DICOM WG 22 Dentistry

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Reducing Dental Forensic Errors by using DICOM & SNOMED

International Forensics Symposium on Error Management

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SAN Business Consultants

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Forensic Odontology

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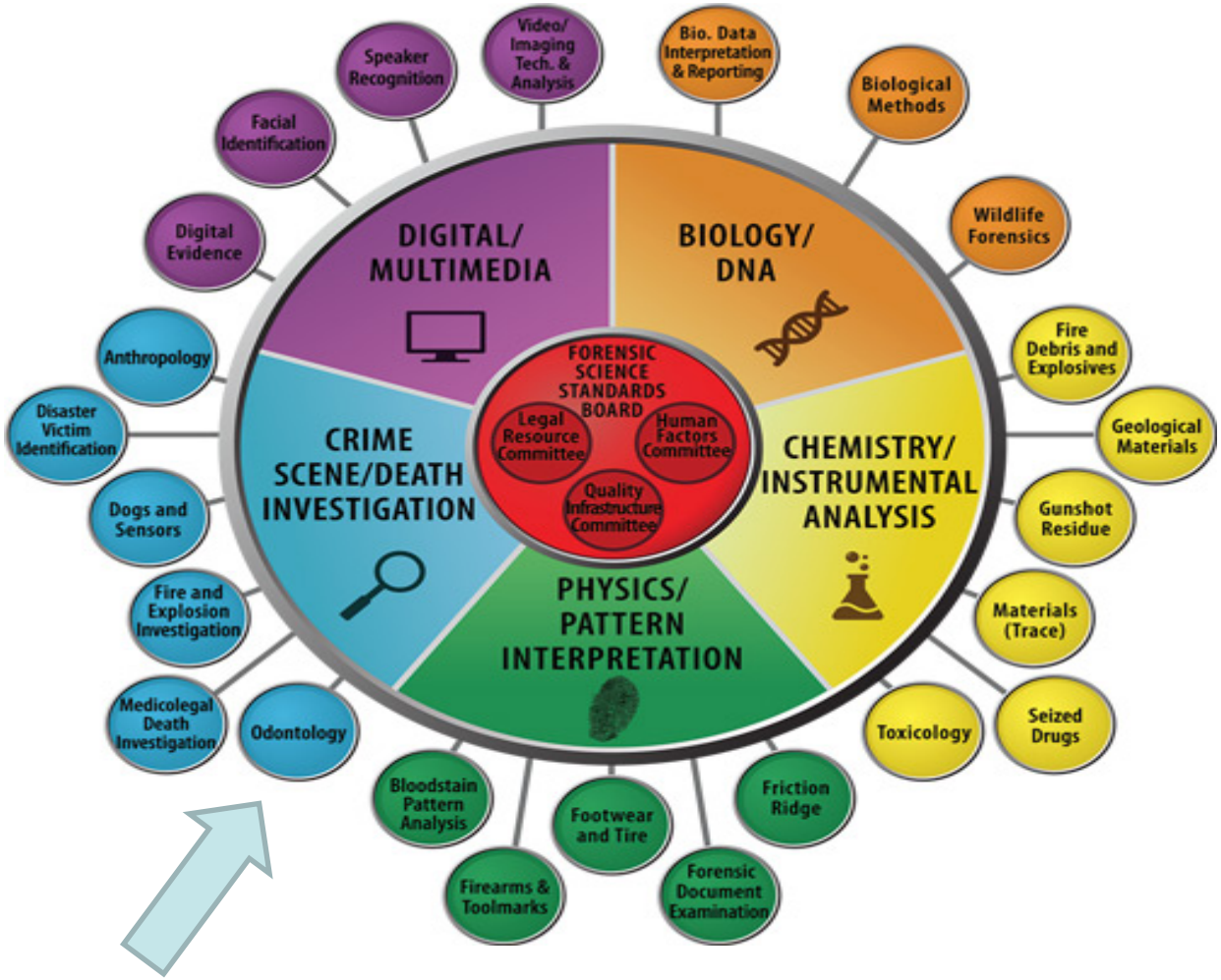

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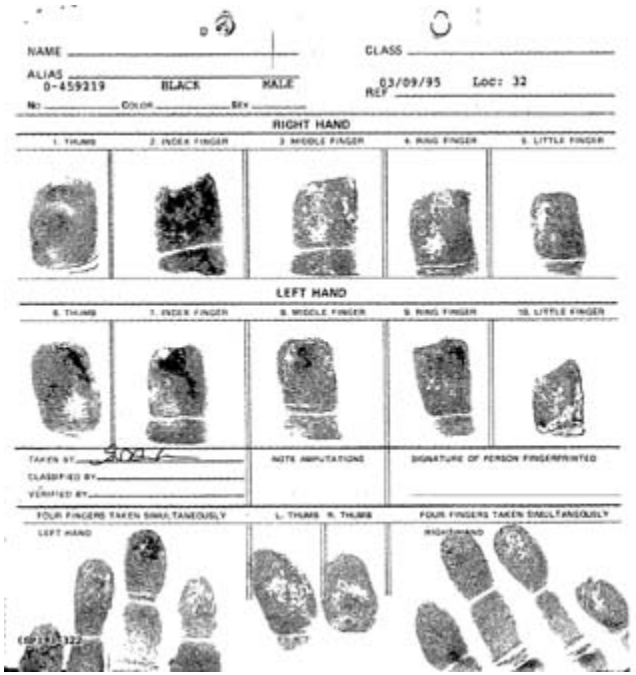
In the 1990s

