

# Craniofacial Phenotyper

Innovative Freshman Experience

Freshmen Imaging Science Students



Chester F. Carlson  
**CENTER** for  
**IMAGING**  
**SCIENCE**

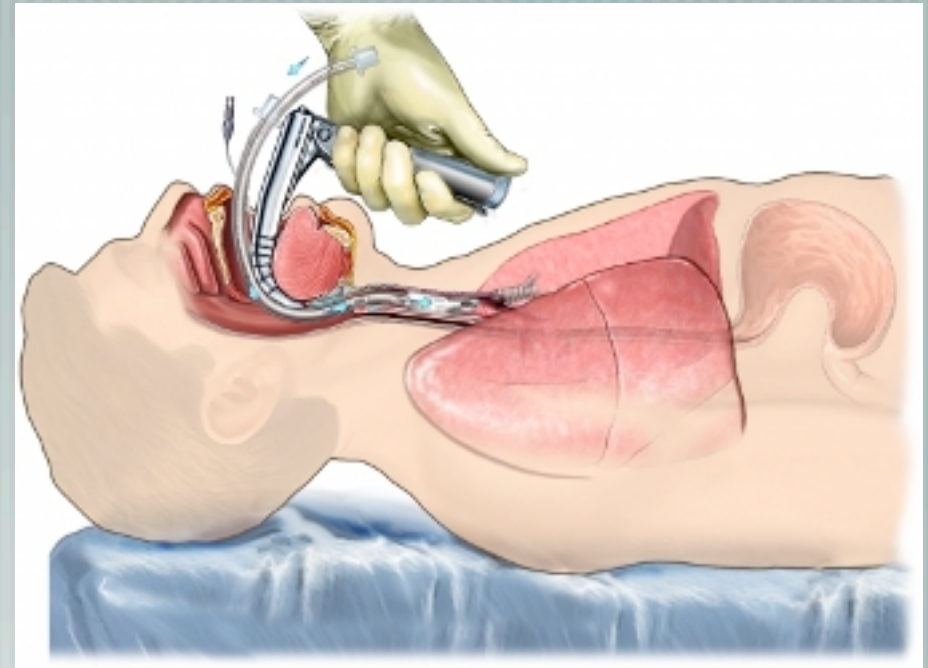
- 1. Introduction**
2. Background & Theory
3. Methods
4. Examples
5. Looking Forward
6. Schedule

# Intubation

What is it?

Why is it necessary?

How?



<http://www.aurorahealthcare.org/yourhealth/healthgate/getcontent.asp?URLhealthgate=%22112024.html%22>

# What's the problem?

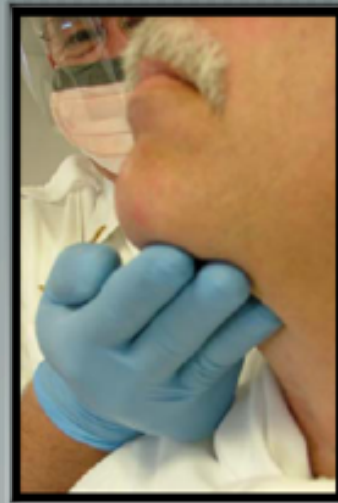
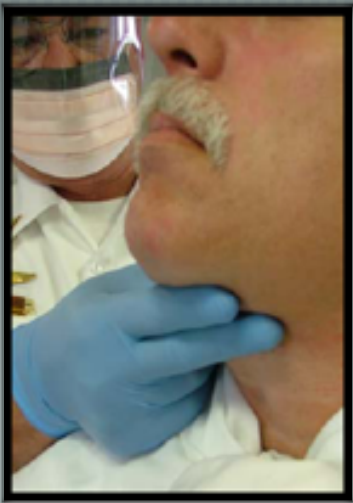
- [ Intubation is a difficult process

- [ Accurate prediction of Difficult Tracheal Intubation (DTI) can prevent complications

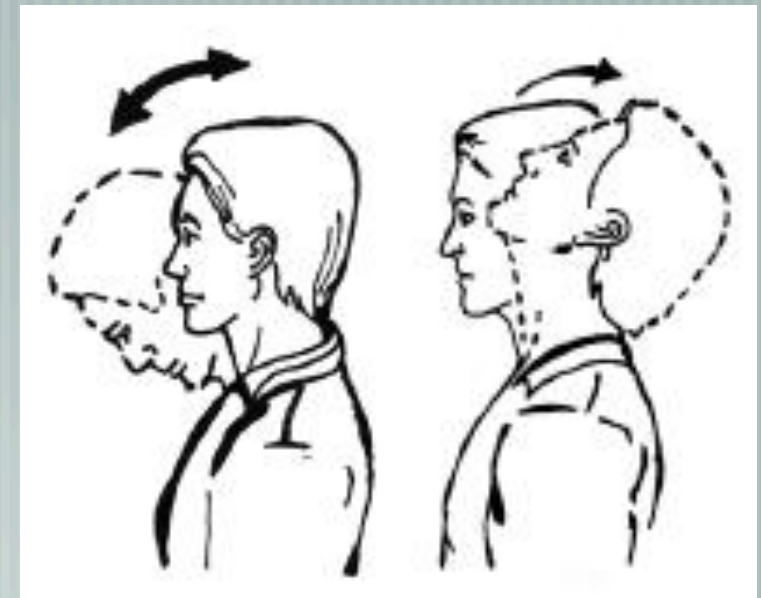


# Traditional Intubation Assessment

## Evaluate

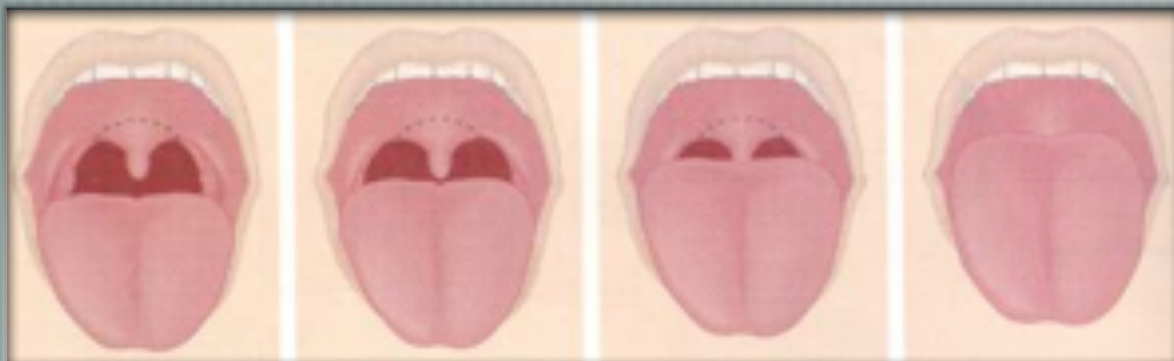


## Neck Mobility



<http://members.shaw.ca/chuangmc/module2/resources/neck-movement.jpg>

## Mallampati Scale



<http://www.uptodate.com/contents/image?imageKey=EM%2F4405>

# Our Motivation



**Dr. Jacek A. Wojtczak, M.D., Ph.D.**  
URMC Anesthesiologist, Associate Professor  
[Jack\\_Wojtczak@URMC.rochester.edu](mailto:Jack_Wojtczak@URMC.rochester.edu)



[http://www.cs.rochester.edu/research/vision/people/Bo\\_Hu/](http://www.cs.rochester.edu/research/vision/people/Bo_Hu/)

**Dr. Bo Hu, Ph.D.**  
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# Dr. Wojtczak's and Dr. Hu's Theory

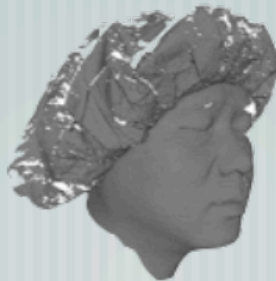
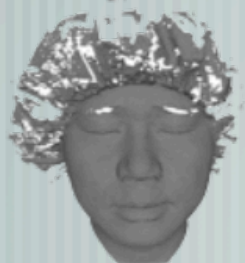
- [ “Surface contour measurements on the head may act as surrogate indicators that reflect the underlying skeletal structures or soft tissue anatomy.” –Wojtczak
- [ Limitations of current method of achieving these measurements:
  - Expensive software & hardware (\$50,000+)
  - Long processing time (over 1 hour)

