32nd Annual Plenary Meeting

Collaborating Toward Global Interoperability

October 1, 2018
HL7’s 32nd Annual Plenary Meeting  
October 1, 2018

Collaborating Toward Global Interoperability

8:30 – 8:45am  
**Welcoming Comments**  
*Charles Jaffe, MD, PhD*, CEO, Health Level Seven International

8:45 – 9:30am  
**Keynote Session 1: Update from the National Coordinator**  
*Donald Rucker, MD*, Office of the National Coordinator (ONC) for Health Information Technology, U.S. Department of Health and Human Services

9:30 – 10:15am  
**Keynote Session 2: A Payer’s Perspective to Interoperability**  
*Sagran Moodley*, Senior Vice President, UHC Clinical Data Services & Technology at UnitedHealth Group

10:15 – 10:45am  
**Break**

10:50 – 11:35am  
**Keynote Session 3:**  
*What is CIMI Up to, and How Does It Fit in?*  
*Stan Huff, MD*, Chief Medical Informatics Officer, Intermountain Healthcare

11:35 – 12:20pm  
**Keynote Session 4:**  
*Interactive 3D Visualization in the Wide Web of Health*  
*Nicholas Polys, PhD*, Director of Visual Computing at Virginia Tech

12:20 – 12:30pm  
**Closing Comments**  
*Calvin Beebe*, Chair, HL7 Board of Directors
Closing Comments

8:30 – 8:45 am

Charles Jaffe, MD, PhD
CEO, HL7 International
Keynote Session 1: Update from the National Coordinator

8:45 – 9:30 am

*****

Donald Rucker, MD
National Coordinator for Health Information Technology,
Office of the National Coordinator for Health IT (ONC),
U.S. Department of Health and Human Services
Dr. Don Rucker is the National Coordinator for Health Information Technology in the Office of the National Coordinator for Health IT (ONC). He came to the ONC from the Ohio State University, where he was Clinical Professor of Emergency Medicine and Biomedical Informatics and Premise Health, a worksite clinic provider, where he served as Chief Medical Officer.

Dr. Rucker started his informatics career at Datamedic Corporation, where he co-developed the world's first Microsoft Windows based electronic medical record. He then served as Chief Medical Officer at Siemens Healthcare USA. Dr. Rucker led the team that designed the computerized provider order entry workflow that, as installed at Cincinnati Children’s Hospital, won the 2003 HIMSS Nicholas Davies Award for the best hospital computer system in the US. Dr. Rucker has served terms on the Board of Commissioners of the Certification Commission for Healthcare Information Technology and Medicare’s Evidence Development and Coverage Advisory Committee (MEDCAC). He has extensive policy experience representing healthcare innovations before Congress, MedPAC and HHS.

He has practiced emergency medicine at Kaiser in California, Beth Israel Deaconess Medical Center in Boston (where he was the first full-time Emergency Department attending), the University of Pennsylvania’s Penn Presbyterian and Pennsylvania Hospitals and at Ohio State University’s Wexner Medical Center.

Dr. Rucker is a graduate of Harvard College and the University of Pennsylvania School of Medicine with board certifications in Emergency Medicine, Internal Medicine and Clinical Informatics. He holds an MS in Medical Computer Science and an MBA, both from Stanford.
Slides not available for Dr. Donald Rucker’s presentation.
Keynote Session 2: A Payer’s Perspective to Interoperability

9:30 – 10:15 am

Sagran Moodley
Senior Vice President, UHC Clinical Data Services & Technology, UnitedHealth Group
Sagran Moodley serves as Senior Vice President of Clinical Data Services & Technology for UnitedHealthcare’s Clinical Services organization. In this role, he is responsible for clinical data acquisition for all members across UnitedHealthcare’s Medicare, Medicaid and Commercial lines of business.

Sagran has more than 20 years leading transformative health care IT and business initiatives in both the public and private sectors. He has held multiple senior leadership roles in the private sector, including positions across UnitedHealthcare and Optum. Most recently, Sagran led teams focused on defining clinical infrastructure capabilities to enable clinical care coordination and complex case management both for Optum and United HealthCare stakeholders. Additionally, Sagran led product initiatives for Optum Government, where his portfolio included large-scale solutions supporting health care operations, data warehousing and analytics, program integrity, quality improvement, provider data management and population health for state Medicaid enterprises.

