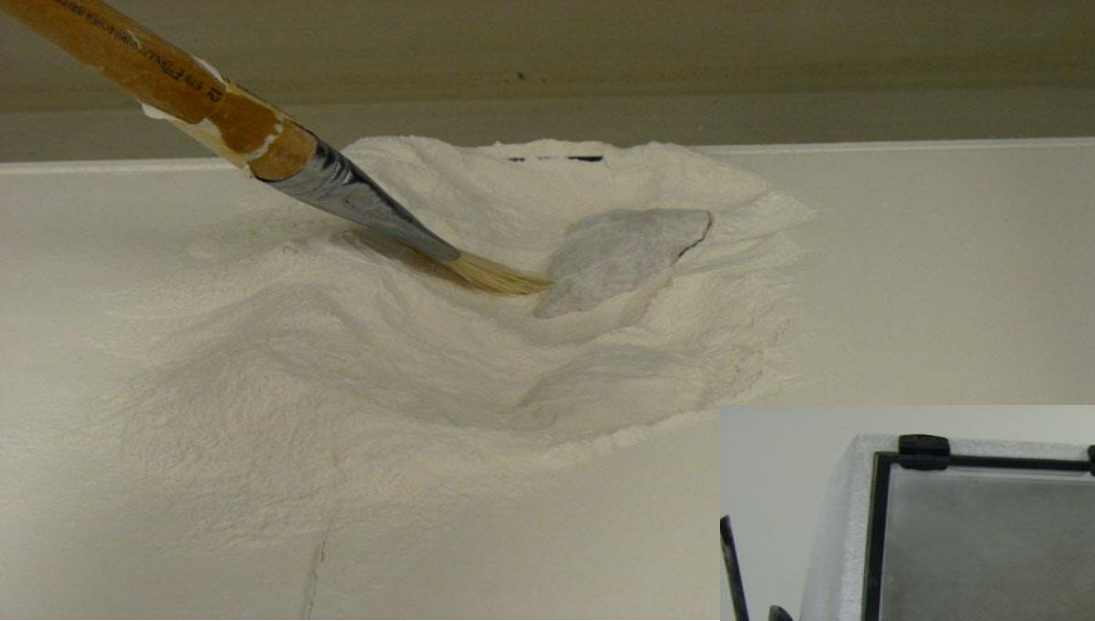
Printing

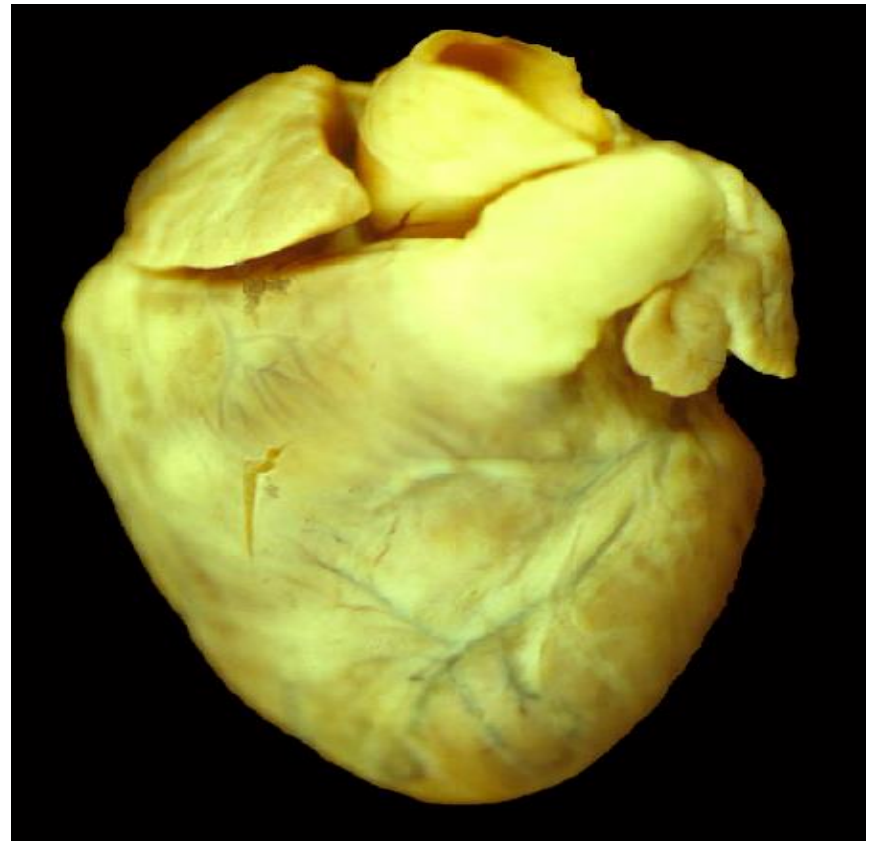
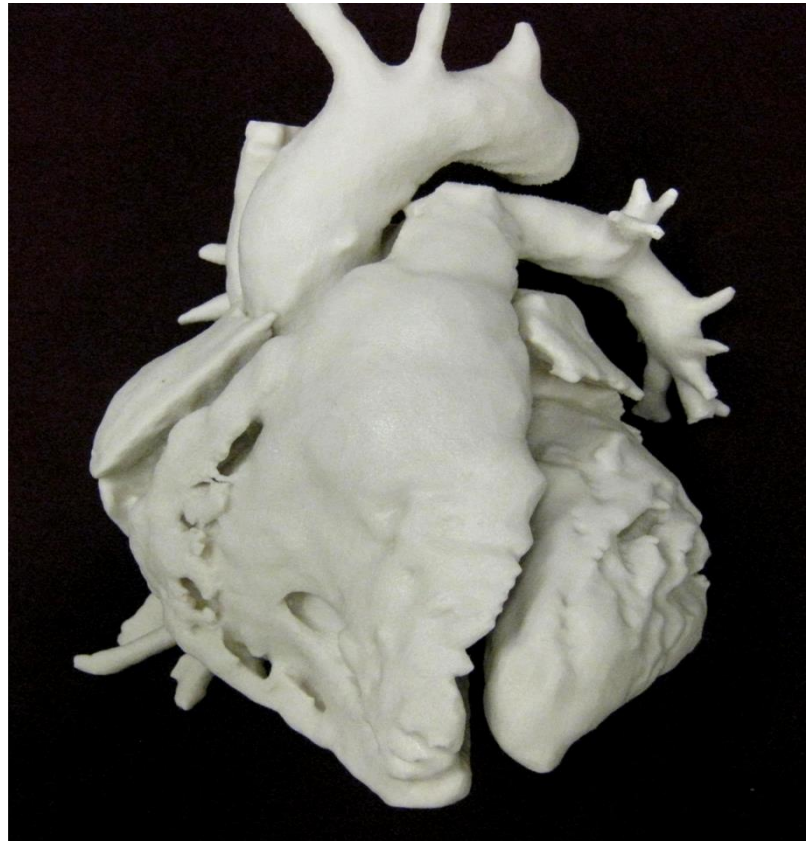


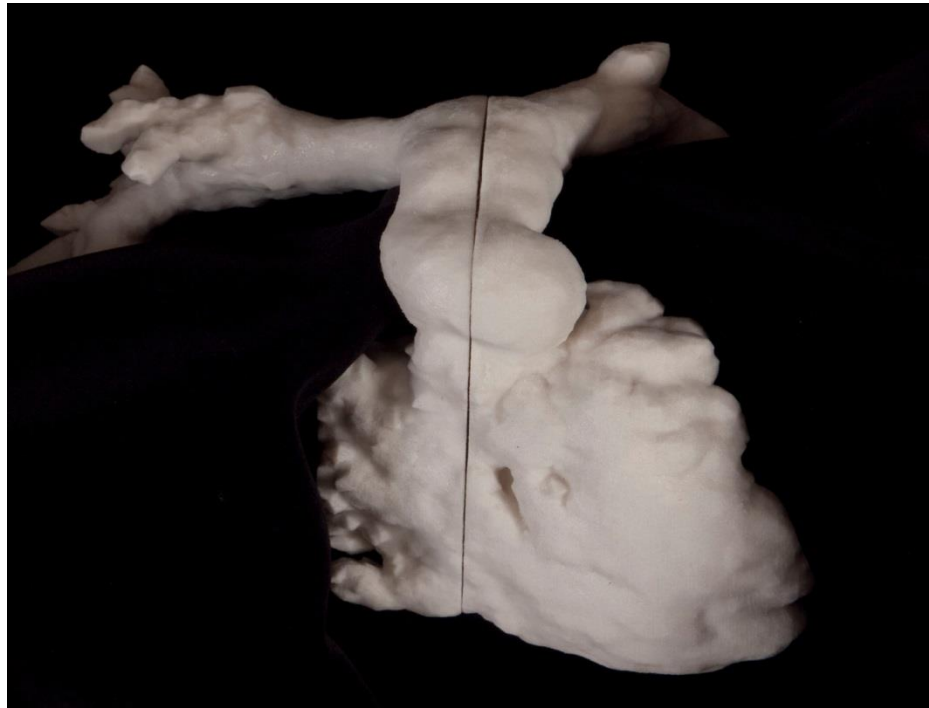


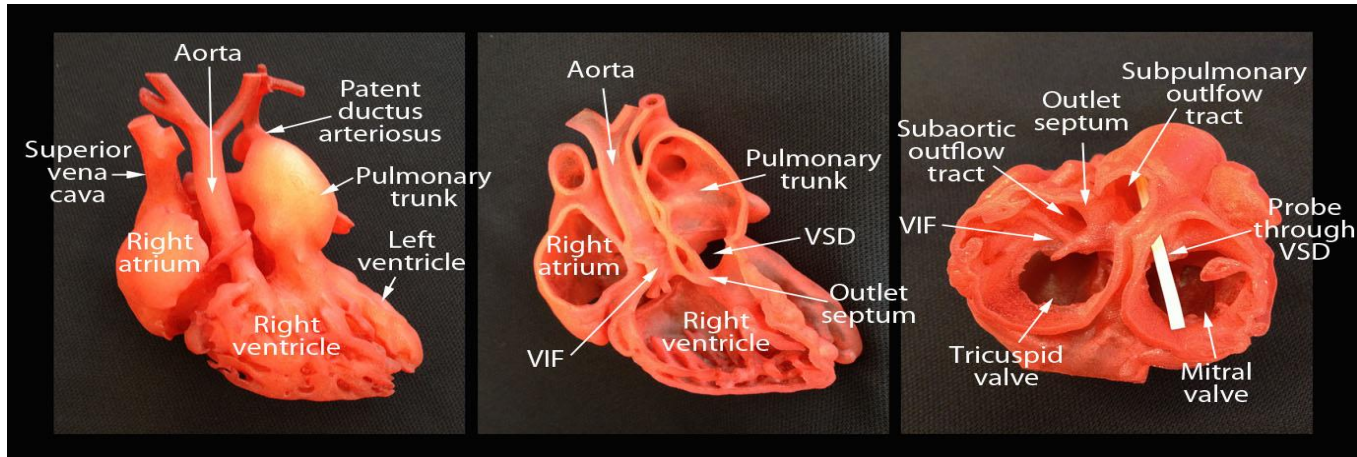












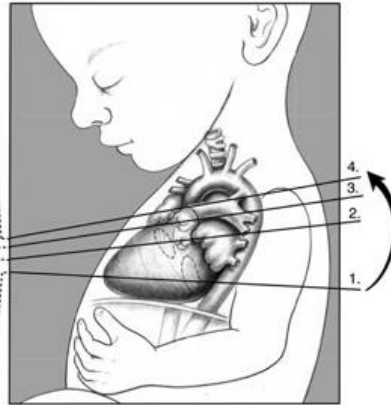
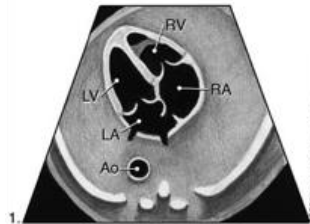
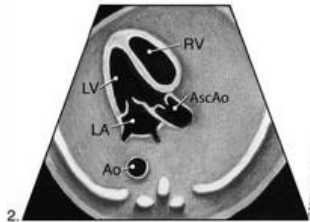
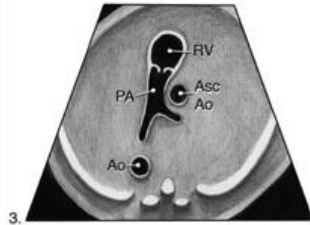
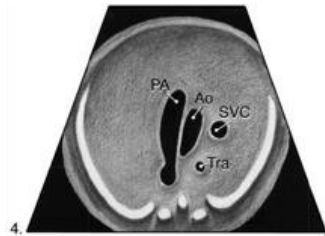
Clinical application of 3D printing

