# The Future of Sample-based Representations
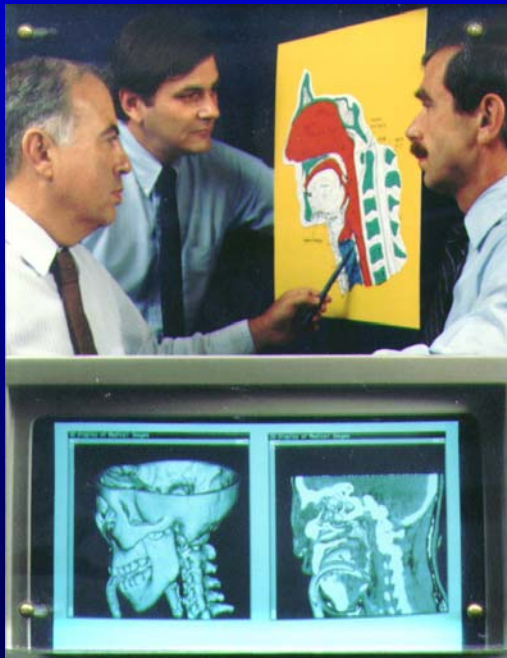
Bill Lorensen

GE Research

lorensen@crd.ge.com

# Sample-base Representations

- The Past
- The Future

# The Past

- **Dividing Cubes**
  - **Offshoot of Marching Cubes**
  - **Generates points from volumes**



H.E. Cline, W.E. Lorensen, S. Ludke, C.R. Crawford and B.C. Teeter, *Two algorithms for the three-dimensional reconstruction of tomograms*. Medical Physics, 15(3):320-327 (1988).

US4719585: Dividing cubes system and method for the display of surface structures contained within the interior region of a solid body

# Dividing Cubes – 1984-1992
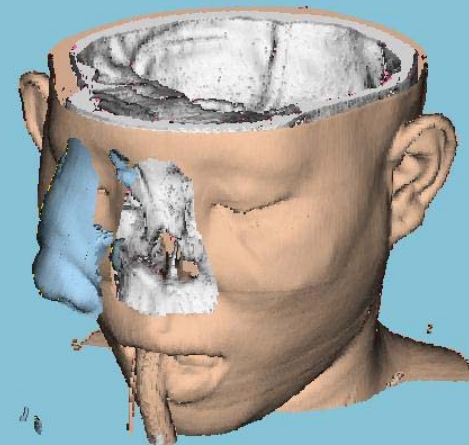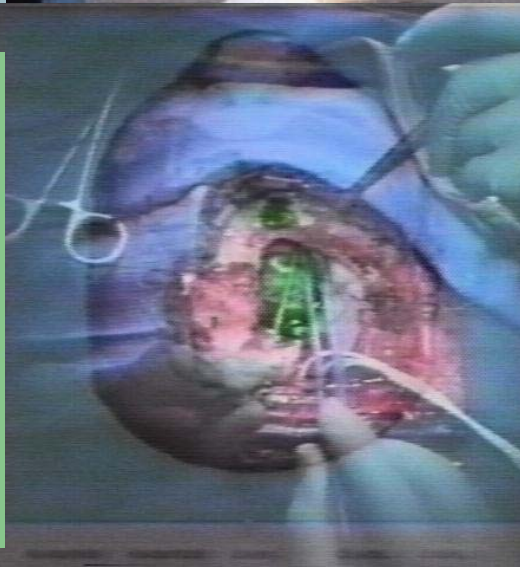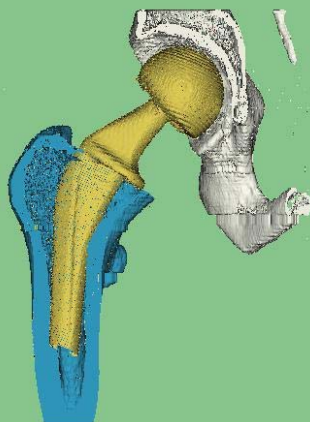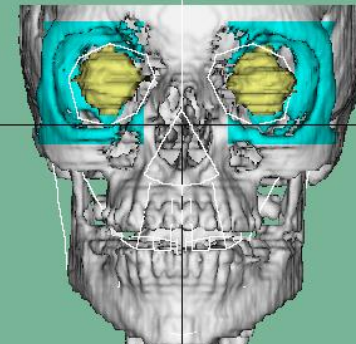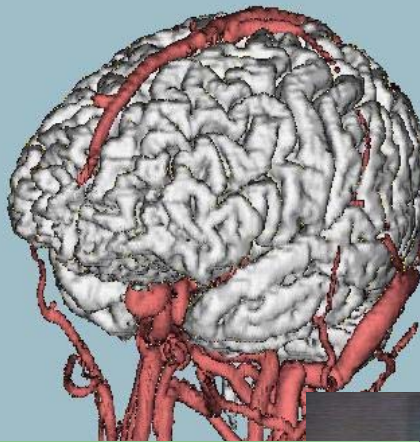
# Hardware Point Rendering - 1987