In the public sector, he has worked closely with state governments to lead the promotion and adoption of the Health Information Technology for Economic and Clinical Health (HITECH) Act and many other large-scale IT implementations at the state level. Notably, Sagran assumed the technology implementation that contributed to the successful turnaround of the Massachusetts Affordable Health Care (ACA) Exchange, bringing the Commonwealth’s ACA transition back on track.

Previously, Sagran served as Chief Delivery Officer at Coventry Healthcare in 2009, where he led Medicaid operations in a number of states. With Coventry, his oversight included Pharmacy Benefit Management and Behavioral Health, in addition to the Medicaid Management Information System (MMIS) fiscal agent scope of services. Additionally, he held a senior IT leadership role at Allen Systems group, the largest independent software vendor at the time, where he had worldwide leadership responsibility for software engineering across North America, EMEA, APAC, and Central and South America.
Slides not available for Sagran Moodley’s presentation.
HL7 Plenary Meeting Notes:
Keynote Session 3: What Is CIMI Up To And How Does It Fit In?

10:50 – 11:35 am

*****

Stan Huff, MD
Chief Medical Informatics Officer,
Intermountain Healthcare
Stan Huff, MD, currently serves as the Chief Medical Informatics Officer at Intermountain Healthcare. Intermountain Healthcare is a charitable not-for-profit healthcare organization in the intermountain west that includes 22 hospitals, numerous primary care and specialty clinics, and a health plans (health insurance) division. Dr. Huff is responsible for the architecture and strategy for clinical information systems. He is board certified in clinical pathology.

Dr. Huff has been a professor (clinical) in Bioinformatics at the University Of Utah School Of Medicine since 1987, where he also currently serves as an adjunct professor of nursing. His expertise is in the following areas: medical information representation in database systems; standards for the exchange of data between medical computer systems, including HL7, Logical Observation Identifiers Names and Codes (LOINC), and SNOMED CT; as well as Electronic Medical Record architecture and design.

Dr. Huff received his BS degree in Chemistry from Brigham Young University and a MD degree from the University of Utah. He completed a year of Internal Medicine residency training at the University of New Mexico before completing a residency in Clinical Pathology at the University of Utah. Immediately after completing his residency training, Dr. Huff worked for two years with AT&T Bell Laboratories in Columbus, Ohio. Since that then he has held various positions at Intermountain Healthcare and the University of Utah.

Dr. Huff has been a member of HL7 since 1995 and served as the board chair from 2000-2001 and again from 2014-2015. He received the HL7 Fellowship Award in 2010. Dr. Huff also serves as the board chair for both the FHIR Foundation and the Healthcare Services Platform Consortium (HSPC). He is currently a fellow of the American College of Medical Informatics and a co-chair of the HL7 Clinical Information Modeling Initiative (CIMI) Work Group. He was also a founding member of the LOINC committee and is the current co-chair of the Clinical LOINC committee.
What is CIMI up to, and how does it fit in?

Stanley M. Huff, MD  
CMIO Intermountain Healthcare  
Chair of the Board HSPC  
Chair of the Board FHIR Foundation
Why?

“To help people live the healthiest lives possible.”
Why Interoperability?

- Improve the quality and safety of care
- Decrease the cost of care
- Enable a Learning Health System
- Make providers happier and more effective
- Make patients happier and healthier
- There are many more reasons...
‘The complexity of modern medicine exceeds the inherent limitations of the unaided human mind.’

~ David M. Eddy, MD, Ph.D.

‘... man is not perfectible. There are limits to man’s capabilities as an information processor that assure the occurrence of random errors in his activities.’

~ Clement J. McDonald, MD
We can't keep up!