# Our Assignment

- [ Build a Craniofacial Phenotyper

- Reconstruct a 3D model of the head

- Obtain measurements from 3D reconstruction



# What Exactly Are We Measuring?

## — [ Baselines

- Topographical measurements between specific points
- Volume of lower half of head

## — [ Our ideal model

- Entire head
- Accurate
- Allows for any measurement

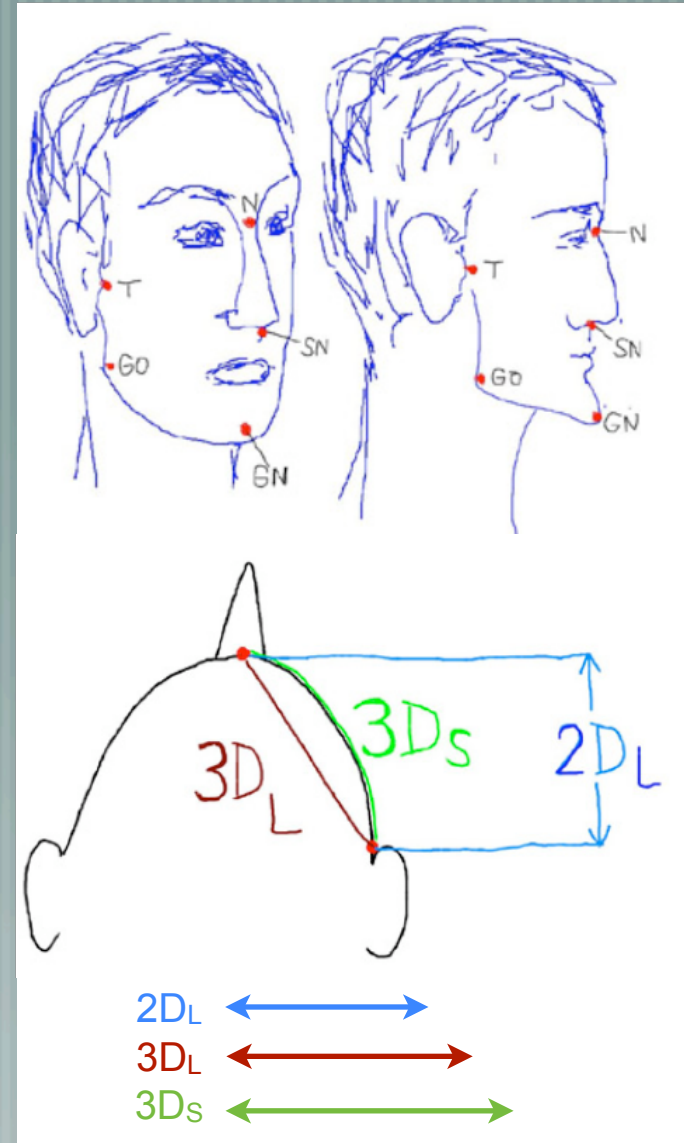


# Topographical Measurements

Current practice: measure distance using 2D photographs ( $2D_L$ )

Improvement upon current practice: measure three-dimensional linear distance ( $3D_L$ )

Ideal (our task): measure distance along surface of face ( $3D_S$ )



## Volume of the Head

Volume of lower half of head indicative of DTI

# Basic Requirements

<b>Safe</b>	Contact-free; harmless wavelengths
<b>Accuracy</b>	$\pm 0.5$ mm
<b>Capture Speed</b>	1 to 5 seconds
<b>Processing Speed</b>	30 minutes or less
<b>Interface</b>	User-friendly
<b>Cost</b>	\$3,000 or less
<b>Robustness</b>	Durable; reliable programming; simple calibration

Expected to be used in physician's office



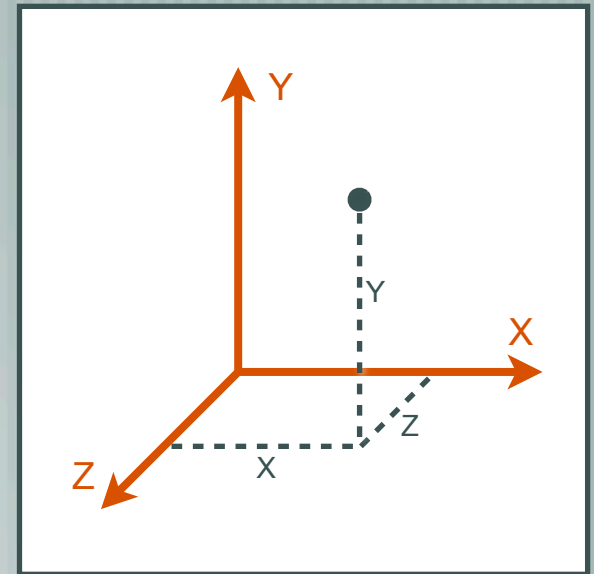
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# Methods of Depth Capture

- Geometric methods

- Time of flight methods

- Goal of each is to generate a point cloud



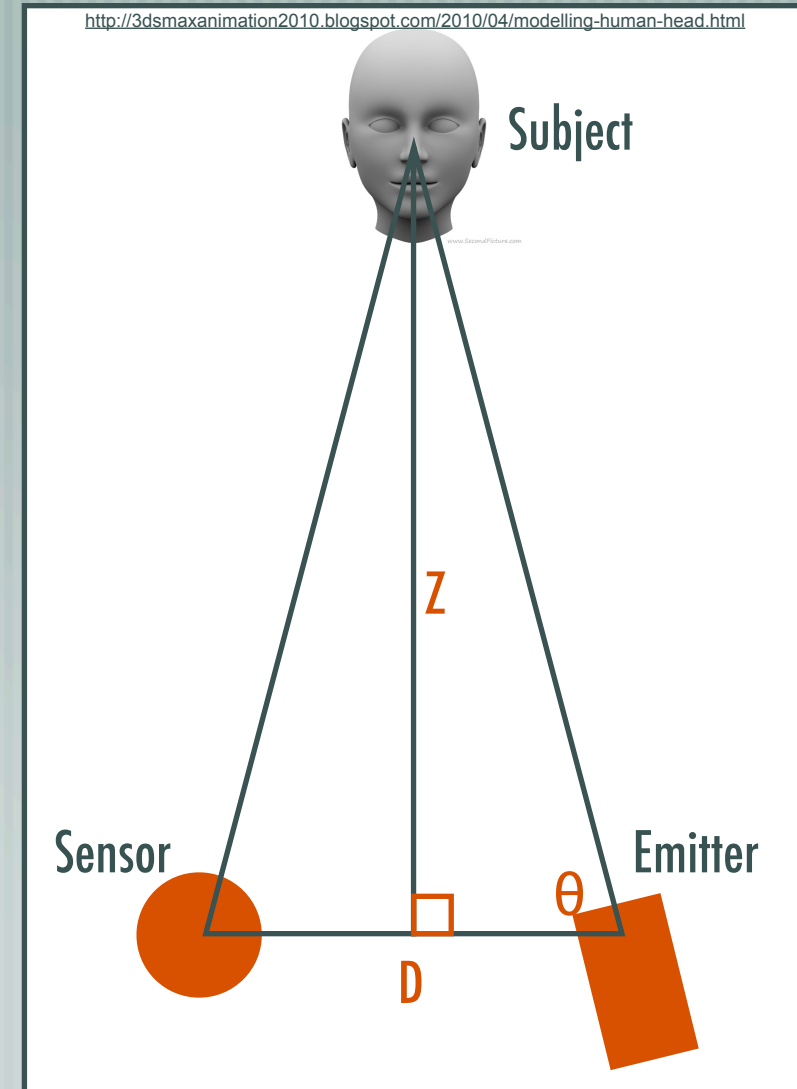
# Geometric Methods

- Based on triangulation

- Determine depth ( $Z$ ) using known quantities:

- Distance ( $D$ ) between emitter and sensor

- Angle ( $\theta$ ) between ray from emitter and  $D$



# Time of Flight Methods

- [ Measure time for pulse of light to travel from emitter to subject and back to sensor