ISSCC 87 / FRIDAY, FEBRUARY 27, 1987 / RHINELANDER SOUTH / 10:45 A.M.

## SESSION XXII: SYSTEMS AND ARCHITECTURES

**FAM 22.4:** **30MHz Compiled Chip Set for Graphics Computations**

Sharbel E. Noujaim, Richard I. Hartley, Harvey E. Cline, Ronald T. Jerdonek, Siegwalt Ludke

General Electric Corporate Research and Development Center

Schenectady, NY

| | Interpolator | Normalizer |
|---|---|---|
| Technology | 1.25 CMOS | 1.25 CMOS |
| Transistor count | 15,000 | 35,000 |
| Chip size | 121 x 128mil$^2$ | 184 x 206mil$^2$ |
| Clock speed | 36MHz @ 25$^\circ$C | 30MHz @ 25$^\circ$C |
| | 40MHz @ 0$^\circ$C | 32MHz @ 0$^\circ$C |
| | 32MHz @ 70$^\circ$C | 28MHz @ 70$^\circ$C |
| Power dissipation | 150mW @ 30MHz | 400mW @ 30MHz |
| Design time | 4 hours | 2 days |
| I/O | TTL compatible | TTL compatible |

## Silicon Compiler

# Rotate Board - 1991
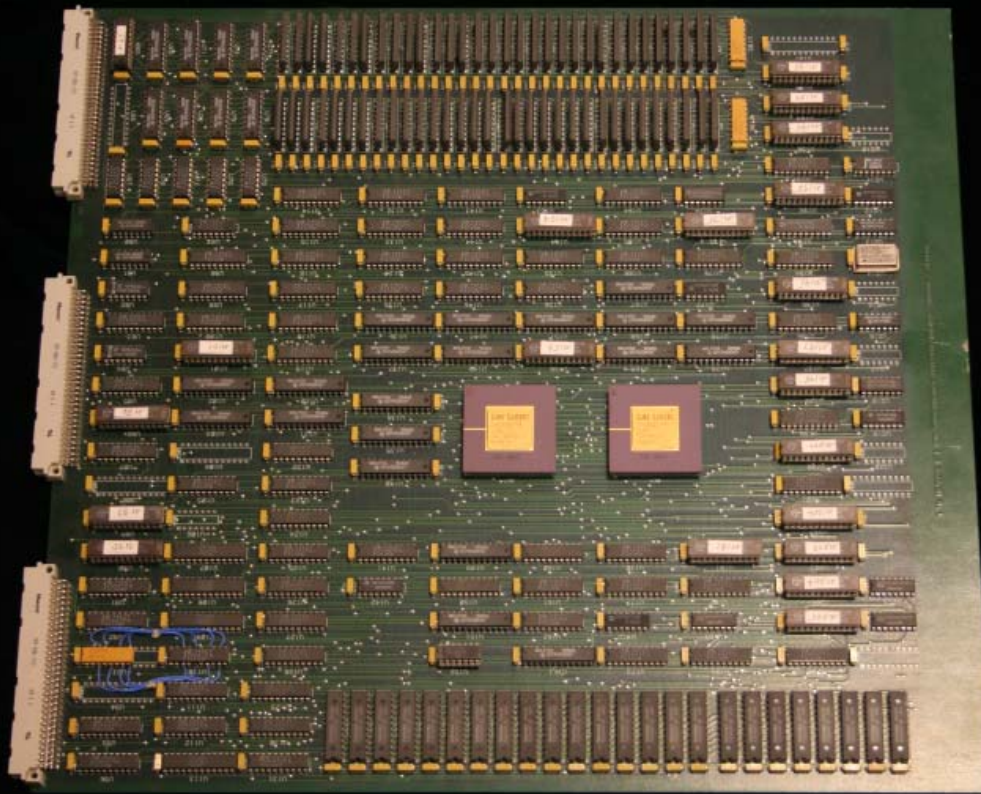


CLINE, H. E., LUDKE, S., LORENSEN, W. E., AND TEETER, B.C. 1990. A 3D medical imaging research workstation. In Volume Visualization Algorithms and Architectures, ACM SIGGRAPH'90 Course Notes, ACM, NY.
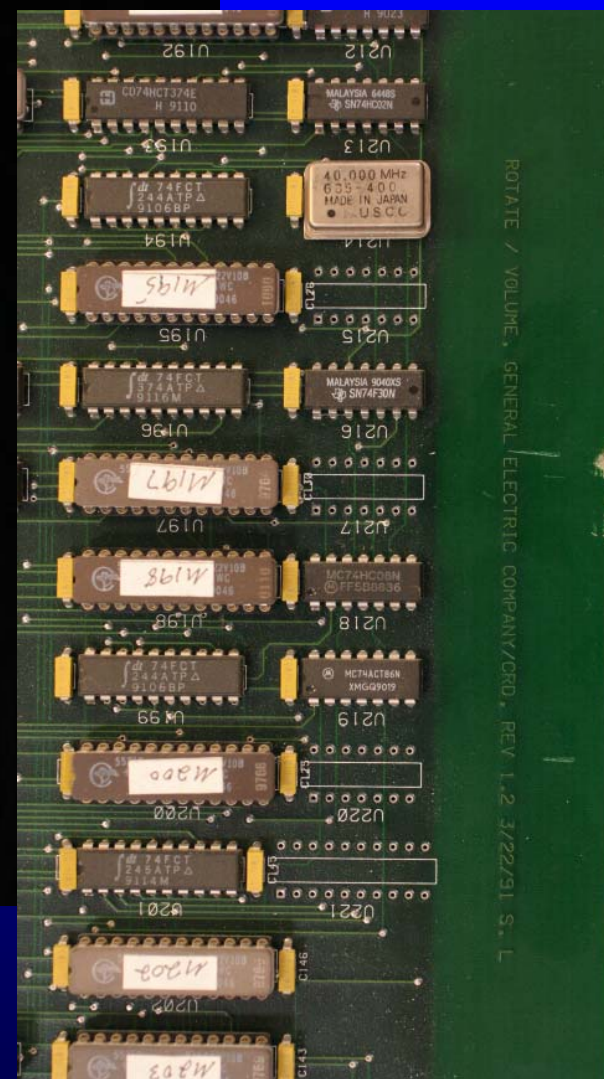
# The Future

- It's time to moving beyond pictures
- Scalar Volume Visualization is a commodity
- More image analysis and modeling

  *Computational Medicine*

# A few tough problems

- Integrating technology into workflow
- Integrating imaging with other information
- Handling massive, distributed datasets
- Detection / quantification
  - Screening
  - Drug trials
- Population studies
- Segmentation/Modeling