- We have ~150 decision support rules or modules
- We have picked the low hanging fruit
- There is a need to have 5,000+ decision support rules or modules
- There is no path from 150 to get to 5,000 unless we fundamentally change the ecosystem
- There is no scalable path from the leading institutions to community hospitals
Eileen
### Table 1

Studies on US death rates from medical error since the 1999 IOM report and point estimate from pooled results

<table>
<thead>
<tr>
<th>Study</th>
<th>Dates covered</th>
<th>Source of information</th>
<th>Patient admissions</th>
<th>Adverse event rate (%)</th>
<th>Lethal adverse event rate (%)</th>
<th>% of events deemed preventable</th>
<th>No of deaths due to preventable adverse event</th>
<th>% of admissions with a preventable lethal adverse event</th>
<th>Extrapolation to 2013 US admissions†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Grades¹¹</td>
<td>2000-02</td>
<td>Medicare patients</td>
<td>37 000 000</td>
<td>3.1</td>
<td>0.7*</td>
<td>NR</td>
<td>389 576</td>
<td>0.71</td>
<td>251 454</td>
</tr>
<tr>
<td>Office of Inspector General¹²</td>
<td>2008</td>
<td>Medicare patients</td>
<td>838</td>
<td>13.5</td>
<td>1.4</td>
<td>44</td>
<td>12</td>
<td>0.62</td>
<td>219 579</td>
</tr>
<tr>
<td>Classen et al³³</td>
<td>2004</td>
<td>3 tertiary care hospitals</td>
<td>795</td>
<td>33.2</td>
<td>1.1</td>
<td>100</td>
<td>9</td>
<td>1.13</td>
<td>400 201</td>
</tr>
<tr>
<td>Landrigan et al¹⁴</td>
<td>2002-07</td>
<td>10 hospitals in North Carolina</td>
<td>2341</td>
<td>18.1</td>
<td>0.6</td>
<td>63</td>
<td>14</td>
<td>0.38</td>
<td>134 581</td>
</tr>
<tr>
<td>Point estimate from all data</td>
<td>2000-08</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.71</td>
</tr>
</tbody>
</table>

~251,454 deaths /year during inpatient admissions.

**BMJ May 2016**
What is the vision for the future?
May 2011

- HL7 WG Meeting Orlando
  - Fast Healthcare Interoperability Resources (FHIR) – (HL7 v4?)
  - Clinical Information Modeling Initiative (CIMI)
    - Improve the interoperability of healthcare systems through shared implementable clinical information models.
SMART on FHIR® – Open Platform Architecture

- Heterogeneous Systems
- OAuth
- FHIR Profiles from CIMI detailed clinical models
- REST API
- SOA Orchestration
- mHealth
- Web Apps

Real Impact
- Occult sepsis
- Community Acquired Pneumonia
- Pulmonary Embolus
- ICU Glucose
- Ventilator management

http://smartplatforms.org/smart-on-fhir/

Others...
Our end user is someone who makes this stuff work. ... But what is this end-user looking for? We kind of made a gambit statement that we *could* define a world in which point to point mapping wouldn't be required. I think we showed that:

(a) that's not possible - all uses of V3 I've seen, ... have use case specific processing

(b) Users are increasingly telling us that they don't care. The price of this consistent semantics is higher than they'd pay *even if* we solved the consistent semantics problem. Instead, they want ad-hoc wire forms that are close to their domain use cases. ...

So. Is that right? Does it ring bells for anyone else? Am I saying that we shouldn't try for plug-and-play?
“We have definite goals to enable plug and play globally for some kinds of uses in some kinds of contexts - mostly infrastructure/exchange, and read-only access to summary information. But we remain true to the [previous] vision you quote when it comes to actual workflow; adaptation will always be required.”
Partial Interoperability

Application and User

Standard Structure (Non-standard codes)

Structure Translators

Local databases, Cerner, Epic, Allscripts, etc.

Partial Interoperability
Preferred Strategy – Full Interoperability

Application and User

Standard Structure
AND Standard Terms
(As defined by CIMI Models)

Term and Structure Translators

Local databases, Cerner, Epic, Allscripts, etc.