- [ Calculate distance using speed of light

- [ We have eliminated ToF methods because:

- Cost-prohibitive (\$10,000+)

- Insufficient spatial resolution ( $\pm 15$  mm)

# Point Cloud

- [ Output format of 3D imaging system

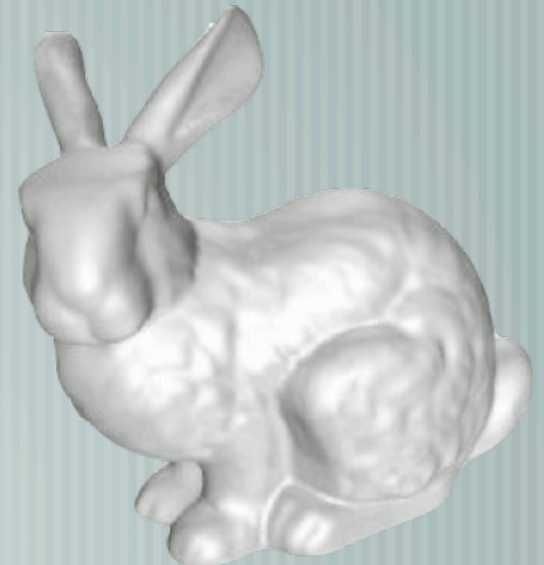
- [ Collection of spatial coordinates

- [ Mesh can be created from coordinates

- [ Software can measure distances along curvature of mesh



<http://www.engineeringspecifier.com/public/primages/pr1200.jpg>



<http://www.farfieldtechnology.com/products/toolbox/pointcloud/bunny1w.jpg>

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# Methods & Systems We've Investigated

— [ LIDAR

— [ DAVID/Line Laser  
Scanner

— [ Structured Light

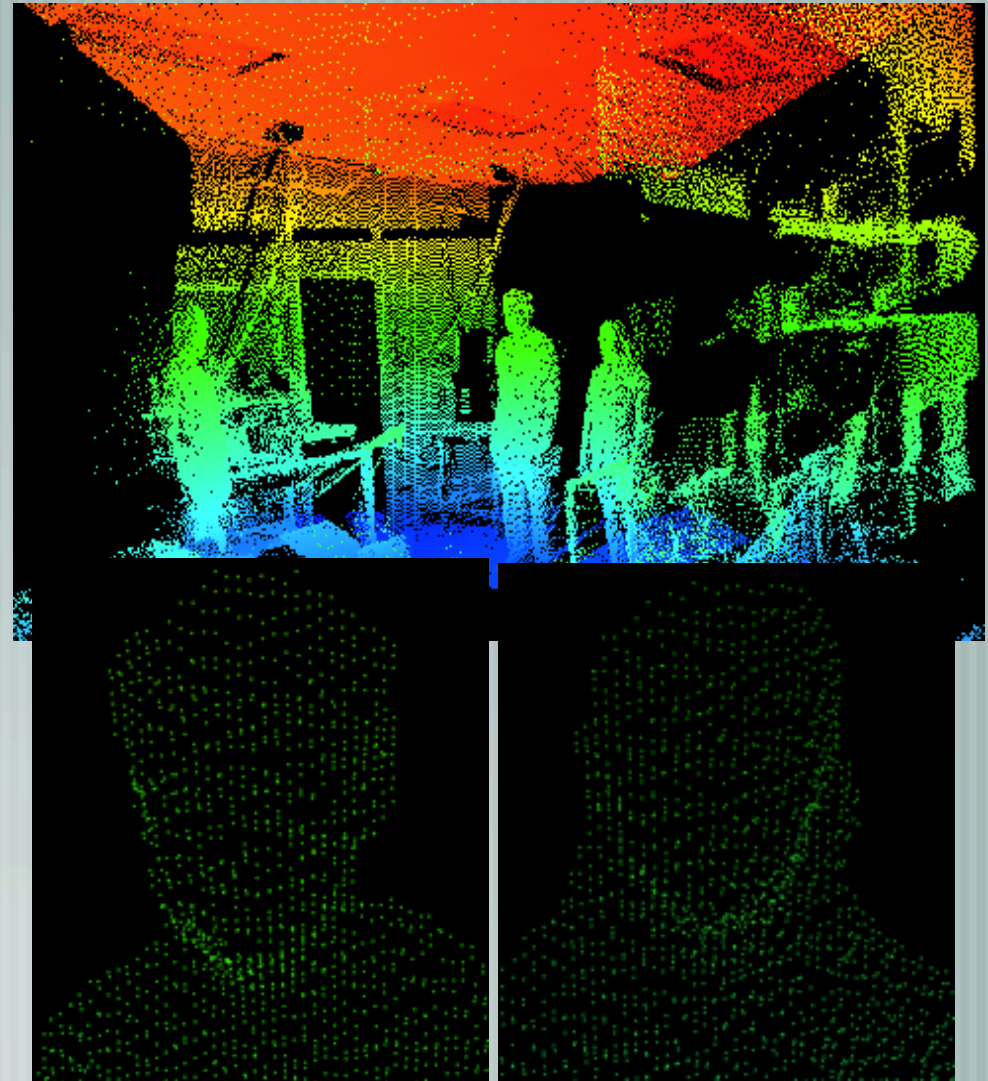
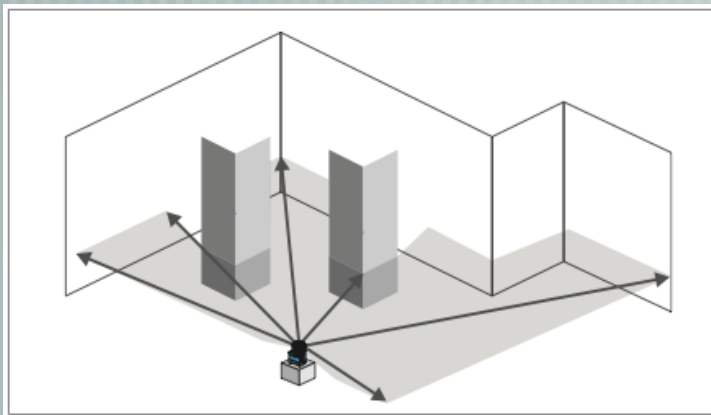
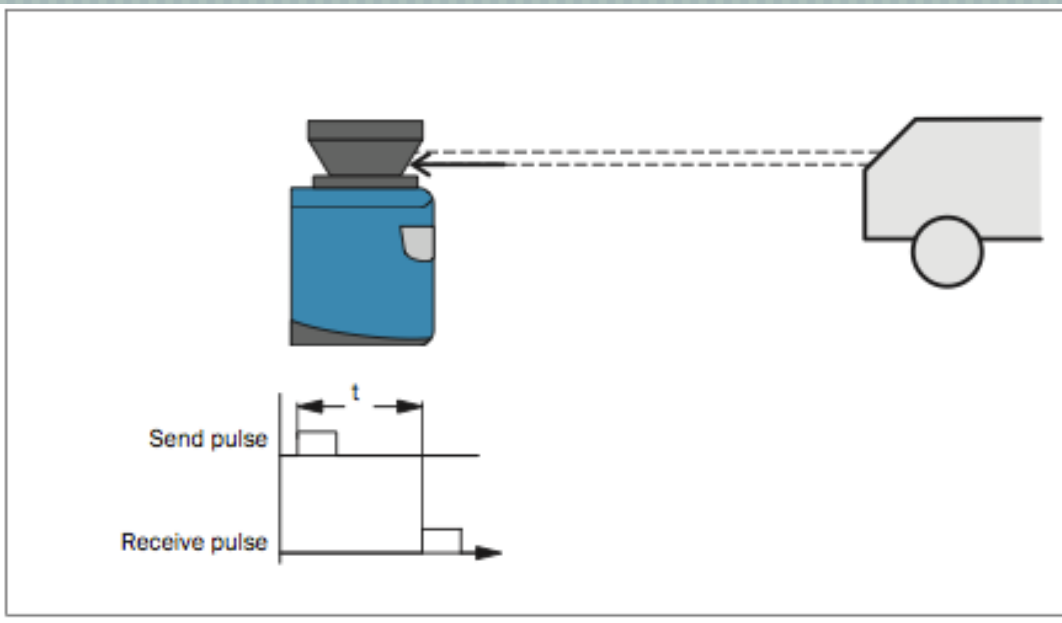
— [ Kinect