The Challenges of Interdisciplinary Communication

# Beyond Pixels

- Modern radiology scanners produce high resolution volumetric images
- Image analysis techniques segment tissues and organs
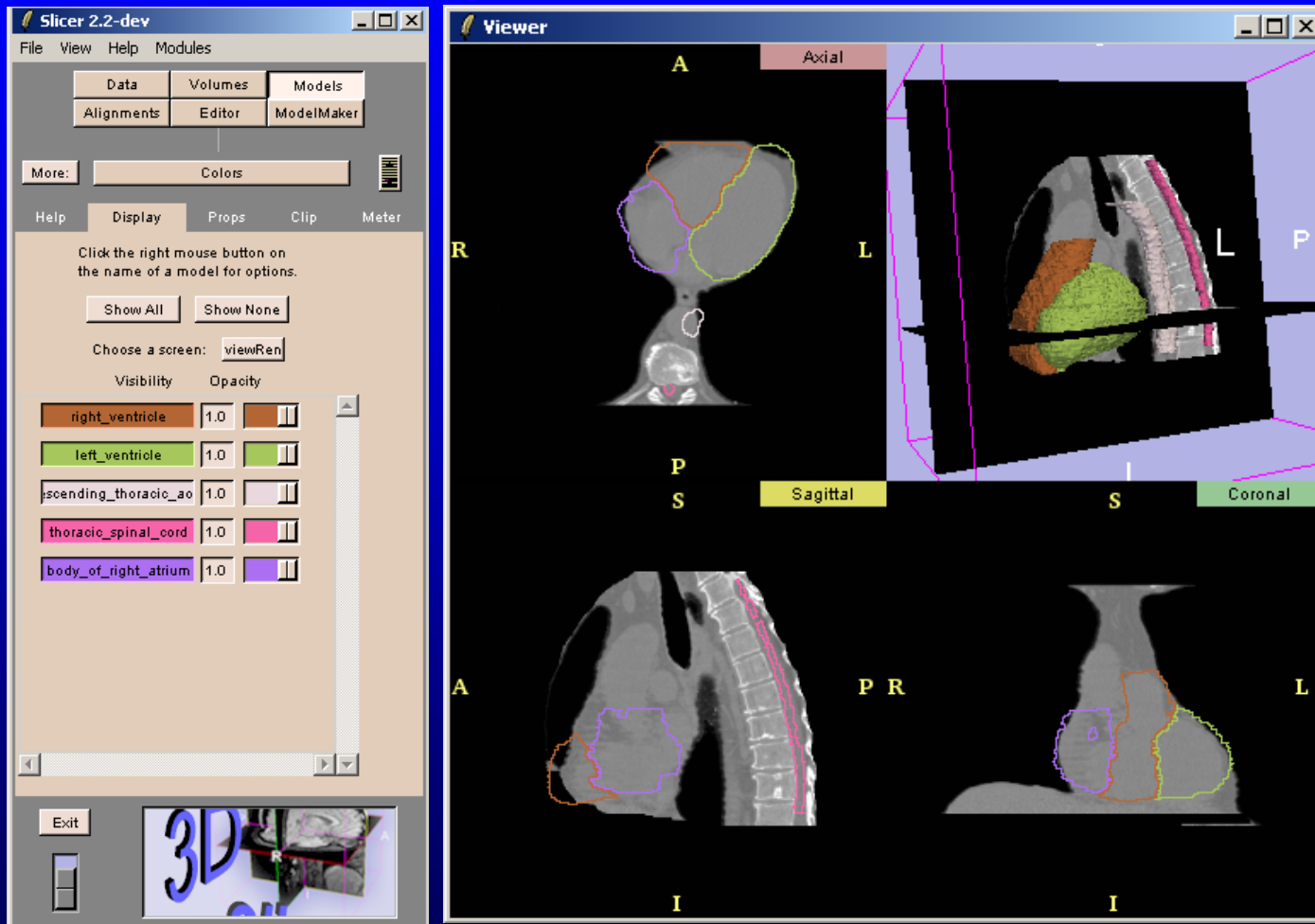- Ontologies relate segmented structures to anatomical knowledge