Application

Requirements
What does CIMI do?
How does CIMI fit in?
Healthcare Services Platform Consortium

Improve health by creating a vibrant, open ecosystem of interoperable applications, content, and services

HSPC is wholly dependent on CIMI for models

Clinical Information Interoperability Council

Improve health by creating a vibrant, open ecosystem of interoperable applications, content, and services

CIIC supplies detailed clinical knowledge to CIMI
## August 2018 CIIC meeting at NLM

<table>
<thead>
<tr>
<th>Clinical Societies</th>
<th>Providers</th>
<th>Government</th>
<th>Standards</th>
<th>Vendors</th>
<th>Consultants</th>
<th>Academic</th>
<th>NGOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACOG</td>
<td>Intermountain Brigham</td>
<td>AHRQ</td>
<td>CDISC</td>
<td>Api Focal</td>
<td>Centri Health</td>
<td>Duke</td>
<td>OSEHRA</td>
</tr>
<tr>
<td>AAFP</td>
<td></td>
<td>CMS</td>
<td>HL7</td>
<td>Care Progress</td>
<td>Constable</td>
<td>LSU</td>
<td>Mitre</td>
</tr>
<tr>
<td>ACC</td>
<td></td>
<td>FDA</td>
<td>Open Group</td>
<td>Cognitive</td>
<td>Deloitte</td>
<td>NYU</td>
<td>PCPI</td>
</tr>
<tr>
<td>ACS</td>
<td></td>
<td>NIDDK</td>
<td></td>
<td>Evidence Care</td>
<td>Hi3 Solutions</td>
<td>U of Utah</td>
<td>Sequoia</td>
</tr>
<tr>
<td>ACP</td>
<td></td>
<td>NLM</td>
<td></td>
<td>Wolters Kluwer</td>
<td>JP Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMA</td>
<td></td>
<td>ONC</td>
<td></td>
<td>Intersystems</td>
<td>MD Partners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASCO</td>
<td></td>
<td>VA</td>
<td></td>
<td>Medical</td>
<td>Parexcel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGIM</td>
<td></td>
<td></td>
<td></td>
<td>Algorithms</td>
<td>Perspecta</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nuance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Optum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oracle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PenRad</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Siemens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HSPC/CIIC
Tasks for Clinical Experts

- What data should be collected? (part of domain analysis)
  - It will be different for different situations
  - Sherlock Holmes, “Data! Data! Data!” he cried impatiently. “I can’t make bricks without clay.”

- How should the data be modelled? (CIMI)
  - Two fields or one (the degree of pre and post coordination)

- What does the data mean?
  - How do we make computable definitions for diabetes mellitus, myocardial infarction, heart failure, chronic renal failure, etc.
Coordinating CIMI work at HL7

- CIMI works with HL7 Domain WGs to establish high level classes, patterns
- CIMI works with professional societies and clinical experts to define detailed model content
- CIMI works with FHIR Infrastructure to determine that the FHIR profiles created from CIMI models are technically correct
How do CIMI/HSPC/CIIC relate to other interoperability activities?

- **Argonauts**
  - We build on the HL7 FHIR profiles that the Argonauts create

- **Sequoia**
  - We depend on Sequoia to create the network, trust agreements, and data exchange infrastructure

- **SMART**
  - We depend on SMART for integration into EHRs

- **HL7**
  - FHIR – the approved API for sharing patient data
  - CIMI – provides the detailed information models that are essential for interoperability

- **Federal Health Information Model (FHIM)**
  - We use FHIM classes as the pattern for CIMI models

- **SOLOR**
  - SOLOR is the source of coded concepts used in CIMI models

- **NLM Value Set Authority Center (VSAC)**
  - We are aligning and placing SOLOR refsets in VSAC

- **SDOs (OMG, NCPDP, X12, ISO, CEN)**
  - We use their standards whenever possible

- **Commonwell, Center for Medical Interoperability, AMA Integrated Health Model Initiative, CDEs, openEHR, OMOP (OHDSI)**
  - We want to work together as partners with all groups with whom we have overlapping interests
Invariant Profile Structure – CIMI Leaf Node Content
Interoperability Pyramid

- HL7 Version 2 Compliance
- HL7 FHIR Compliance
- Argonaut Compliance
- CIMI (HSPC) Compliance

- Structure, No terminology Constraints
- Structure(s), Generic LOINC
- Common resources, extensions and some specific LOINC and SNOMED
- Preferred structure, standard extensions, explicit LOINC and SNOMED, units, magnitude, ...
Current and planned HSPC/CIIC projects that need CIMI models

- ACOG - OPA Family Planning
- FDA – Women’s Health Registry
- Cancer Interoperability
- Registries on FHIR
- Pain Assessment
- Occupational Health Data
- Common Data Elements (Pew Trust)
- Standard laboratory test results
- More …
Thank you

stan.huff@imail.org

@HSPConsortium

#HSPCIImplementersForum
Clinical Information Interoperability Council

Working specifically with professional organizations
- American College of Surgeons
- American College of Obstetricians and Gynecologists
- American College of Cardiology
- American Association of Family Physicians
- Radiology
- Inviting others
  - American Nurses Association
  - Internal medicine
  - Anesthesiologists
  - Emergency Department
  - Etc.