A paradigm shift – the next step in the evolution of cardiovascular imaging

COMPLEX CONGENITAL HEART DISEASE



Baby A
6 week-old



1. Four Chamber View
2. Left Ventricular Outflow Tract
3. Right Ventricular Outflow Tract
4. Three Vessels Trachea View

KKH fetal heart
C9-2
39Hz
RS

2D
72%
Dyn R 49
P Low
HRes



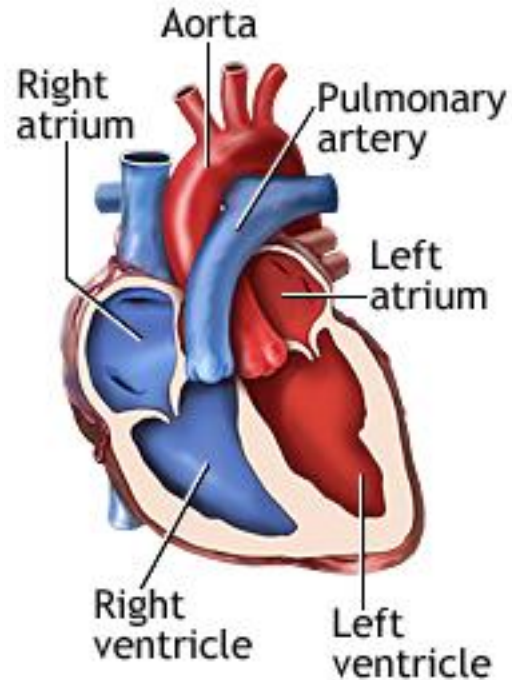
KKH fetal heart
C9-2
39Hz
RS

2D
72%
Dyn R 49
P Low
HRes

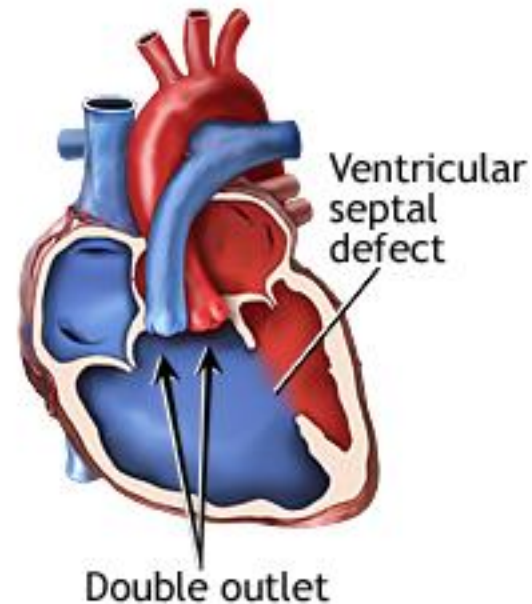


DOUBLE OUTLET RIGHT VENTRICLE

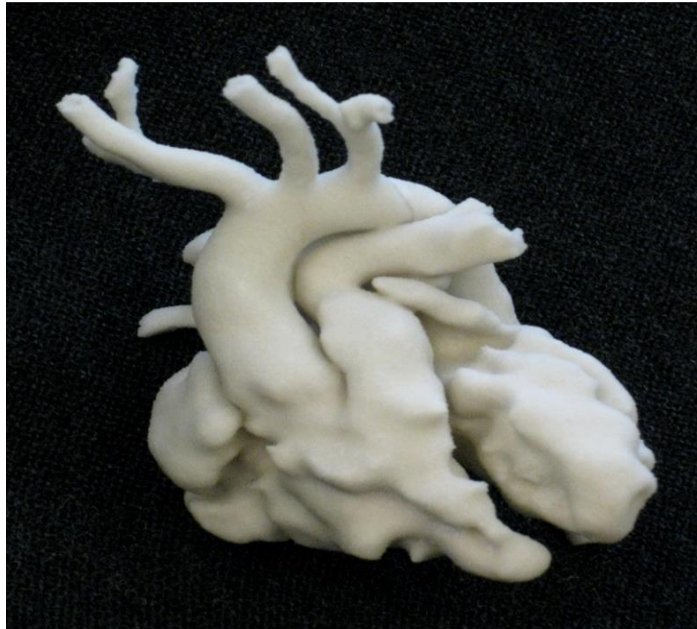
Normal heart



Double outlet right ventricle



DORV: WHAT'S IN THE NAME?

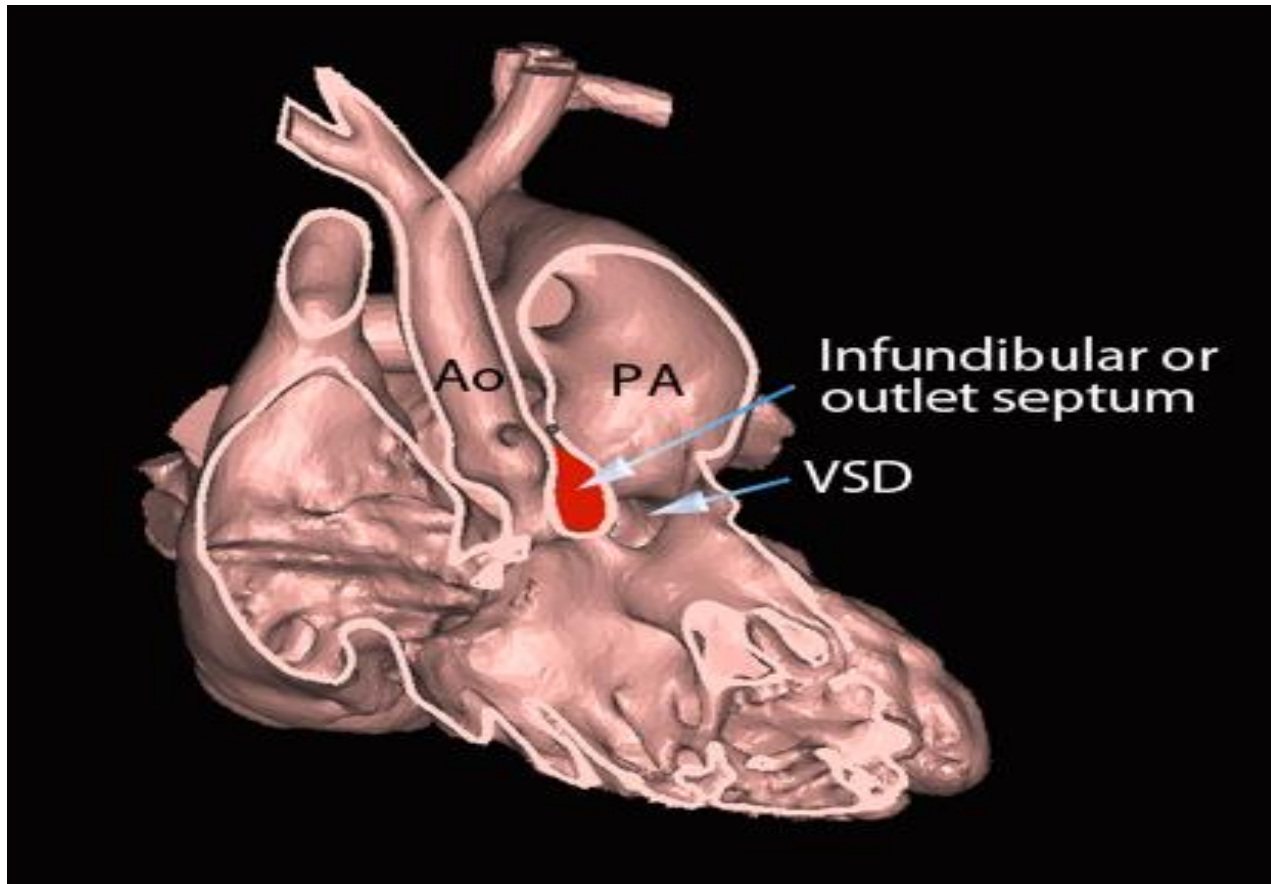


- Descriptive term for one form of ventriculoarterial connection
- More than $\frac{1}{2}$ of both arterial trunks arising from the morphologically right ventricle

DORV: MAJOR VARIABLES

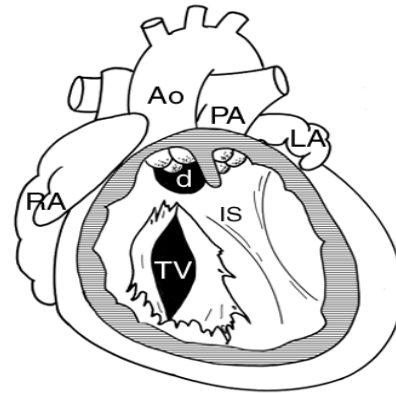
1. Location of the VSD within the septum
2. Great arterial relationship
3. Orientation of the outlet septum

Determine the spatial relationship between the VSD and arterial trunks and therefore the hemodynamics.