*Ontologies can provide the bridge between pixels and anatomy*

# Foundational Model of Anatomy
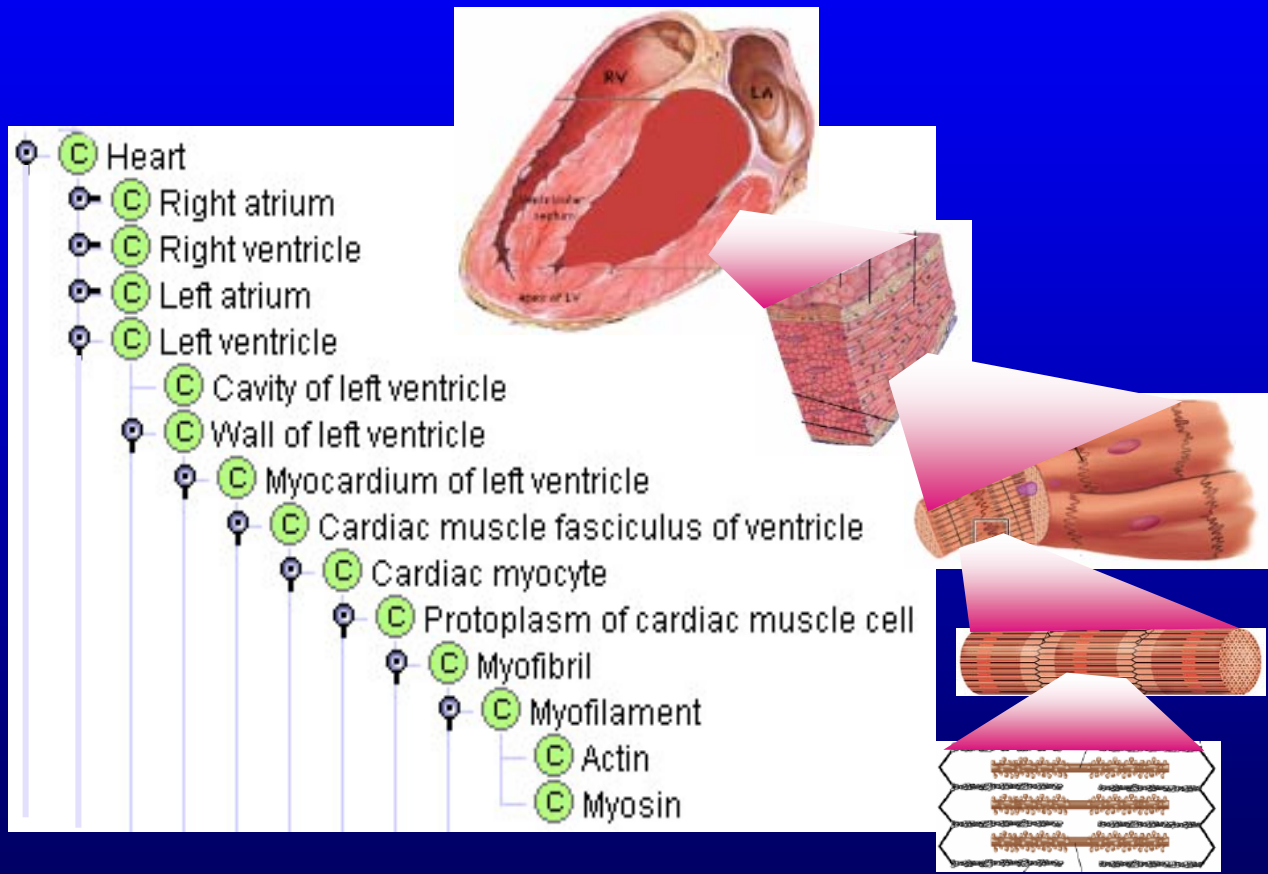


U Wash Foundational Model of Human Anatomy

# Atlas Registered to Novel CT Data



Volume Graphics 2006

# Implicit Anatomical Modeling
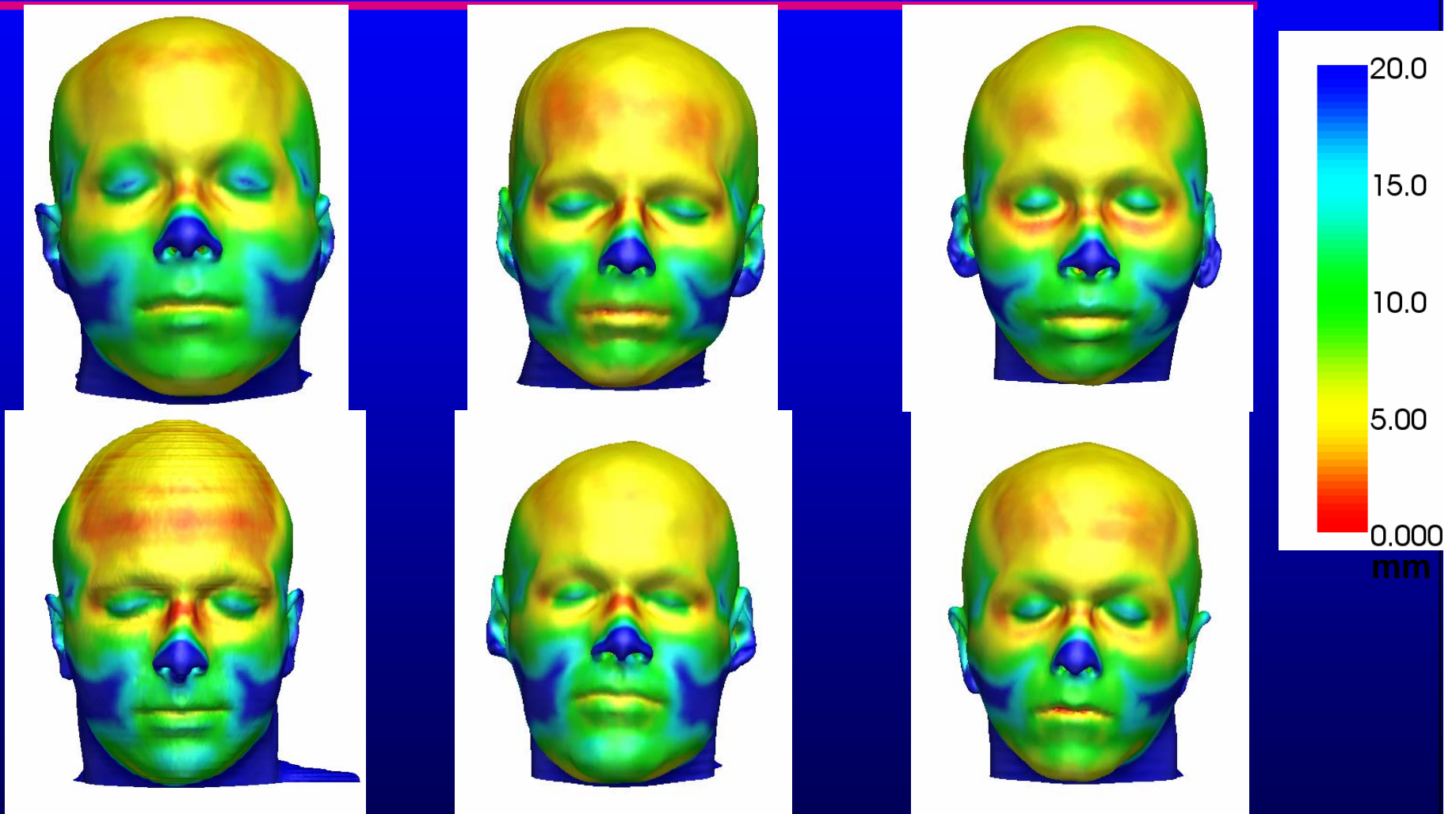


0 mm: right_ventricle

10 mm: left_ventricle

40 mm: left_atrium

81 mm: thoracic_esophagus

100 mm: esophageal_submucosa

102 mm: right_lower_lobe_of_lung

103 mm: azygos_vein

112 mm: mediastinum

113 mm: unknown