— [ Shadow

— [ Binocular Disparity  
System

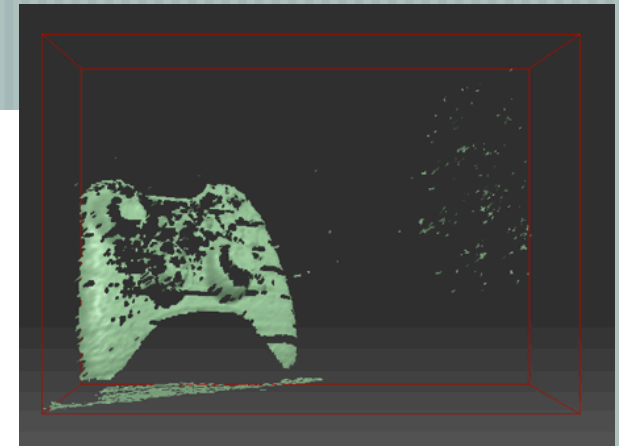
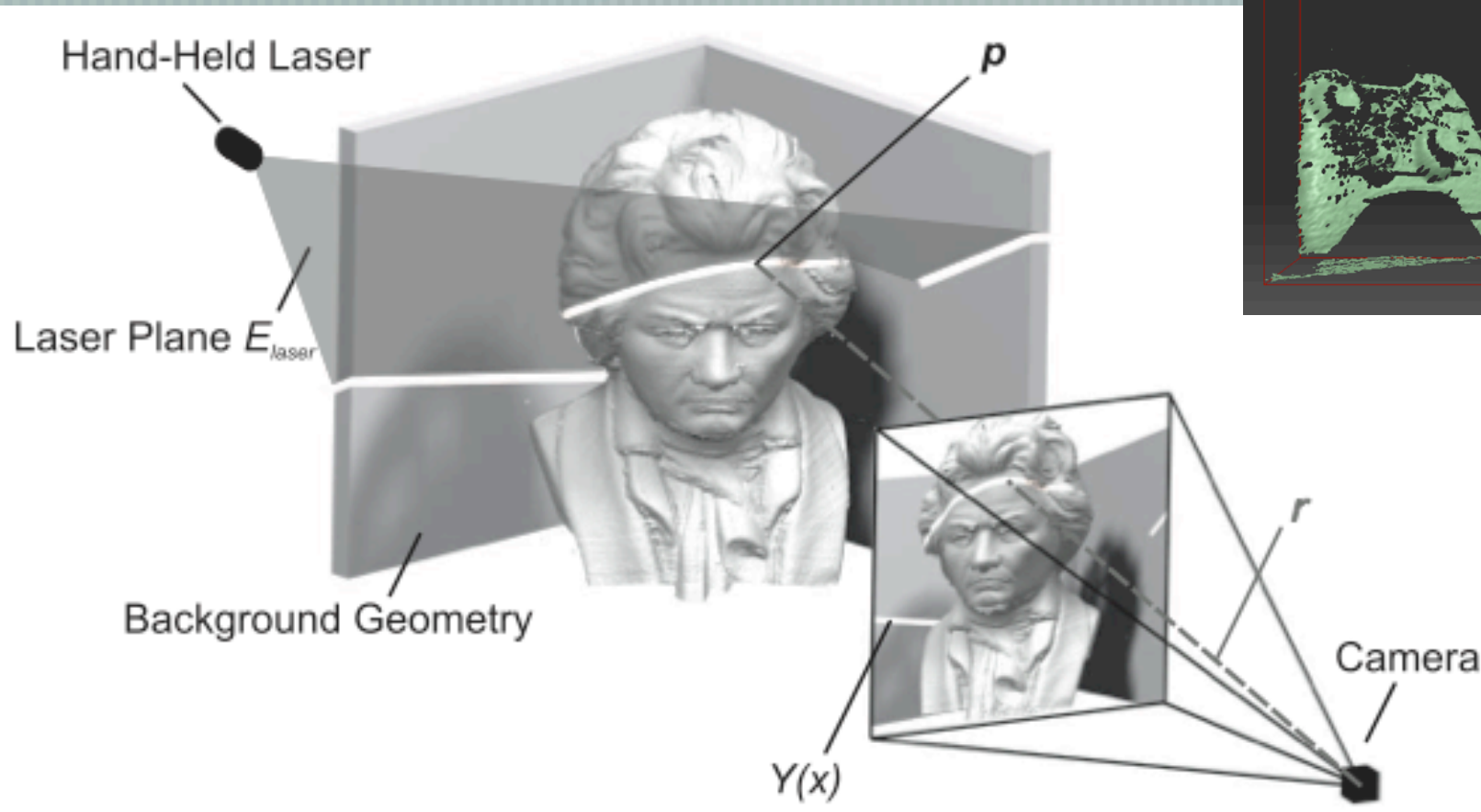
# LIDAR

(Time of Flight system)





# DAVID/Line Laser Scanner



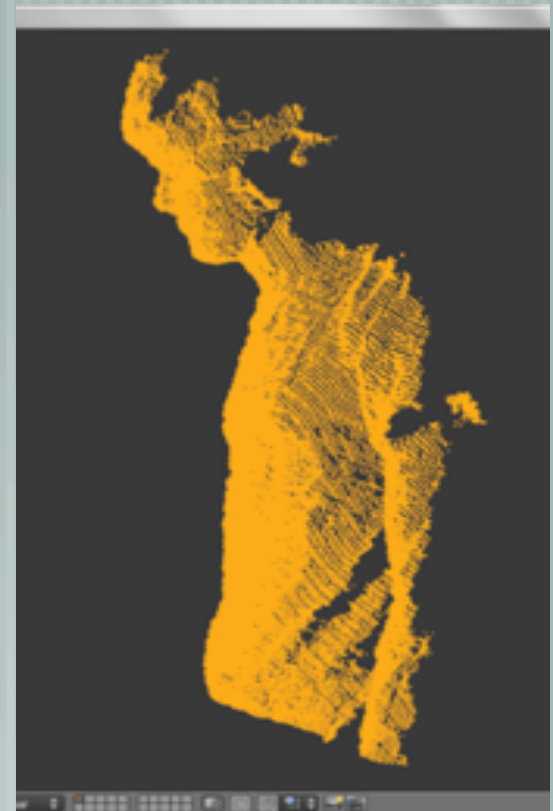
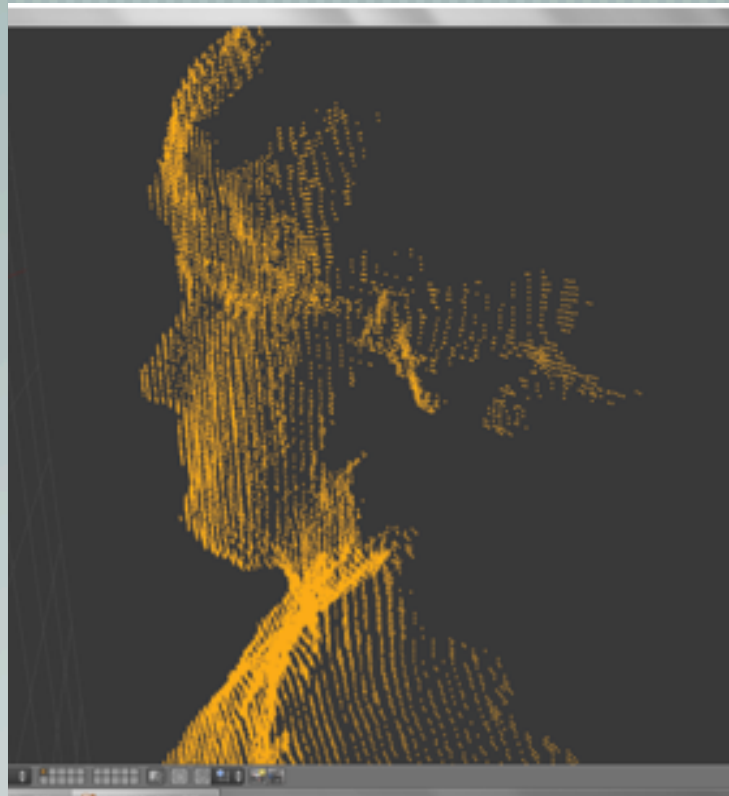
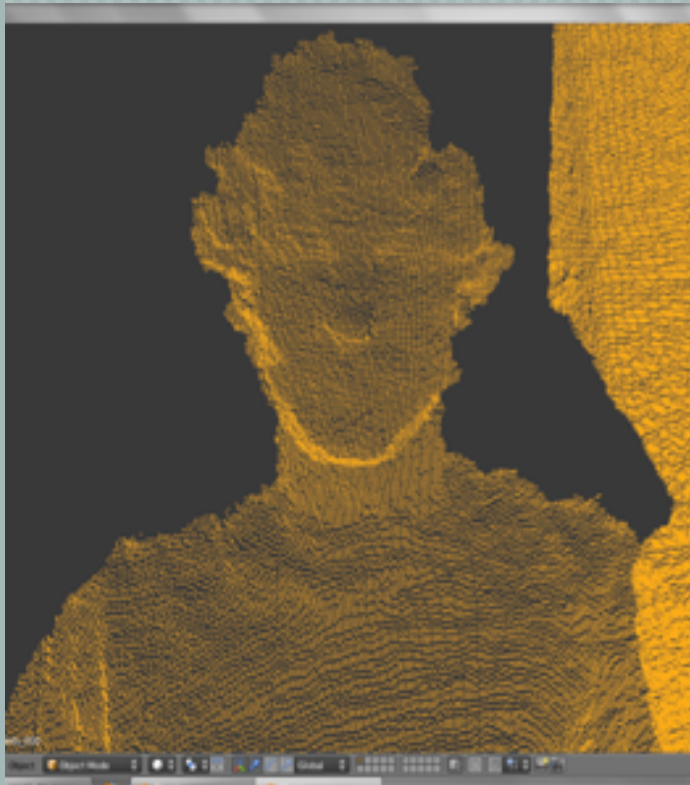
Winkelbac, Simon, Sven Molkenstruc, and Friedrich M. Wahl. "Low-Cost Laser Range Scanner and Fast Surface Registration Approach." Web. <<https://wiki.rit.edu/download/attachments/52792681/triangulation+and+the+dauid+laser+scanner.pdf?version=1&modificationDate=1320170864260>>.