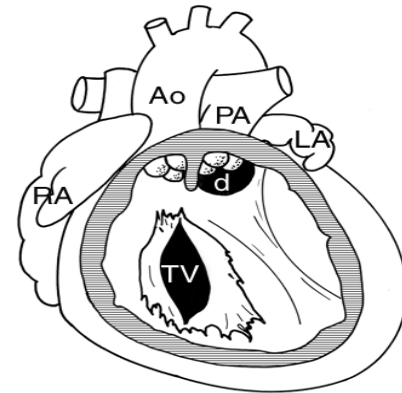


Infundibular or outlet septum in DORV

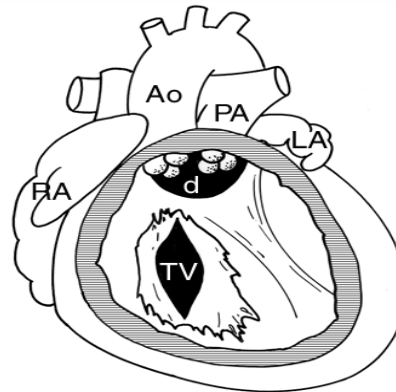
VSD's IN DORV



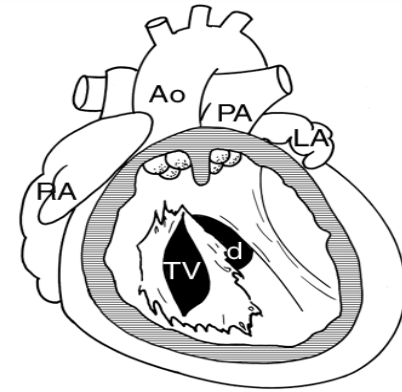
Subaortic defect



Subpulmonary defect



Doubly committed defect



Remote defect

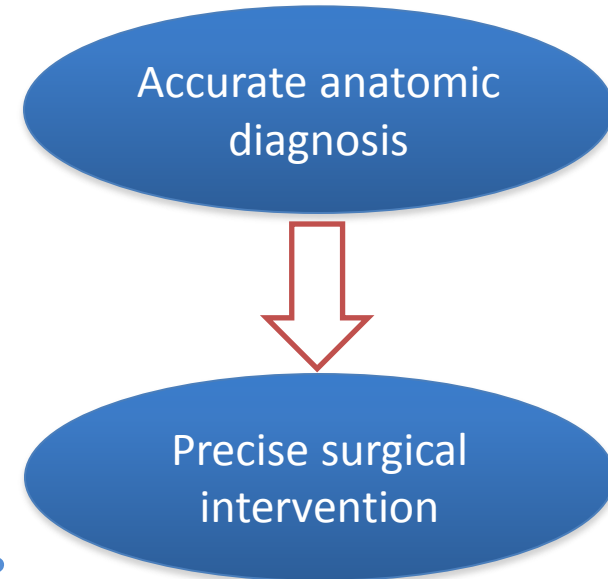
CONGENITAL HEART DISEASE

Complex Cyanotic Congenital Heart Disease

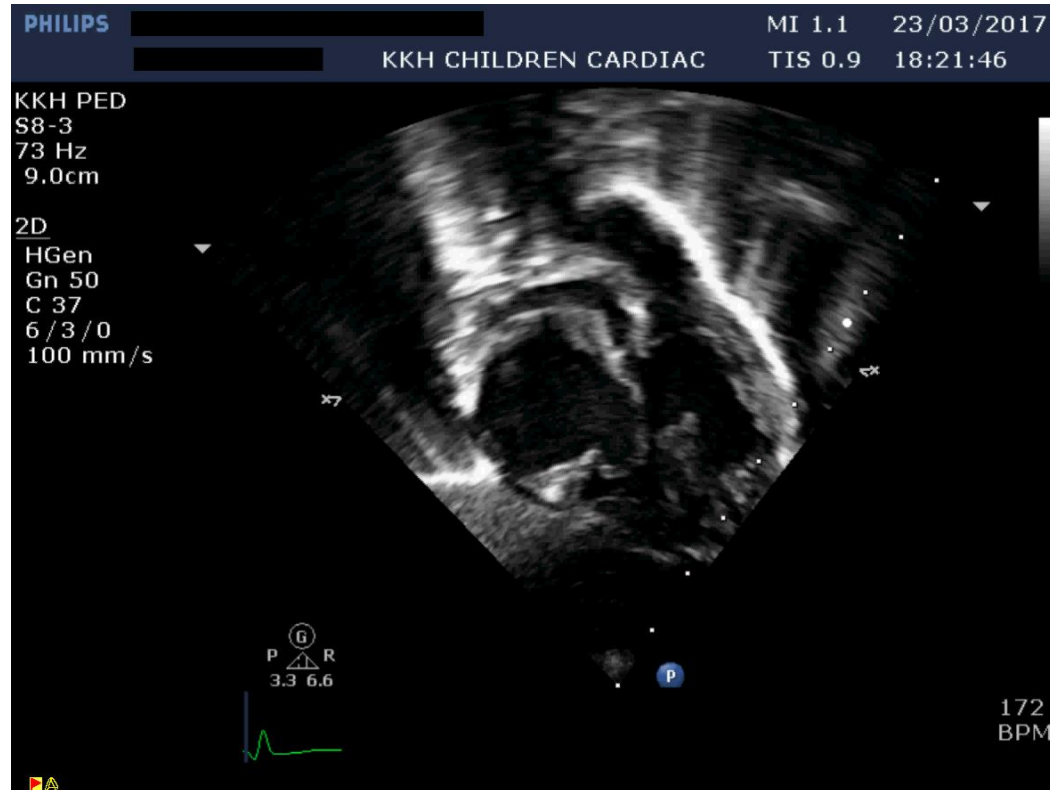
Usual atrial arrangement
Discordant atrioventricular
connections

Double outlet right ventricle

Transposition of great arteries
Pulmonary stenosis



COMPLEX CONGENITAL HEART DISEASE



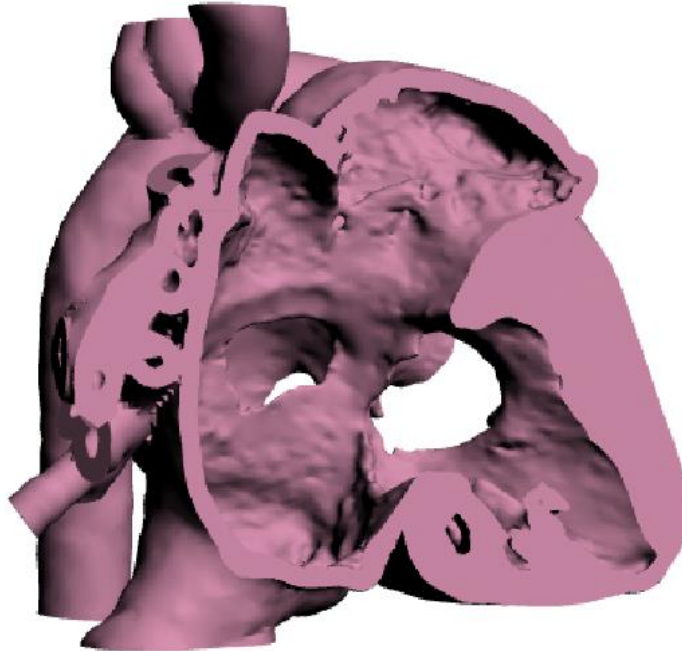
3D ECHOCARDIOGRAPHY

WHY RAPID PROTOTYPING?

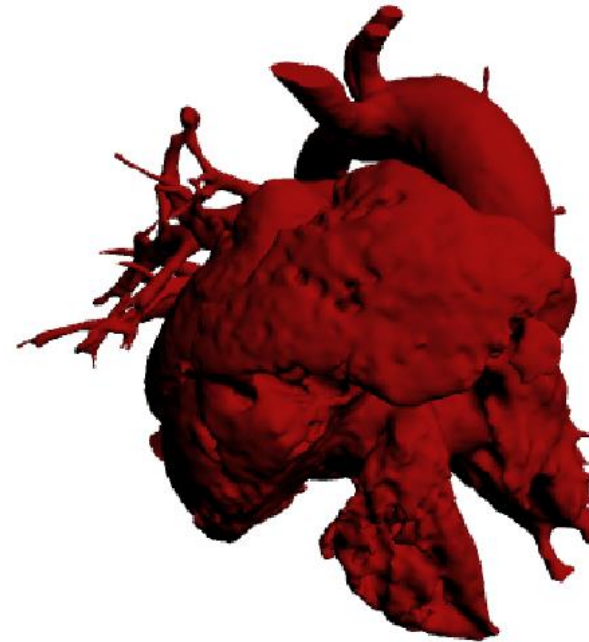
“No matter how good 3D graphics are, there is nothing like a model in your hands...”

H.K. Kawamoto, UCLA Medical Center, US

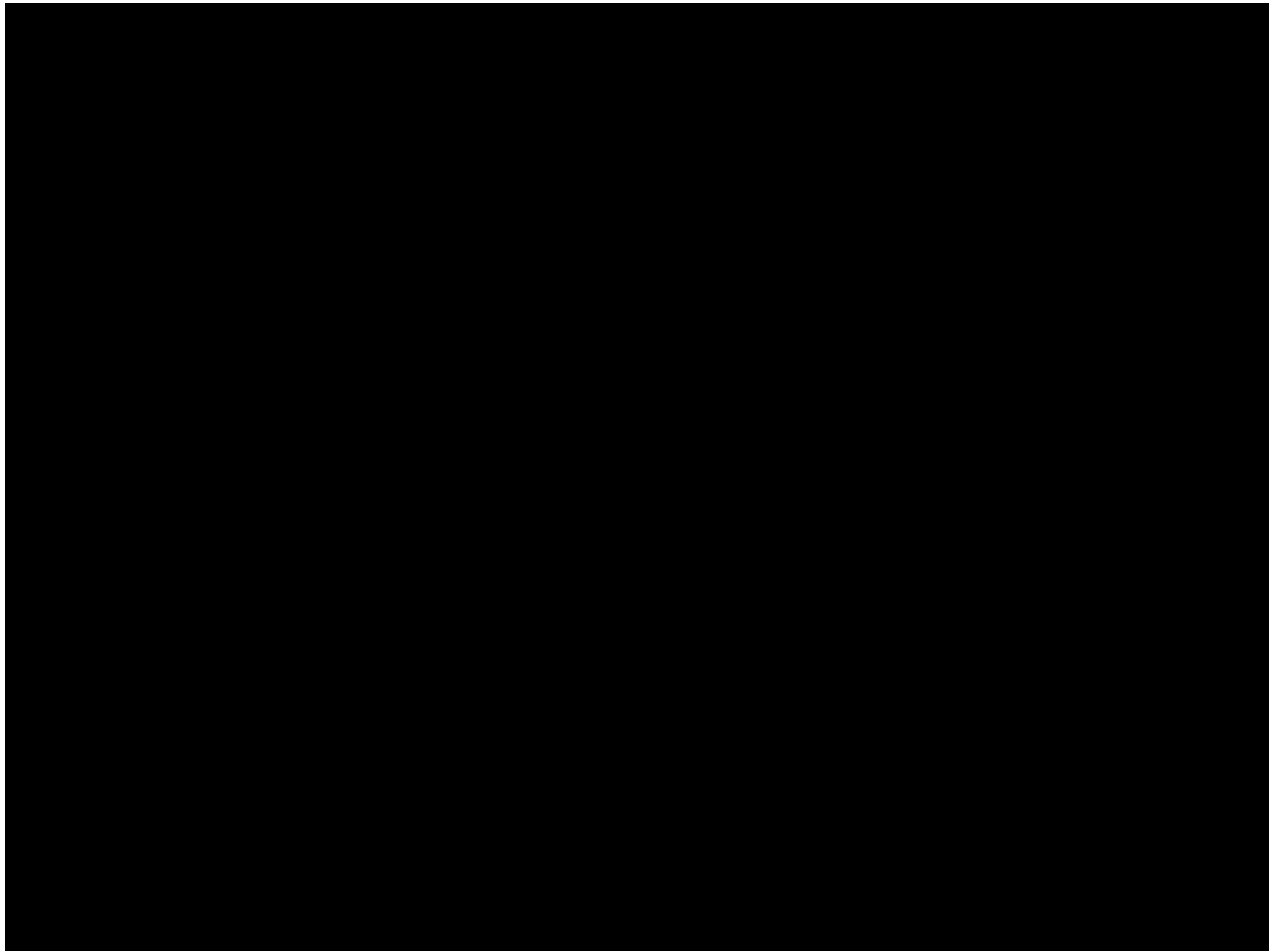
IMPROVED (ANATOMICAL) DIAGNOSIS



Hollow model



Blood pool



IMPROVED COMMUNICATION

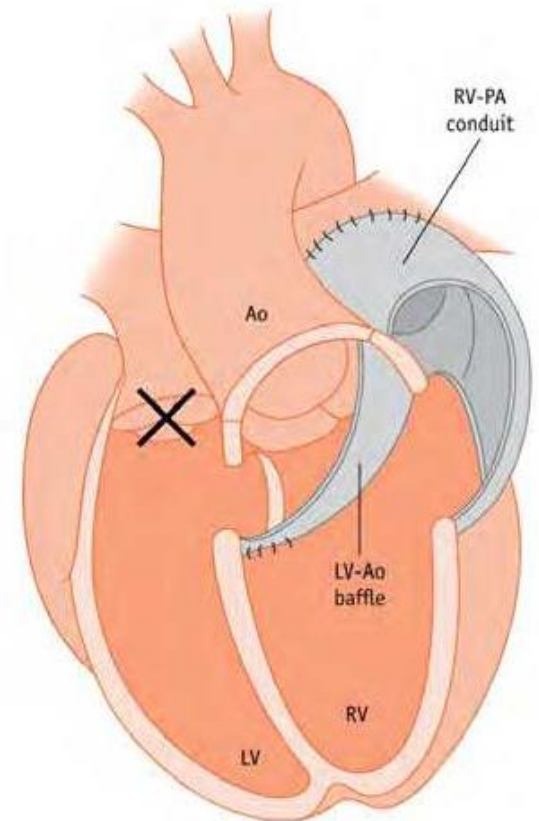
Cardiologist

Cardiothoracic Surgeon (Dr M Nakao)