115 mm: intervertebral_disc_of_sixth_thoracic

119 mm: sixth_thoracic_vertebra

147 mm: unknown

168 mm: sixth_thoracic_vertebra

185 mm: muscle_of_back

205 mm: unknown

206 mm: rhomboid_major_muscle

212 mm: unknown

213 mm: trapezius_muscle

228 mm: unknown

230 mm: subcutaneous_tissue_of_trunk

235 mm: skin_of_trunk

241 mm: unknown

July 30, 2006

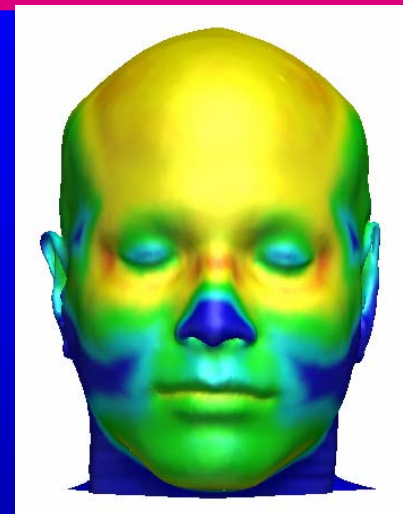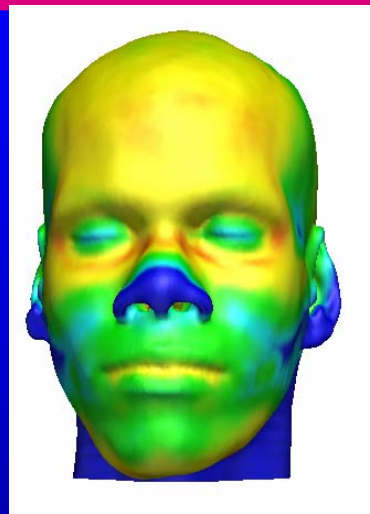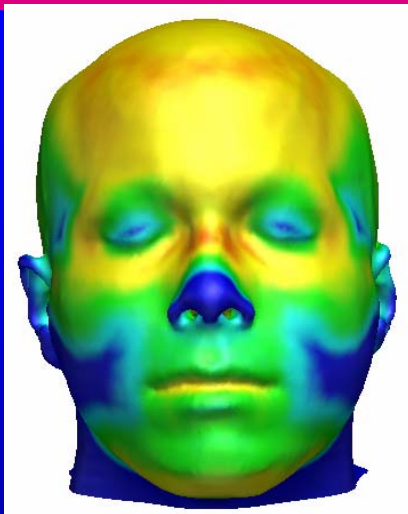# Dense Tissue Depth: Male, European-descent