# Structured Light Scanner

Creator/Contributor: Dave Nilosek

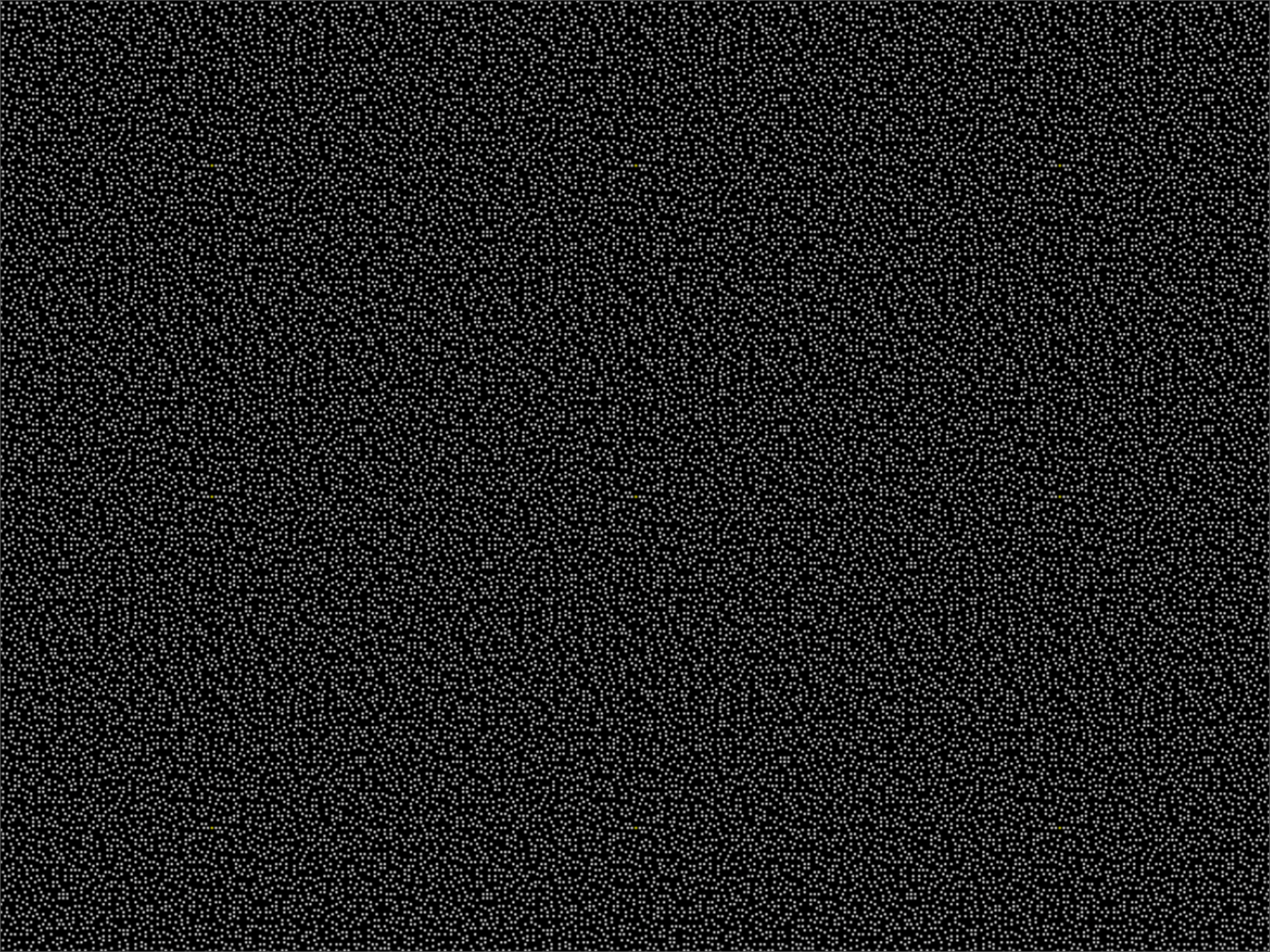


# Kinect



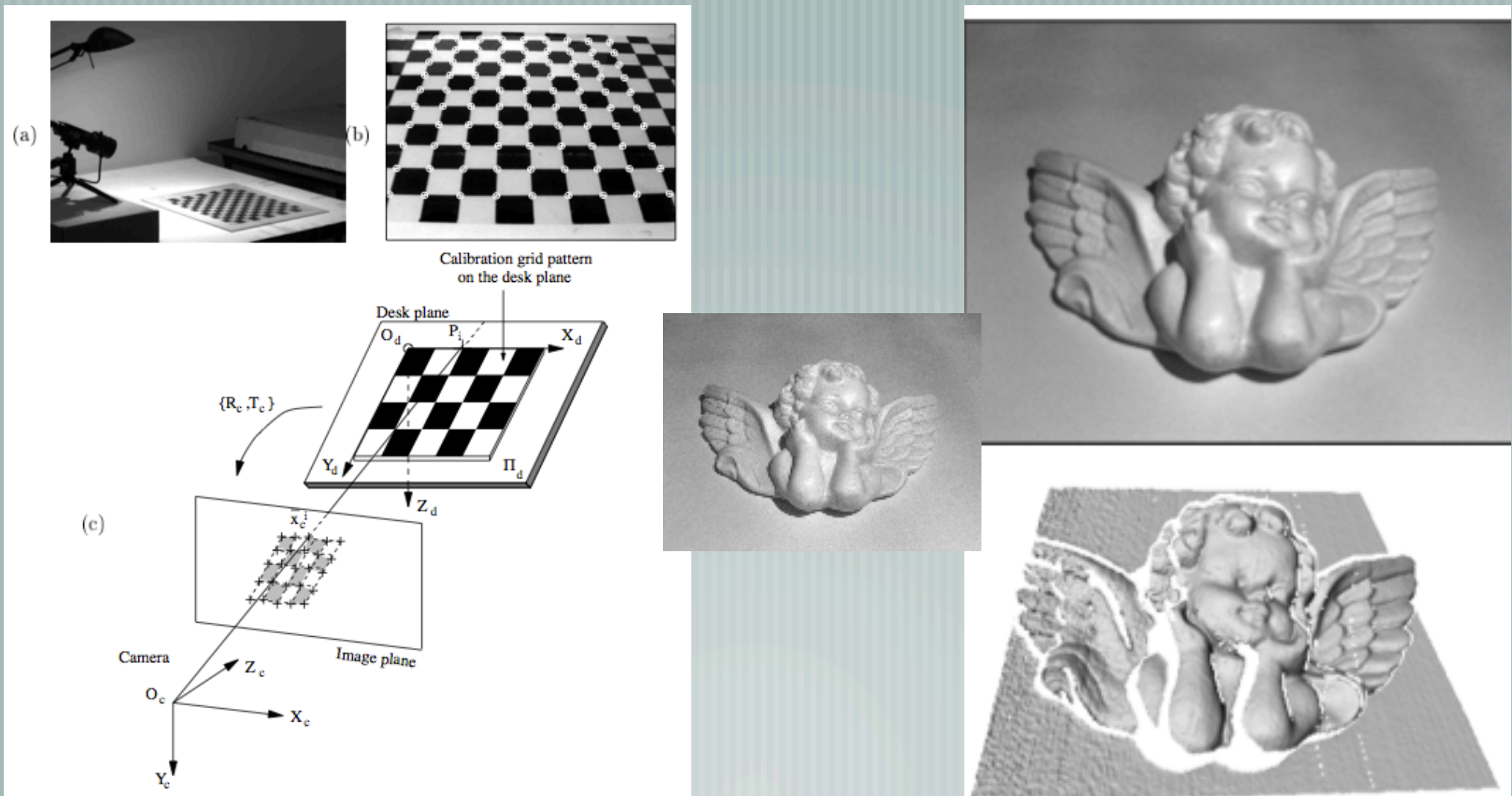
<http://www.dualshockers.com/2010/07/21/come-kinect-and-move-with-me-what-motion-gaming-means-for-mainstream-gamers/>





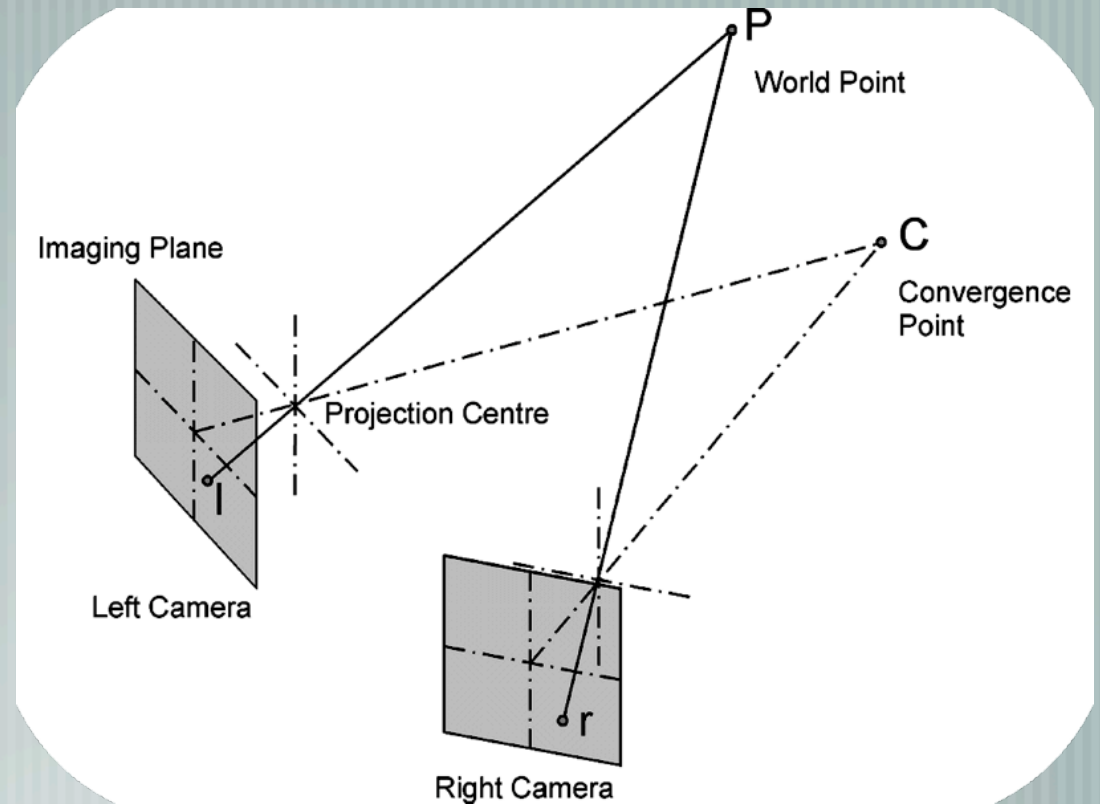


# Shadow Systems



[http://www.google.com/search?client=safari&rls=en&q=photometry+on+your+desk&ie=UTF-8&oe=UTF-8&sc=ps-psy-ab&hl=en&client=safari&rls=en&source=hp&q=desk+capture+angel&pbx=1&oq=desk+capture+angel&aq=f&aql=&aql=&gs\\_sm=e&gs\\_upl=42061211251012133013812615101012001329310.15.113110&bav=on.2,or\\_gc.r\\_pw,cf.osb&fp=e0c045c56ff39c1&biw=1180&bih=635](http://www.google.com/search?client=safari