PRECISION OF SURGICAL REPAIR

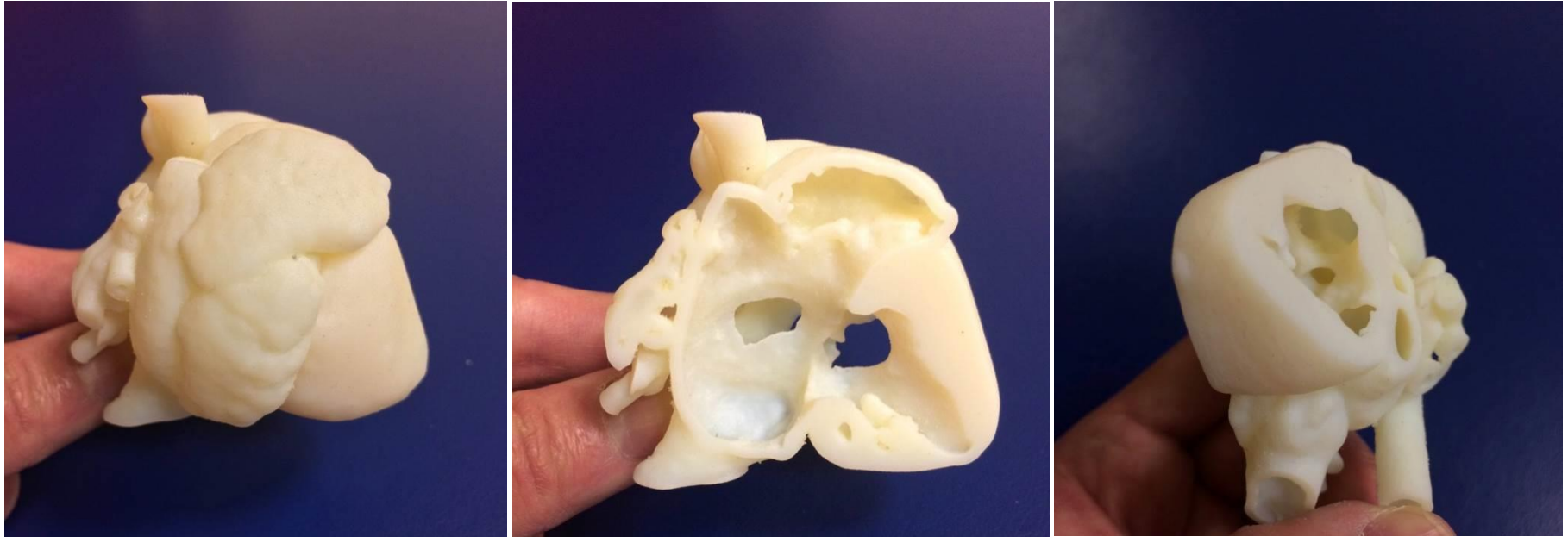




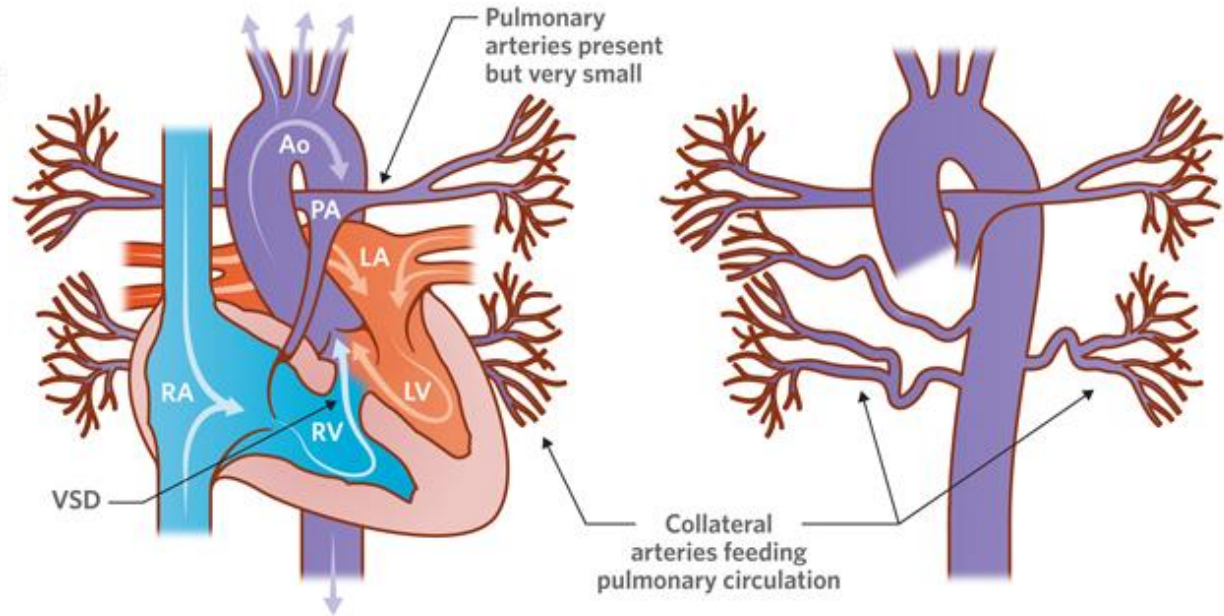
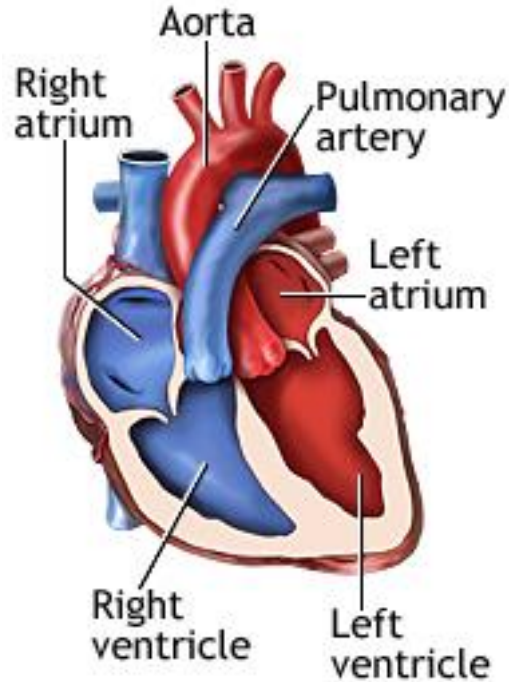
LV-Ao baffle +
RV-PA conduit

IMPROVED COMMUNICATION

- With parents / caregivers

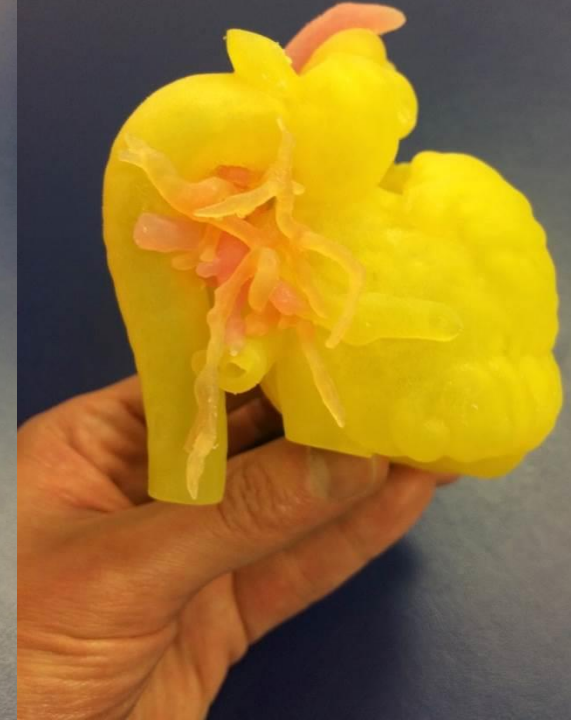
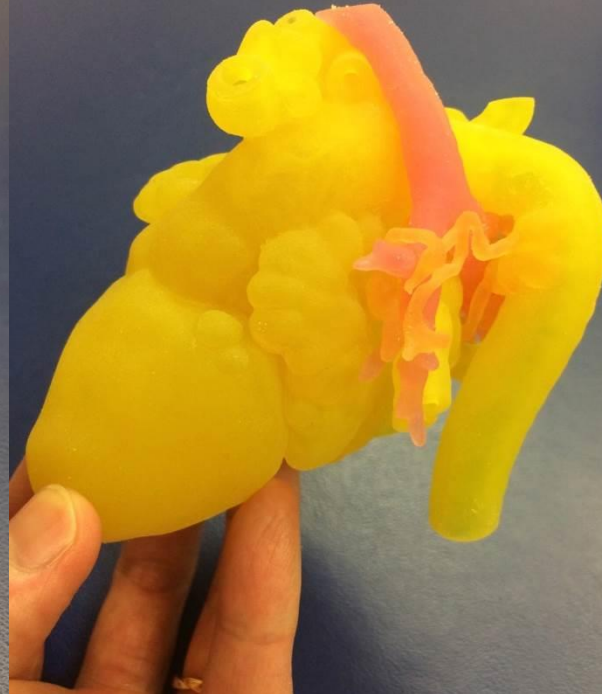