Terminology and Model Review
Repository of Shared Models in an approved Formalism

FHIR Profiles
Repository of Shared Models in an approved Formalism

Knowledge Models
Repository of Shared Models in an approved Formalism
HL7 Plenary Meeting Notes:
HL7’s 32nd Annual Plenary

Keynote Session 4: Interactive 3D Visualization in the Wide Web of Health

11:35 – 12:20 pm

*****

Nicholas Polys, PhD
Director of Visual Computer, Virginia Tech
Research Computing Group
Nicholas Polys is Director of Visual Computing with Virginia Tech Research Computing Group and Affiliate Research Professor in the Department of Computer Science. He has developed interactive 3D graphics content and systems since 1997. His research interests lie at the center of graphics and Human Computer Interaction: the intersection of visualization, virtual environments, and perception. After his undergraduate research in Cognitive Science at Vassar College (1996), he jumped into the networked information space of the WWW developing audio, visual, and 3D assets and software. His doctoral work at Virginia Tech (2006) examined perceptual cues and layout behaviors for Information-Rich Virtual Environments for desktop to immersive platforms. He is a member of ACM, IEEE Computer Society, and the Web3D Consortium. He is co-author of the international standard (ISO) Extensible 3D (X3D), elected Director and President of the Web3D Consortium, and Chair of the Web3D User Interface Working Group.

Professor Polys runs the Visionarium Lab at Virginia Tech where he studies the effects of displays and perception of 3D graphics. He is also the elected President of the Web3D Consortium.
Interactive 3D Visualization in the Wide Web of Health

Nicholas F. Polys, PhD
Virginia Tech

Keynote: HI7 PLenary Meeting Baltimore, MD
Oct 1, 2018
Outline

- Web3D & Me
- Born 3D
- Things Change - a Lifetime of 3D
- Standards
- The Many Faces of 3D Health Data
  - Metadata
  - Health & Medicine
  - Access: WWW, Virtual & Augmented Reality, 3D printing
  - Data-driven 3D visualization
- Interoperability
- The Path Forward
Goal:

*Global Interoperability!*

To achieve this, we need to:

1. Cross-fertilize informatics communities, knowledge, and practice
2. Adopt standards to improve exchange and reproducibility today
3. Extend standards and practice for better outcomes tomorrow
Introduction

1996: BA in Cognitive Science
1998: built first VRML world of the Giza Plateau
1999: attended first ACM Web3D Conference & joined Web3D Consortium
2006: received PhD in Computer Science from Virginia Tech, U appointments
2007: took over the Visionarium Lab, aligned with Central IT: HPC
2008: Medical WG and Volume Component
2010-present: leadership with DICOM, MMVR, IEEE VR, Web3D, SIGGRAPH, ...
2017: HL7 Collaboration
VirtuWorlds Giza (1998)

Early searches into 3D and Virtual Reality:

- Epistemology
- Metaphysics
- The Web
- Archival 3D

Picture of me in the Hypercube
ISO-IEC Web3D Standards Evolution

Durability of 3D information across industry epochs:

- 1994: VRML 1.0
- 1997: VRML 2.0
- 2002: VRML 2.1
- 2005: X3D 3.0
- 2006: X3D 3.1 ; H-Anim 1.0
- 2008: X3D 3.2
- 2013: X3D 3.3
- 2018: H-Anim 2.0

Encodings:
- XML,
- utf8,
- binary,
- JSON

Bindings:
- Javascript,
- Java,
- C#,
- C++, C,
- Python

http://www.web3d.org/standards/all

http://www.web3d.org/x3d/content/Basic/Web3dOutreach/Web3dTimelineIndex.html
Games and diversions are fun, but what about real 3D?? Health… safety … Utilities…
These are not silicon valley cycles …
Born 3D

… but highly dimensional !:-)

The last centuries’ hopes for health through medical science has been driven by Reductionism

… *while still essential, the situation is now flipped!*...