&rls=en&q=photometry+on+your+desk&ie=UTF-8&oe=UTF-8&sc=ps-psy-ab&hl=en&client=safari&rls=en&source=hp&q=desk+capture+angel&pbx=1&oq=desk+capture+angel&aq=f&aql=&aql=&gs_sm=e&gs_upl=42061211251012133013812615101012001329310.15.113110&bav=on.2,or_gc.r_pw,cf.osb&fp=e0c045c56ff39c1&biw=1180&bih=635)

# Binocular Disparity Systems



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# Future Plans

## Investigate viability of certain systems

- Kinect
- DAVID/Line Laser Scanner
- Structured Light Scanner (Visible/Infrared)
- Binocular Disparity
- Shadow

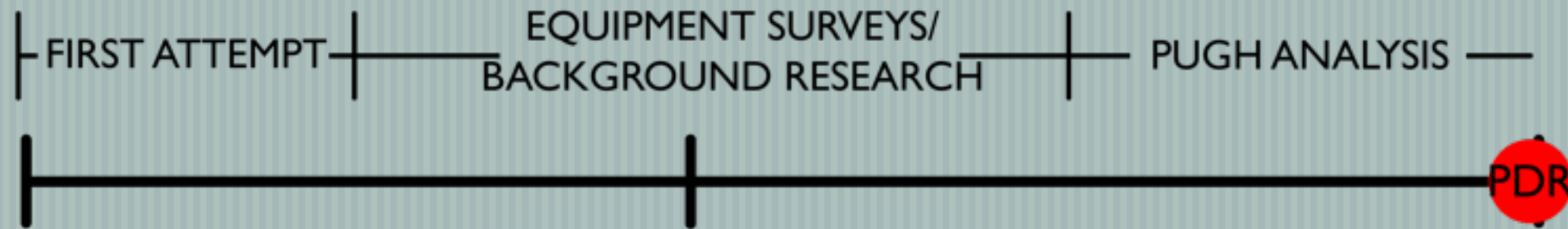
## Split into five groups

- 2-3 students per group
- Design & develop systems in parallel
- Assess systems through Pugh Analysis