PULMONARY ATRESIA, VENTRICULAR SEPTAL DEFECT MAJOR AORTOPULMONARY COLLATERALS



IMPROVED COMMUNICATION

With parents / caregivers





3D Printed Heart Models

as educational tools



SURGICAL MORPHOLOGY AND IMAGING OF CONGENITAL HEART DISEASE

21 – 22 September 2016
Singapore

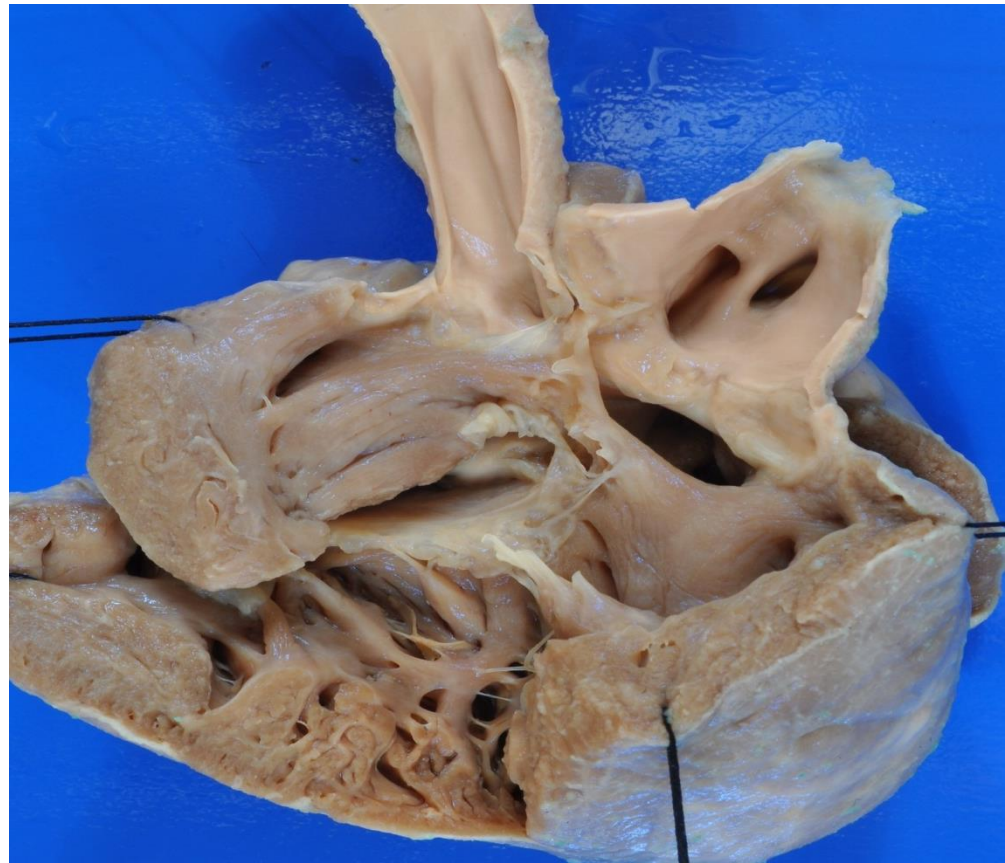
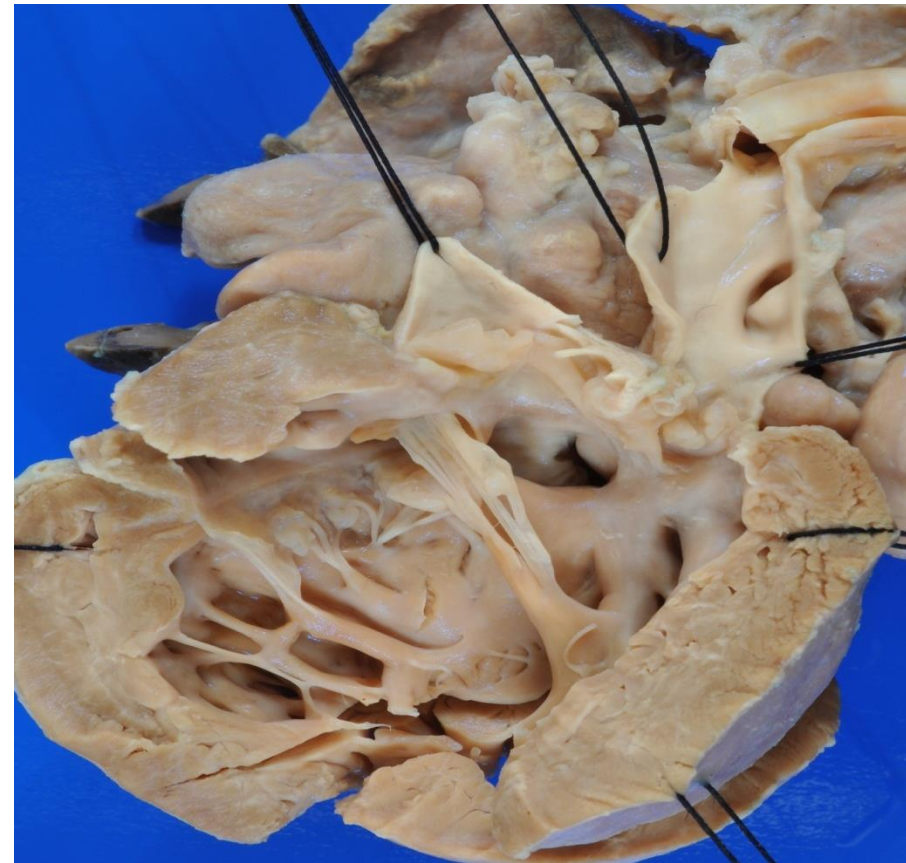
Featuring Hands-on with 3D heart models, Surgical and Echocardiography Workshop