*Subjects from the National forensic Facial Database*

# Dense Tissue Depth

European-descent   African-descent   Asian-descent

Male

Female

20.0

15.0

10.0

5.00

0.000
mm

Volume Graphics 2006   *Subjects from the National forensic Facial Database*   July 30, 2006
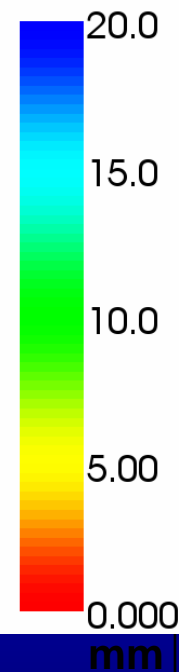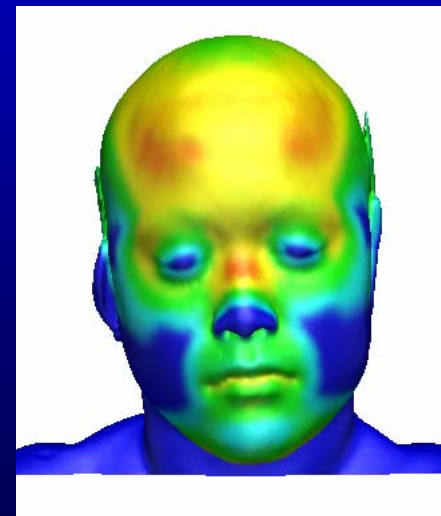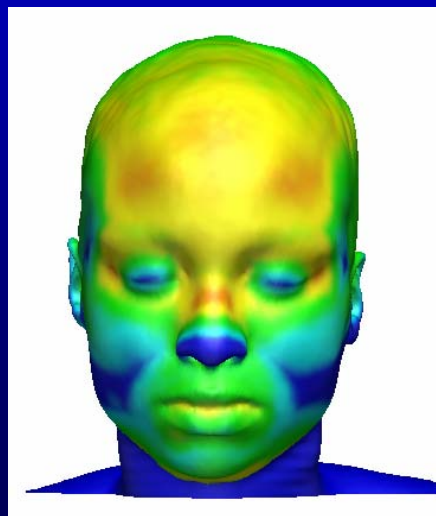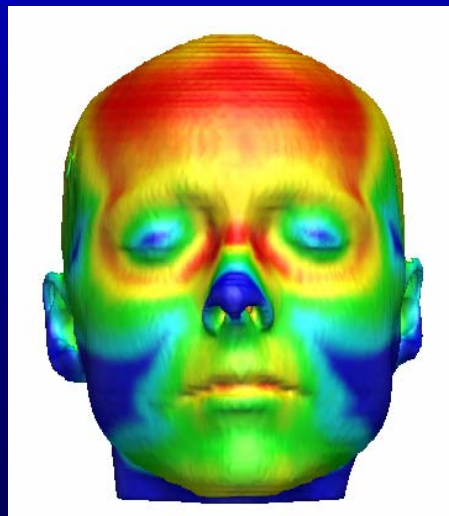
# Additional Reading

On the Death of
Visualization[1]

Can It Survive Without Customers?

Bill Lorensen

Google: "Death of Visualization

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