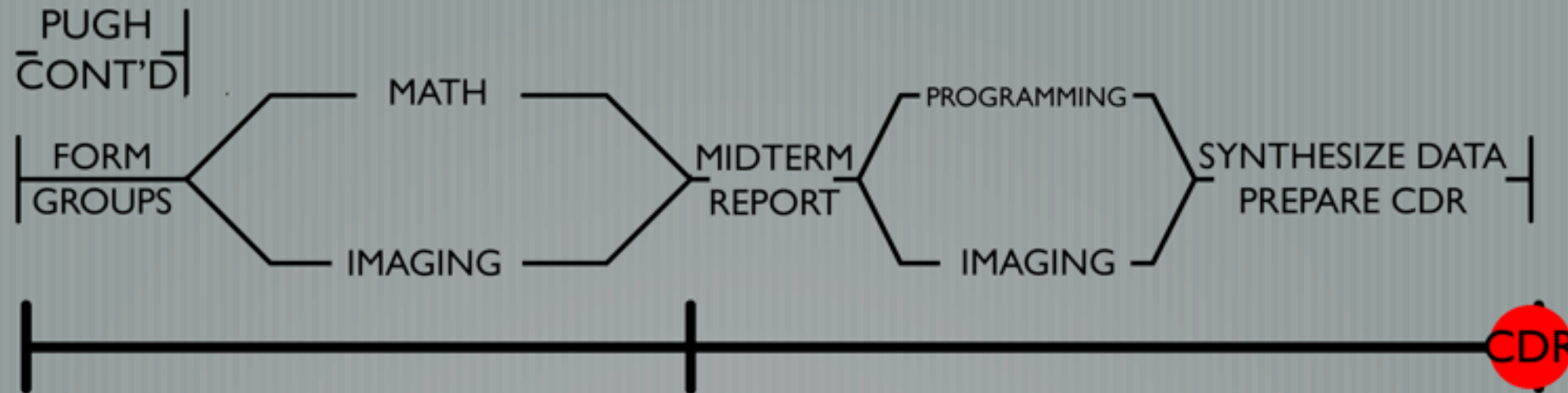


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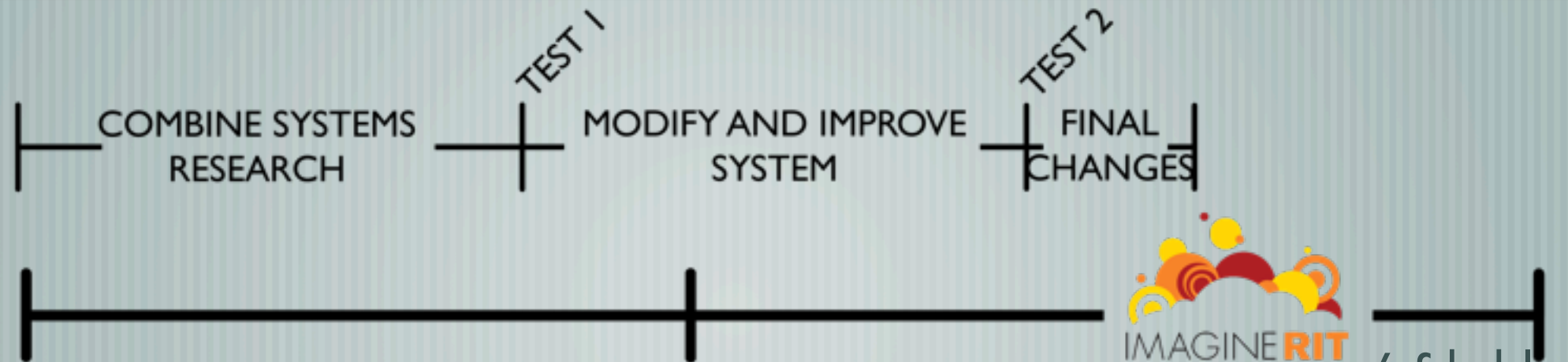
FALL