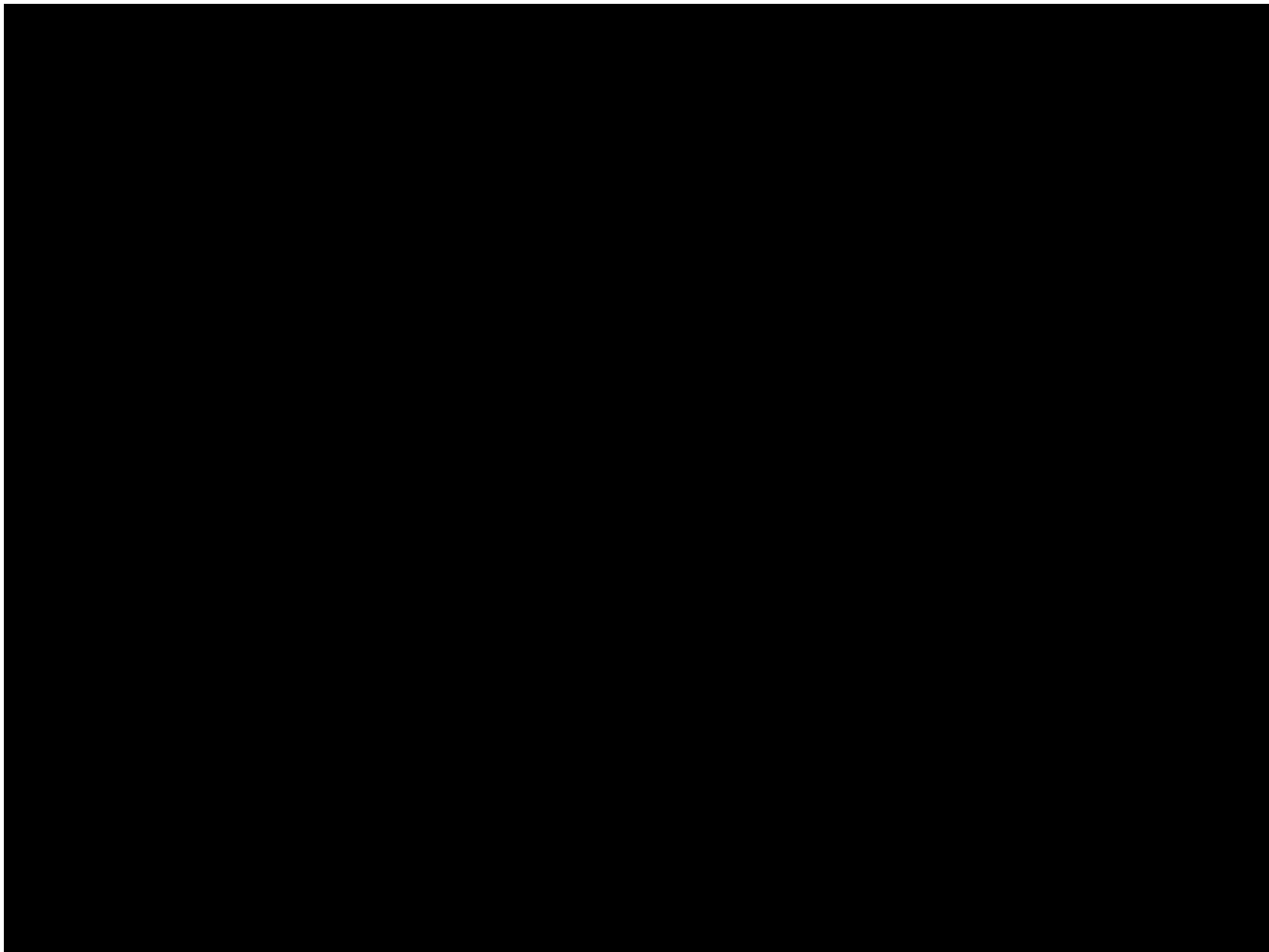
ORGANISERS

SECRETARIAT

WORKSHOP ORGANISERS

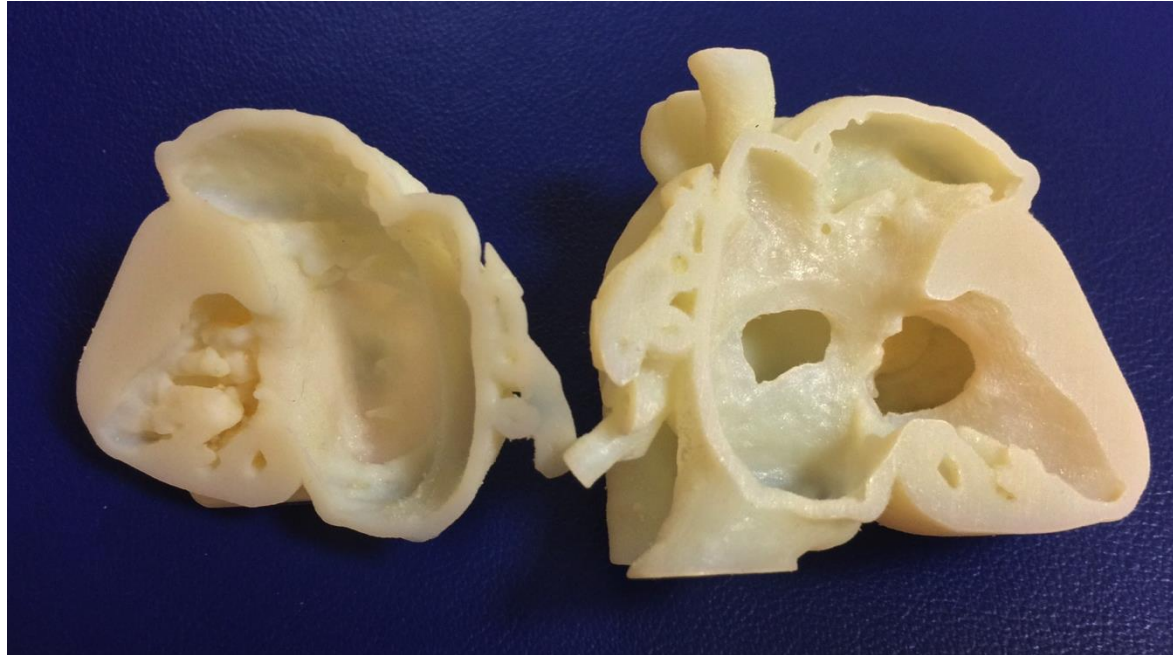
WORKSHOP SECRETARIAT

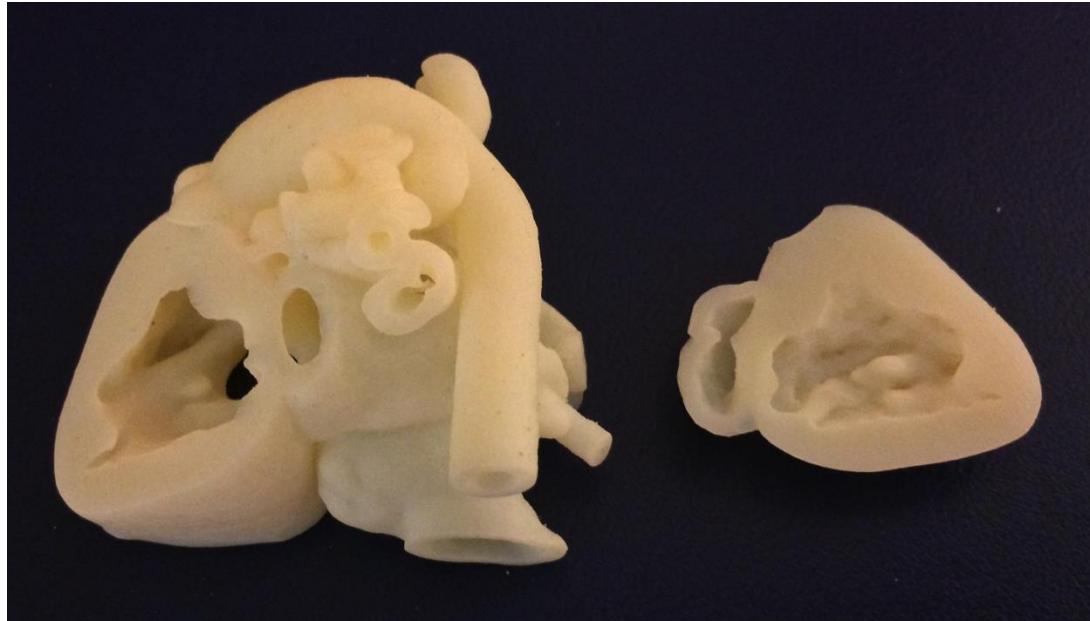




Courtesy of Dr Andrew Cook, UCL

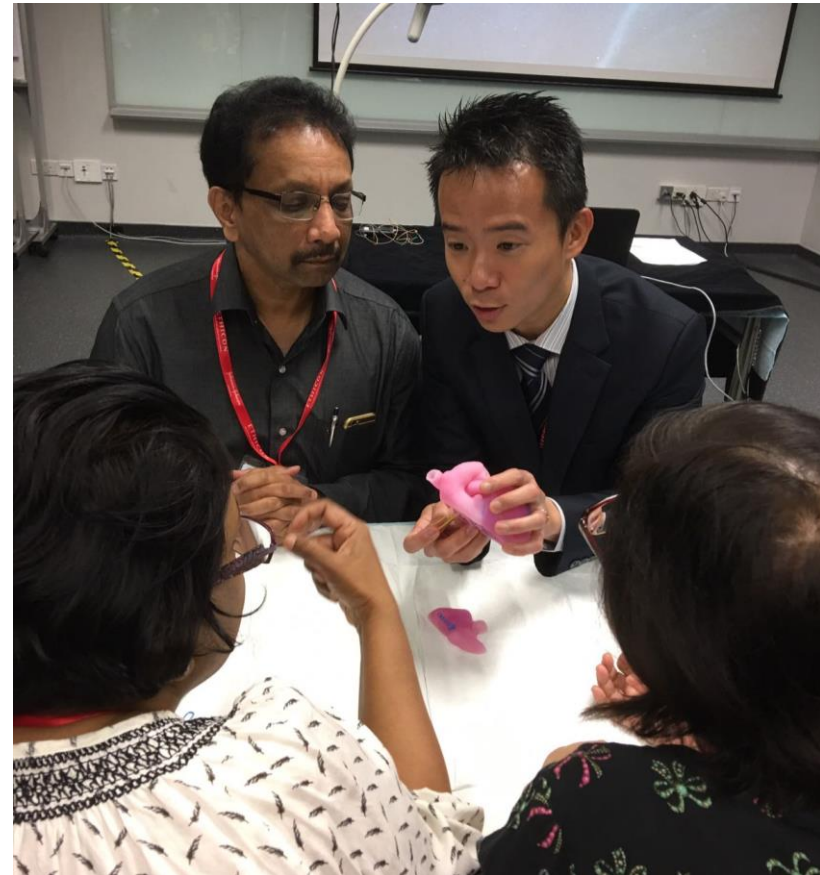






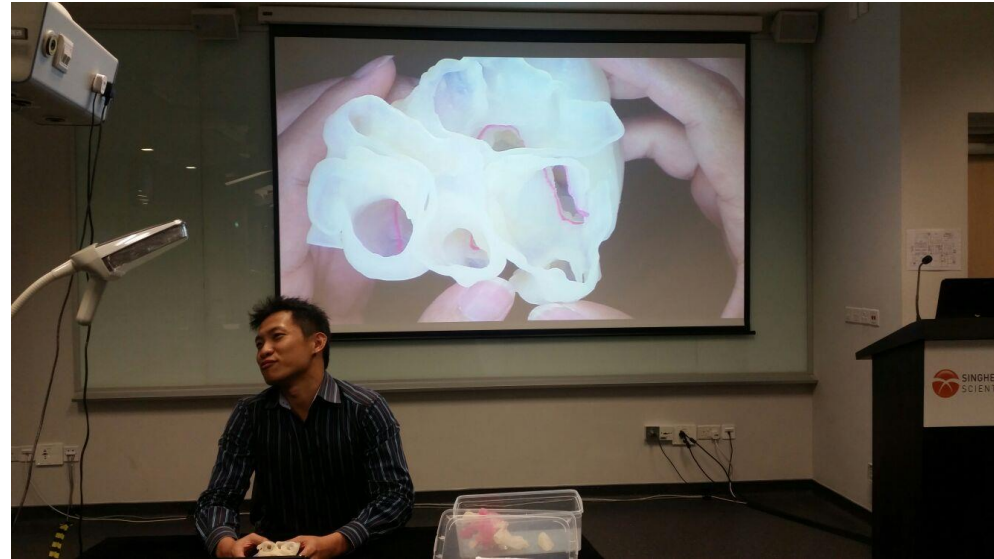


EDUCATION – SIMULATION



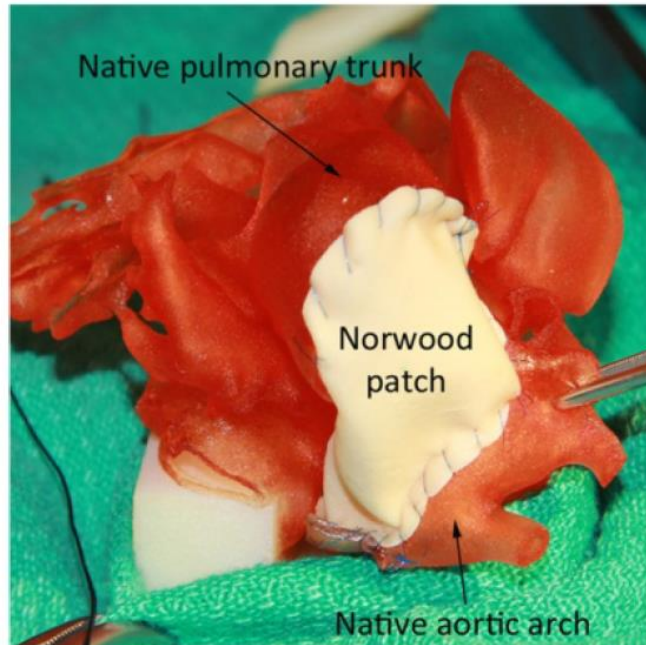


EDUCATION – SIMULATION



EDUCATION – SIMULATION

- Surgical Practice

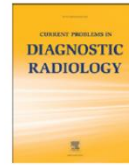


“Practice Practice Practice”

*Glen van Arsdell, Chief CV Surgeon,
SickKids, Toronto*

LIMITATIONS

- Time-consuming
 - Segmentation: 3 – 20 hours
 - Printing: 3 – 4 hours
- Costly
 - Segmentation: USD 1080
 - 3D Printing: USD 430



Three-Dimensional Printing and Medical Imaging: A Review of the Methods and Applications

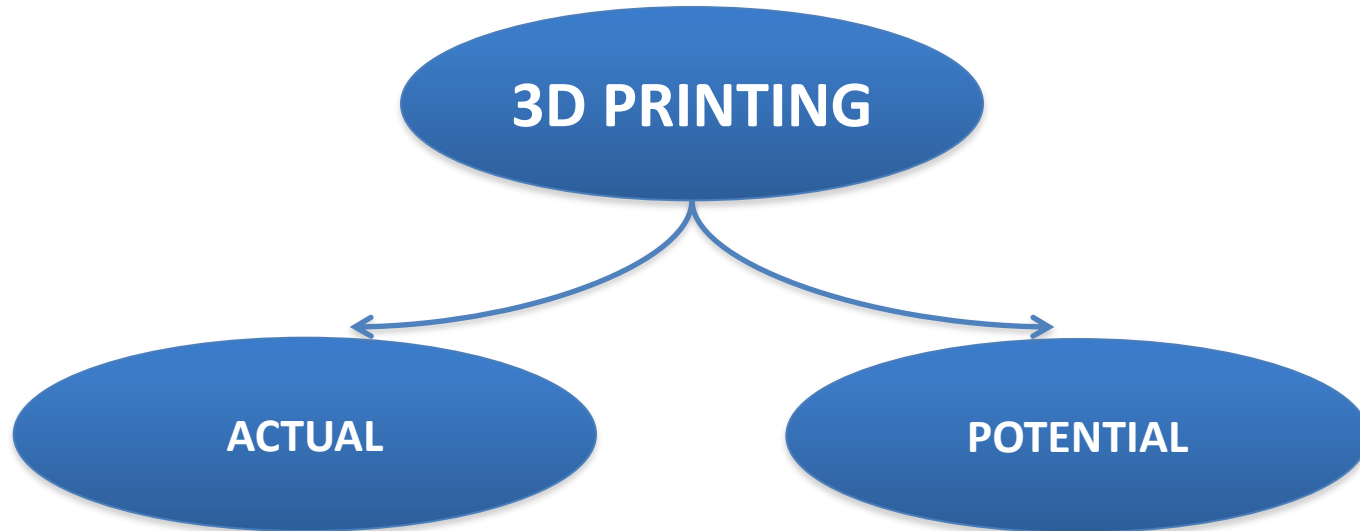
Alessandro Marro, BSc^{a,*}, Taha Bandukwala, MD^a, Walter Mak, MD^b

^a Department of Medical Imaging, University of Toronto, Toronto, Ontario, Canada

^b Department of Medical Imaging, St. Michael's Hospital, Toronto, Ontario, Canada

“Although the theoretical applications for its use in medicine are endless, there are barriers that would need to be addressed before it potential can be fully used. Cost is perhaps the biggest factor in determining the usefulness of 3D printers in clinical practice (...)”