The integration of disparate (Big) data and scientific disciplines provide us new insights into the whole person, their environment, and their health!
Things Change

A lifetime of 3D … ‘Mission-critical data’

- Requires durability longer than Silicon Valley cycles and market hype
- Requires Patient Rights to digital twin and conformant EHR
- Emerging technologies and Access
The Many Faces of 3D Health Data

Which one is not like the others?

Let’s play a game:
Trick question! They are relevant information in determining your health outcome!!!
Web3D & DICOM History

Official Liaison began in 2008 and manifested in several WGs toward the interoperability of 3D semantics and data structures:

- X3D 3.3 Volume Component
- DICOM SUP 132 3D Surfaces
- DICOM SUP 111 Volumes & Segmentations
- DICOM SUP n-D Presentation states (rendering)
- 3D Printing DICOM SUP 205 (eg STL payload)
- 3D Printing DICOM SUP 208 (e.g VRML, X3D payload: TBD)

CURA, LULZBOT etc
Web3D & HL7 Opportunities

- Interactive 3D on the:
  - Desktop (any OS)
  - VR systems
  - mobile device
  - ... or any web browser
- DAM X3D payloads!
- Healthy X3D on the WWW (L7)!
Scope and Requirements

ISO-IEC provides international ratification and recognition.

The X3D and H-Anim specifications provide platform-independent 3D graphics relevant to health.

... How about the values for interoperability?

... How does X3D play across the Health Enterprise?

- Metadata
- Kinds of Health data
- Access (WWW, VR/MR/AR)
- Data-driven Visualization

● VALUE ADD OF X3D
X3D Metadata

Travels with the 3D information and can be granular at any node when embedded in the scene graph. Scenes can be composed through the Inline node.

- UNITS & measures defined per scene
- **Metadata can be on any node in the scene**
  - Provenance and source of data
  - Document processing tool chains for derived data
  - Community vocabularies and annotations (FMA, SNOMED, CT, ...)
  - W3C encryption and authentication by element
Kinds of data, kinds of stakeholders

Health and Medicine

- Exercise
- Therapy
- Simulation
- Surgery
- Genomics
- Analytics
- Networks
- ...

Hanim
HUMANOID
ANIMATION
WORKING GROUP
Exercise

H-Anim 2.0 (ISO-IEC 19774 - 2) specifies the 3D graphics mappings for combining anatomy and Motion Data Animation (e.g. .bvh). These standards data structures are especially important in physical therapy and ergonomics.

Virginia Tech VR exercise mirror for stroke victims: we demonstrated real-time visual feedback for patients as avatars achieving progressive goals of muscular extension.

- EHR: “What happened there?”
High spatial and temporal resolution body scans

www.3dmd.com
Humanoid Animation v2


Level of articulation (LOA) represents the complexity and detail of joints for a humanoid skeletal hierarchy, and can be used for generating various motions based on the joints.

There are five levels of articulation:
- LOA-0 represents only the humanoid_root Joint object without hierarchy.
- LOA-1 represents the simplest organization and hierarchy of joints for a humanoid. 18 joints and 18 segments. Each segment has a joint in the hierarchy.
- LOA-2 consists of 71 joints and 71 segments.
- LOA-3 consists of 94 joints and 94 segments.
- LOA-4 builds on LOA-3 by adding anatomical details of hands and feet, consisting of 148 joints and 148 segments.
H-Anim v2

Anatomies & Motions

ISO/IEC DIS 19774-2

(e.g. .BVH)
Safety and Radiation Therapy

X3D simulation of X-Ray therapy: Felix Hamza-Lup

Surgical Simulation

X3D as a platform for Haptic simulation and Medical training

- H3D.org
- Nigel John’s trainers:
  - Eye surgery simulator
  - Ventricular catheterization training
- MMVR 2014 workshop (cite?)
- “Quantizing the Void” paper (cite)