WINTER



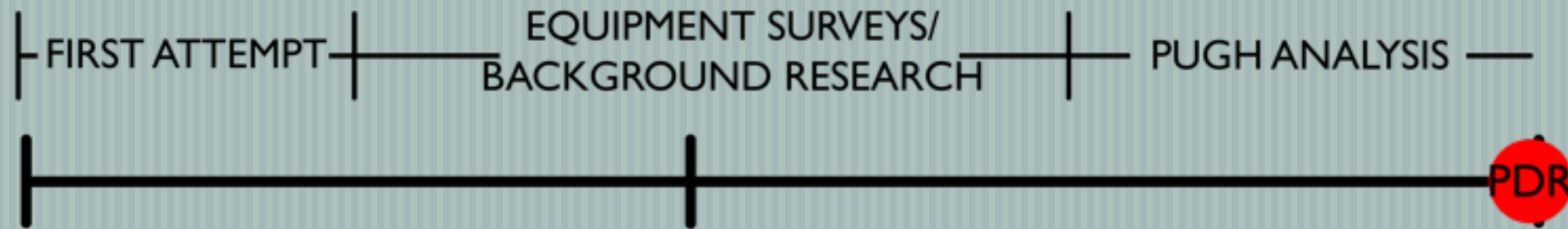
SPRING



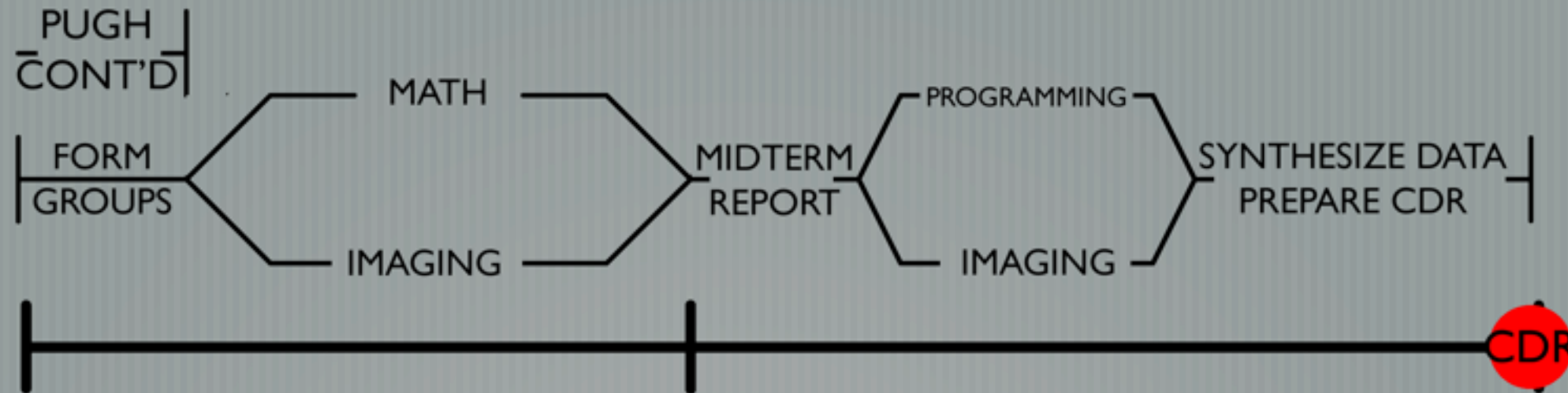
# Fall: Summary of Progress



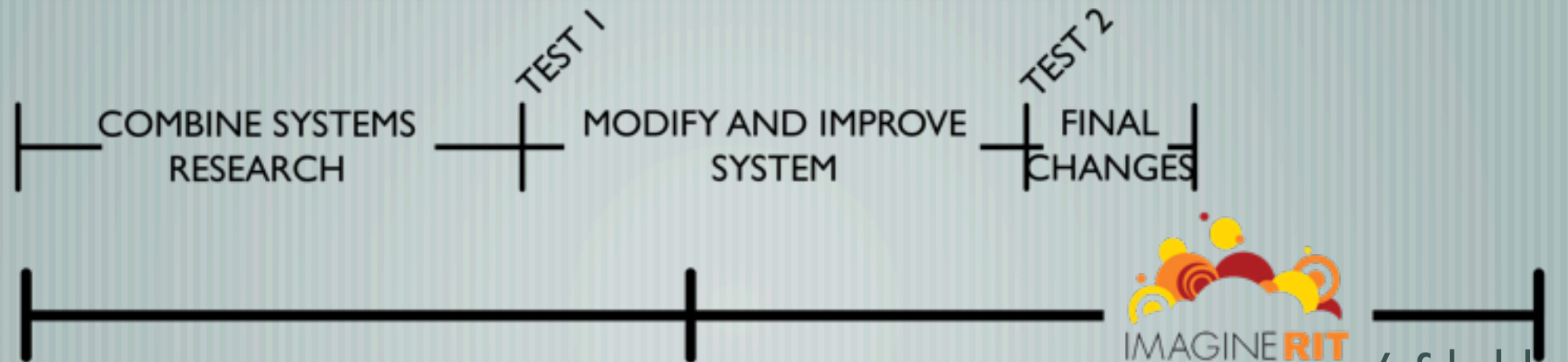
FALL



WINTER



SPRING



# Winter: New Student Integration

- [ Video scavenger hunt

- [ Wiki access

- [ Equipment surveys

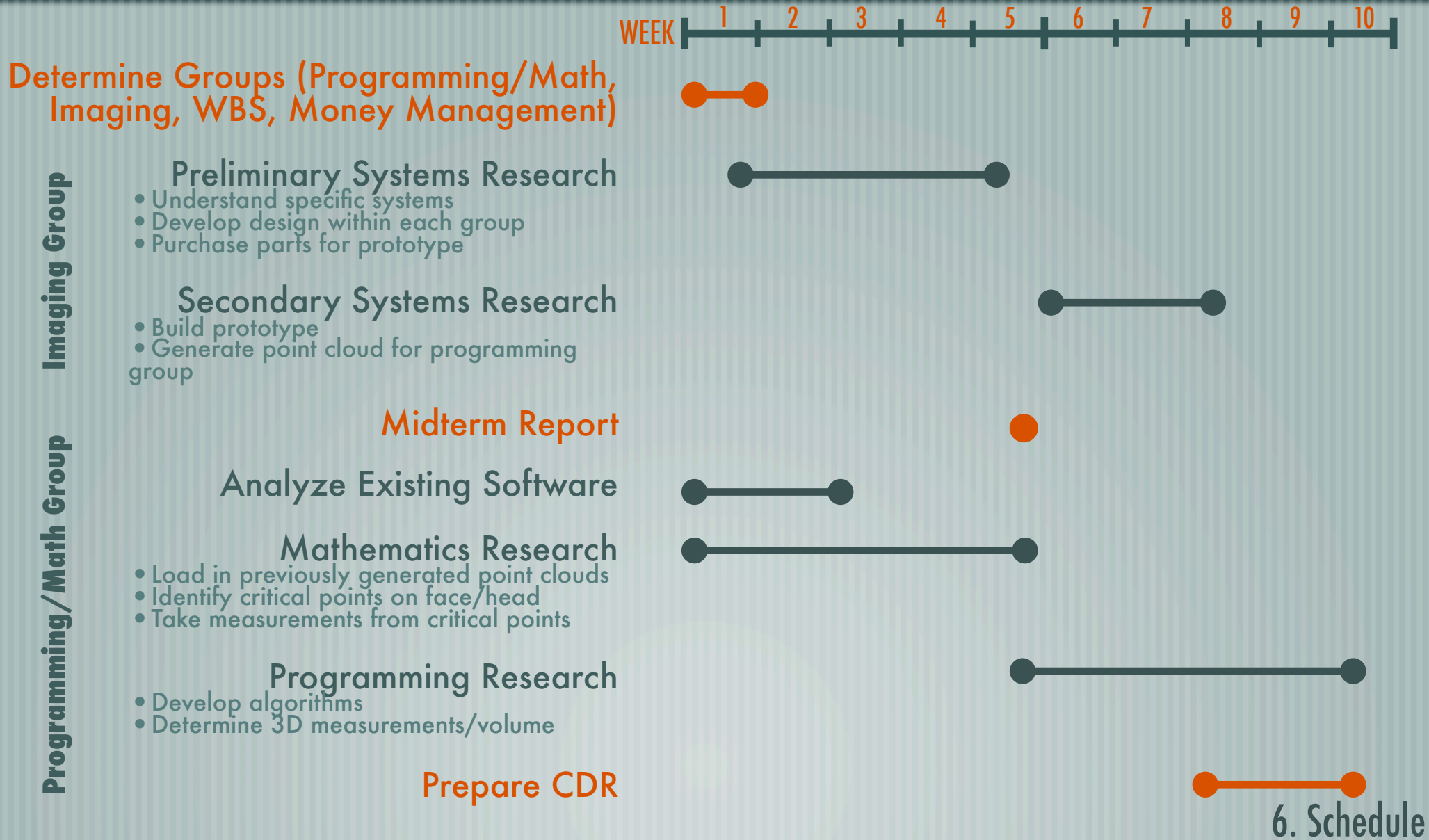
- Software

- Camera characterization

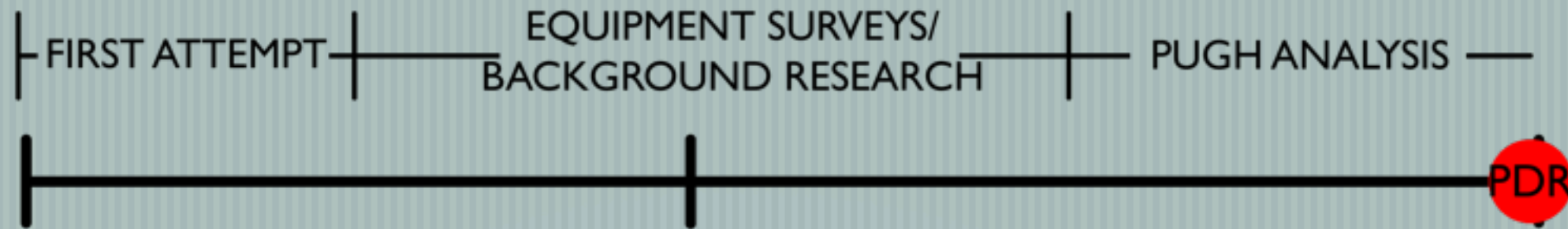
- Photosynth

- Polarization

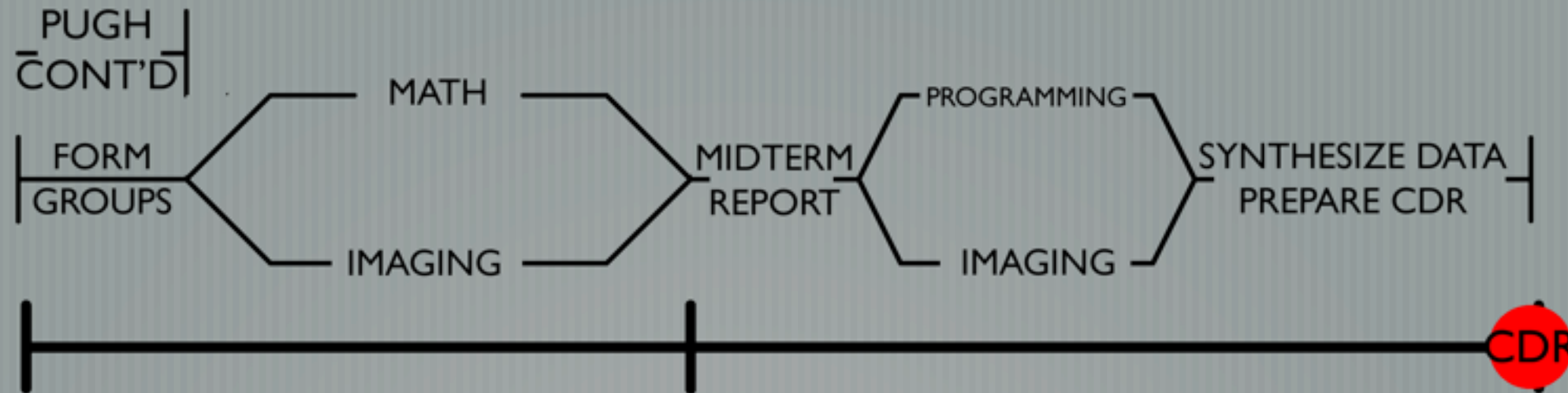
# Winter: Schedule



FALL



WINTER



SPRING