MEDICAL APPLICATIONS OF 3D PRINTING



RESEARCH – 3D BIOPRINTING

- 3D printing using living cells
- Can be used to create tissues and whole organs
- With or without scaffold
- Using stem cells or already differentiated cells

ORGAN TRANSPLANT & REGENERATIVE MEDICINE

- Current applications of 3D bioprinting
 - Skin for burn victims
 - Cartilage
 - Bones (fingers)
 - Blood vessels
 - Miniature organs (liver, kidney)





ORGAN TRANSPLANT & REGENERATIVE MEDICINE

- In Singapore, more than 20 patients waiting for a donor heart
- Paediatric heart transplant programme has just been approved
- Donor shortage
- Children have the highest waitlist mortality

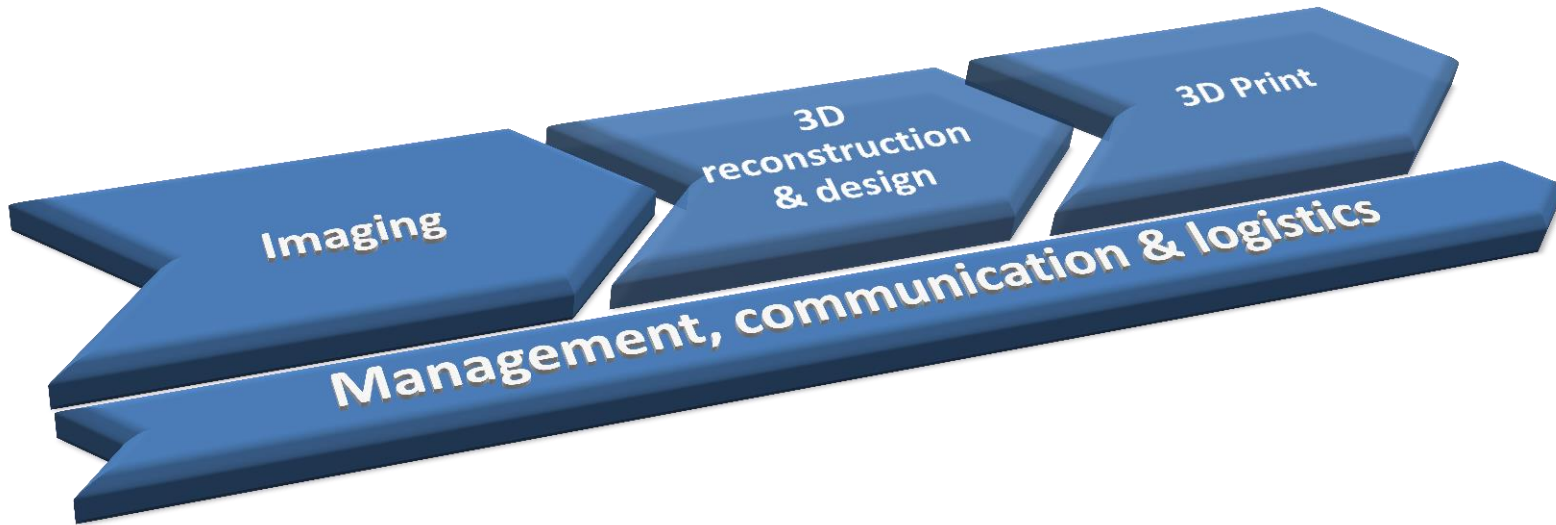
ORGAN TRANSPLANT & REGENERATIVE MEDICINE

- 3D bioprinting can potentially create beating hearts using patients own cells
- No danger of rejection or need for immunosuppression
- Heart can be printed in days rather than waiting years for a transplant



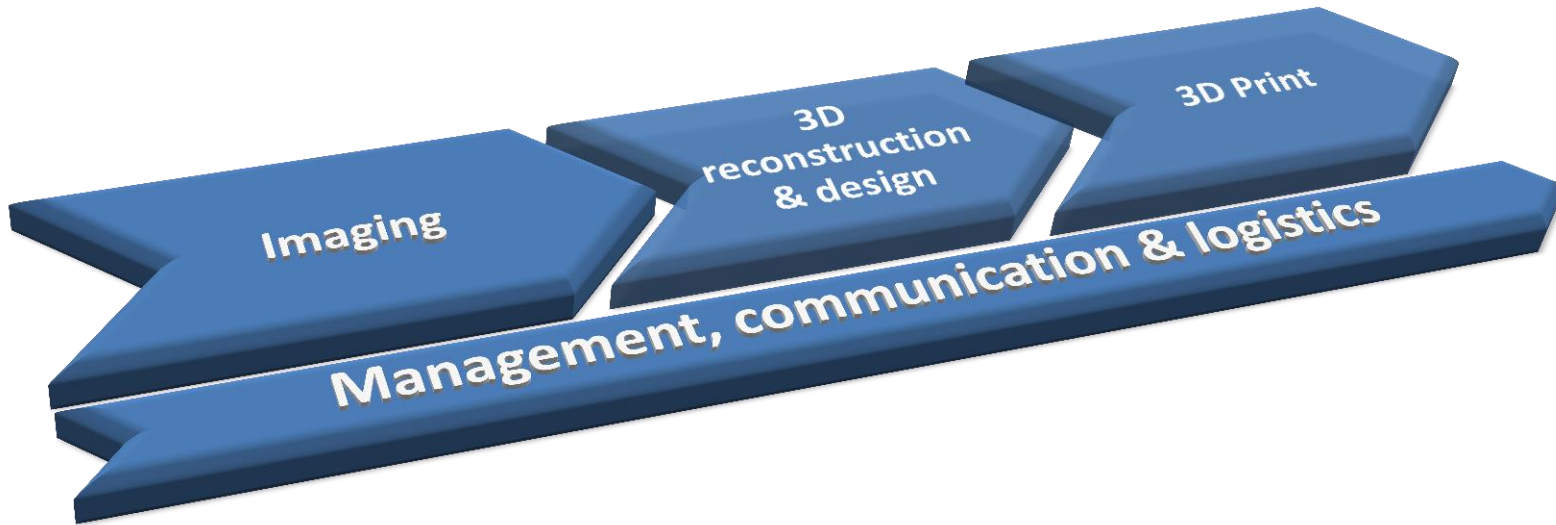


SOURCES OF RISK / ERRORS

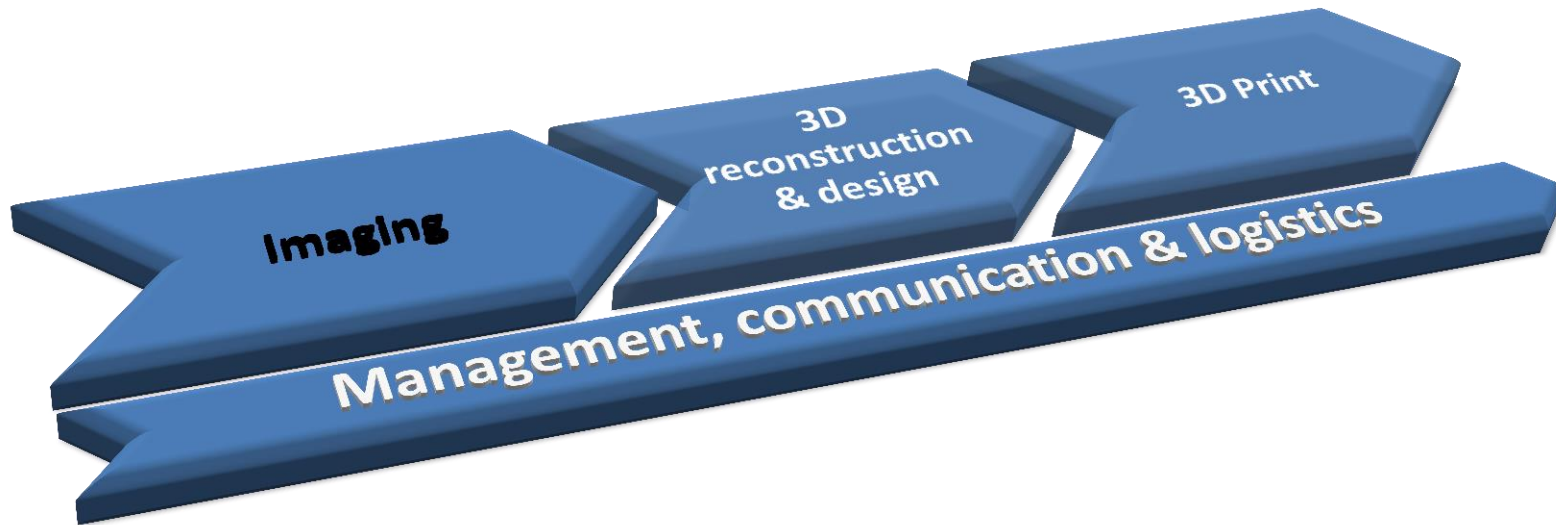


SOURCES OF RISK / ERRORS

Validate your own process!!!

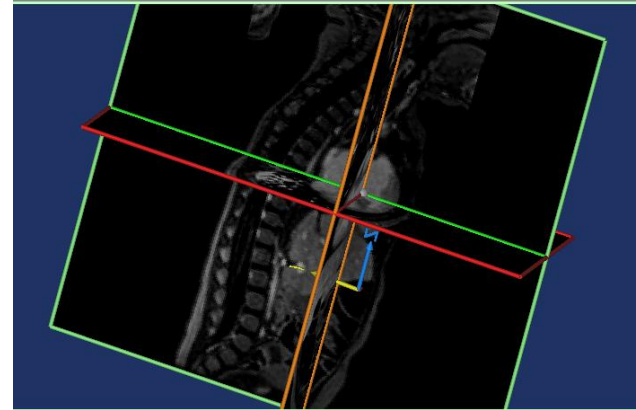


SOURCES OF RISK / ERRORS

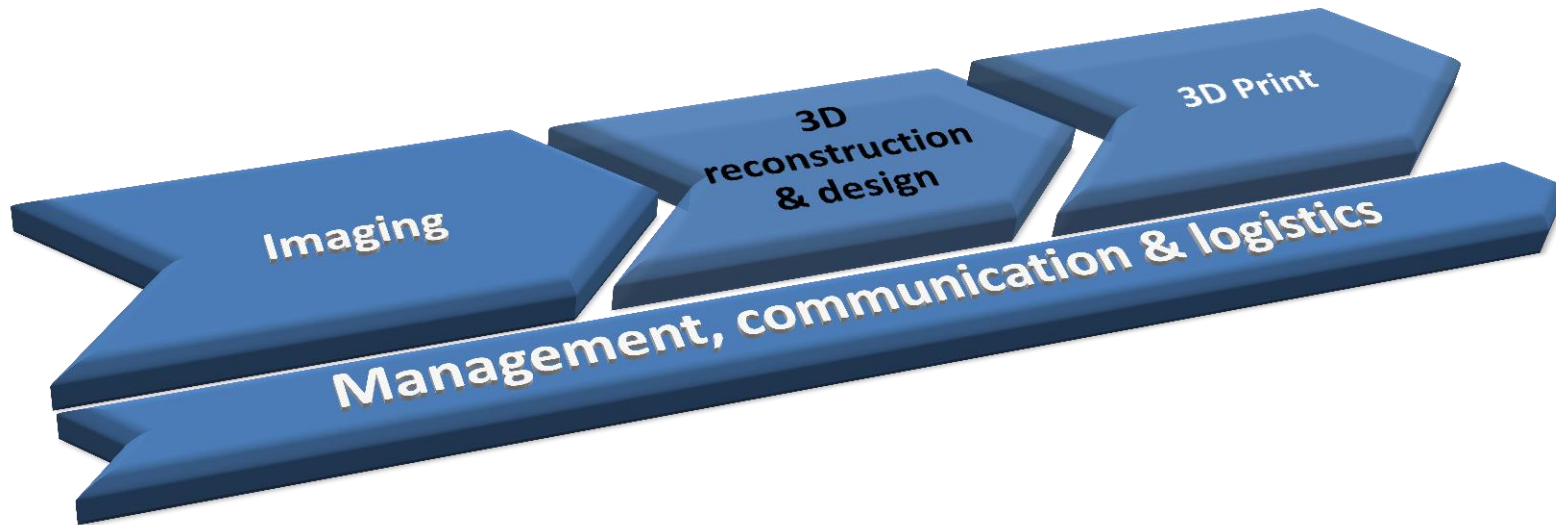


IMAGING

- Pathology-specific protocols for 3D printing
 - Readily available for radiologists
- Imaging quality
 - Hardware and operator
 - Static versus dynamic anatomy
 - Contrast
 - Artifacts
- Criteria to accept or reject images by qualified personnel