Network Visualization

Semantics:
FMA, CT

Ontologies
(Cite *)

Narratives in the Network
- Novel graph mining techniques
- (Cite)


**Immersive VR**

Clinically effective:

- VR experiences reduce subjective pain experience
- Faster out of bed - saves money and reduces risk of secondary issues (e.g. infection)
- Proven treatments for PTSD with VR exposure therapies

https://www.nature.com/articles/s41746-018-0026-4.pdf

Economic analysis of implementing virtual reality therapy for pain among hospitalized patients

http://www.mobihealthnews.com/content/depth-therapeutic-vr-2018-no-longer-just-distraction-therapy?

http://www.mobihealthnews.com/content/15-health-and-wellness-use-cases-virtual-reality

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C47&q=ptsd+and+Vr&btnG=

“What happened there?”
Access: WWW and VR

- X3D: desktop, mobile, immersive VR/MR/AR
- Imaging
  - X3D Volume Rendering
  - TIFF stacks, DICOM, NRRD, PNG
  - Scripted automated conversions
- Molecular Visualization
- Immune Simulation
- Genomic alignment
- Polygons and volumes living together!
- VR and 3D printing !!!


Access: X3D Volume Rendering

- DICOM, NRRD, TIFF:
  - https://www.youtube.com/watch?v=mI7zfrH6A9U&t=37s
- Segmentations and Interaction Mashup:
  - https://www.youtube.com/watch?v=ZO3jWjW9soE
- Cell images with corresponding surfaces:
  - https://www.youtube.com/watch?v=srpiEBvbG-Q&list=UUoQklQuVbdKEBqgefLhzw
- Many publications (cite)
Access: Web Volume Rendering

HTML5 + WebGL + X3D

- VICOMTech: Volumerc.org
- Online drag-and-drop service for DICOM:
  - To HTML5/WebGL/X3DOM
    Mirror4All by VICOMTECH
  and KShell
Access: WWW and VR

- HTML5 + X3D Portals
  - Zebrafish genetic and neuro atlas: zbbrowser.com
  - Virtual Natural History Museum: http://vnhm.de
  - CNS-PF neuron viewer
  - Cell image library
  - NIH 3D Print Exchange


Access: VT Visionarium

Immersive Visualization

27 mil stereo pixels!
Computing stretched DNA

Read More...
Access: WebVR

- X3D and HTML5 files
- Uses the browser as the platform
- Many headsets
3D printed heart : Case Study

From the patient’s MRI, a model was 3D printed and fitted with magnets
Data-driven 3D Visualization

Analyzing high-dimensional data with X3D graphics (i.e. HL7 records)

- 3D Web plotting (Matlab, D3, X3DOM, X_ITE)
- NIST’s Digital Library of Mathematical Functions (DLMF) graphics
- Virginia Tech’s Discovery Analytics: Semantic Interaction
Semantic 3D Interaction

Exploration and Discovery

Where *the human is the loop*:

- Users group records based on visual features, knowledge, and intuition
- Machine learns relevant parameter weights and reprojects records
- Linked panels and plots allow selection and statistical inquiry
Path Forward

**X3D in HL7:**
- XML & JSON payloads of X3D content in FHIR
- DAM-specific integrations

**HL7 in X3D:**
- Metadata vocabularies & reference practice
- Using 3D Semantic Interaction to explore high-dimensional HL7 information
Web3D & HL7 Opportunities

- Reciprocal Liaison membership and joint strategies

- Project-based implementations that can solve health problems with the informatics of 3D
Human Opportunities

- Synergy is real and makes a difference...
- Common languages, practice, and translations are required
- Each new turn of the ratchet takes us up the inclined plane
- Join the efforts!

It’s easier than building Giza or

living under the Tower of Babylon!
Thank You!

npolys@vt.edu

Nicholas F. Polys, Ph.D.

Director of Visual Computing

Virginia Tech Research Computing Division

Affiliate Professor

Virginia Tech Department of Computer Science

and

Join us!

www.Web3D.org - esp Medical Working Group and public wiki
HL7’s 32nd Annual Plenary

Closing Comments

12:00 – 12:30 pm

*****

Calvin Beebe
Board Chair, HL7 International