SOURCES OF RISK / ERRORS



3D RECONSTRUCTION & DESIGN

- Software
 - Level of validation and documentation
 - Regulatory guidance

REVIEW

Open Access

Maintaining safety and efficacy for 3D printing in medicine



Andy Christensen¹ and Frank J. Rybicki^{2,3*}

“Segmentation & preparation for 3D printing (...) in which DICOM images are segmented to create STL files, should use software that is FDA cleared for this purpose” (...)

When (...) major modifications are made, or a comparable modification that changes the patient’s anatomy in planning for a specific intervention, **the software** used to make that modification **should be FDA cleared for this intended use**, and the **printed model** should also be considered a Medical Device.”

3D RECONSTRUCTION & DESIGN

- Software
 - Level of validation and documentation
 - Regulatory guidance

Technical Considerations for Additive Manufactured Devices

Draft Guidance for Industry and Food and Drug Administration Staff

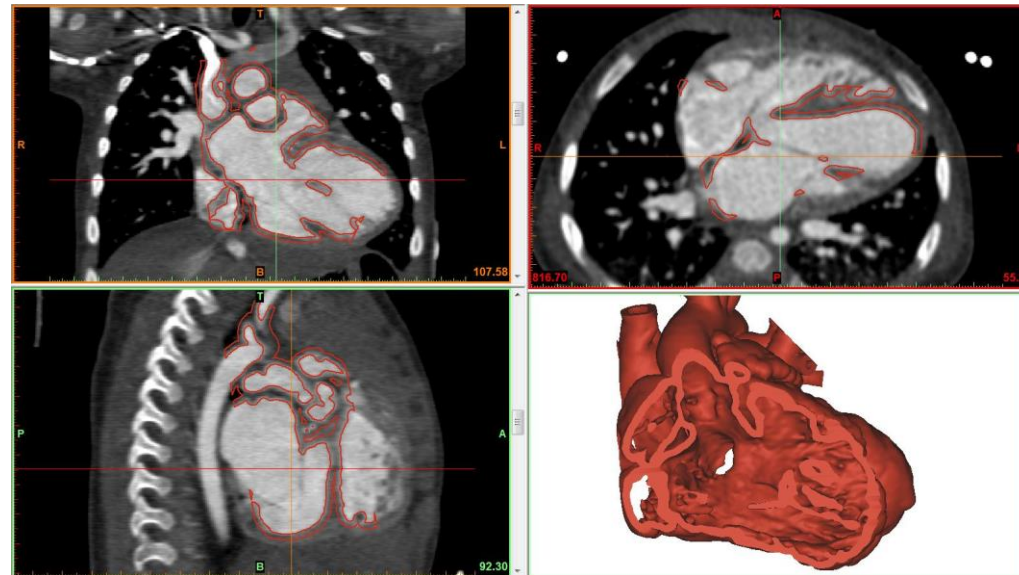
DRAFT GUIDANCE

This guidance document is being distributed for comment purposes only.

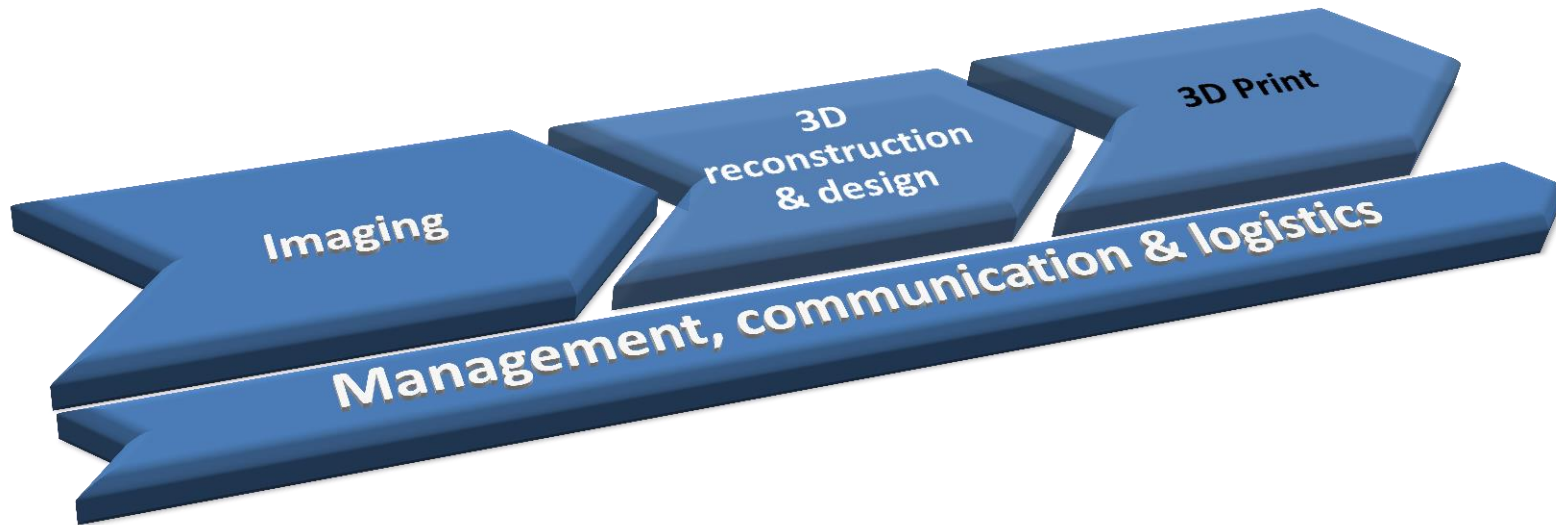
Document issued on May 10, 2016.

3D RECONSTRUCTION & DESIGN

- Software
 - Level of validation and documentation
 - Regulatory guidance
- Segmentation
 - Automated & manual tools
 - Clinical & imaging experts
- 3D reconstruction
 - Smoothing, removing aberrations
 - Wall thickness – linked to print technology
 - Final assessment on the images



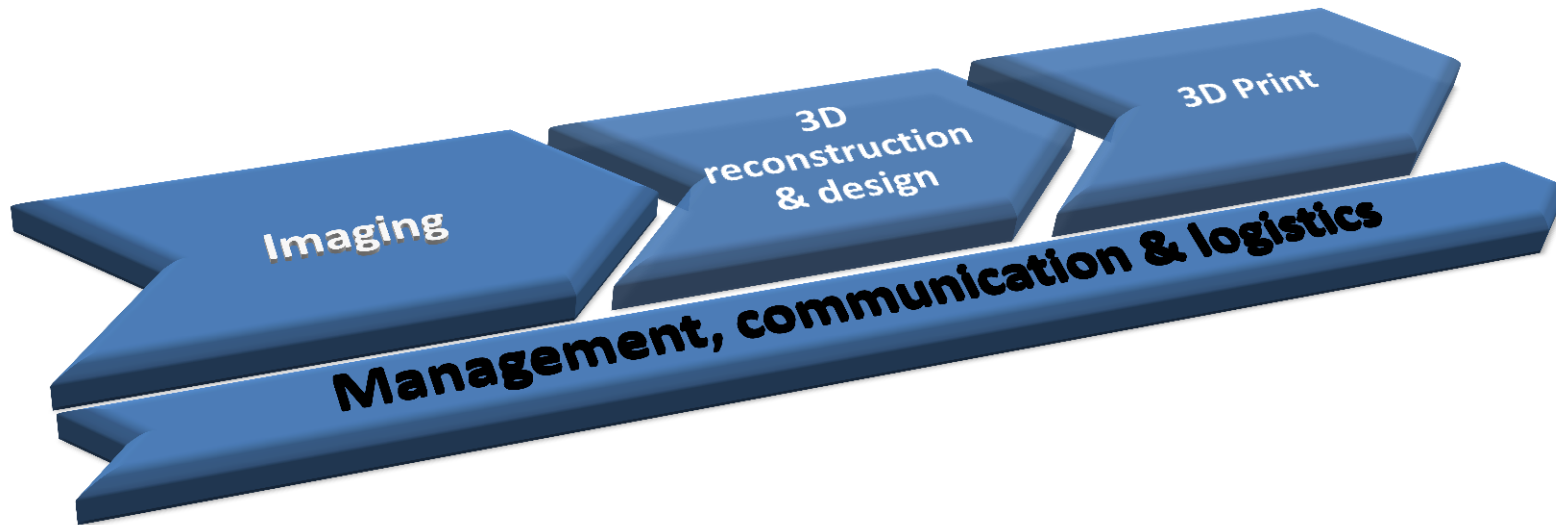
SOURCES OF RISK / ERRORS



3D PRINT

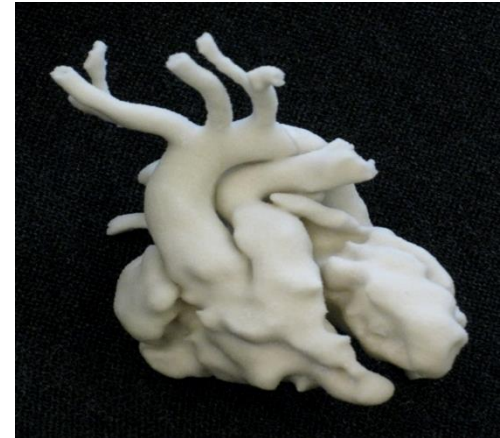
- Material selection
 - Model / guide / implant goal
 - Flexible vs rigid plastic
 - Transparency
- Printer hardware
 - Low-cost vs high-end
 - Calibration
- Finishing
 - Post-processing often forgotten
 - Dedicated hardware & personnel investment

SOURCES OF RISK / ERRORS



MANAGEMENT, COMMUNICATION & LOGISTICS

- Medical image data transfer
 - PDPA compliance
 - Patient privacy
- Physician communication and approval platform
 - PDF report
 - 3D PDF
 - Online viewer / meeting
- Traceability
 - Physical in-printed identification label
 - Segmentation & 3D design parameters
 - Machine build parameters
- Shipping



CONCLUSIONS

- Niche applications in the medicine of congenital heart diseases
- Allows instantaneous and precise understanding of any complex anatomy
- Simulation / hands-on surgical training
- Personalized and precision medicine

CONCLUSIONS





THANK YOU