- Central Registration Depository (CRD) fees, registration/licensing process for firms and reps
- Federal regulatory registration/licensing
- Electronic Fingerprint Processing & Submission to the FBI



WTC Mass Disaster

- **Most of the forensic matches were by fingerprints & dental records**
- **Most of the victims were WTC stockbrokers**
- **CRD helped with the forensic effort**

One Liberty Plaza (NASD)

Forensic Results

- NYC was able to identify remains for about 1,600 (just over half) of the World Trade Center victims
  - 500 identified by dental comparison
- The medical examiner's office collected about 10,000 unidentified bone and tissue fragments that cannot be matched

The Potential of Error

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- Comparison can be subjective
- Currency of AM image set
- Visible Light accuracy for identification
- Discrimination of shape
- Measurements
- Consistency in capture, exchange and display

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Why Dental Informatics is Important

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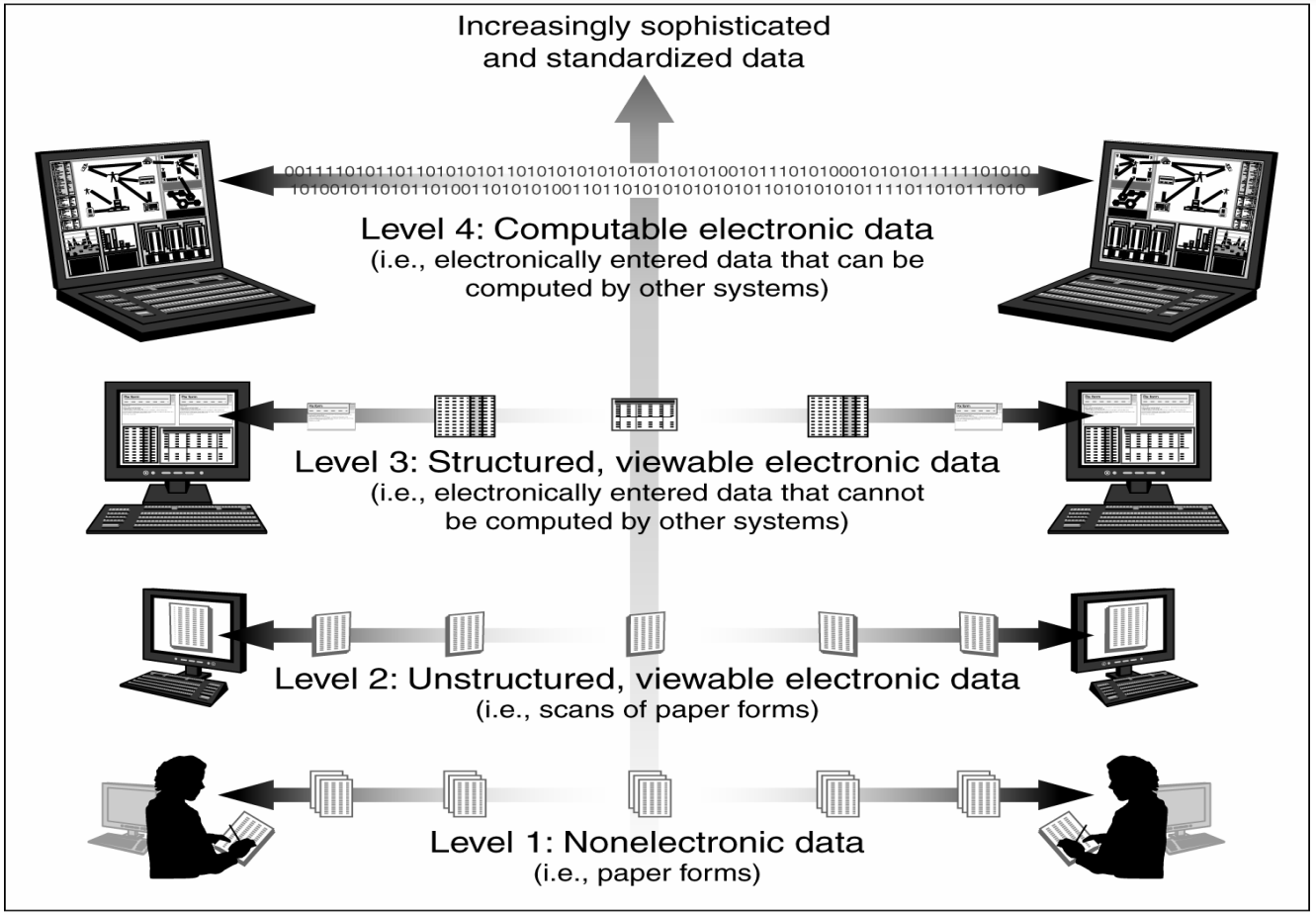
- Dental record comparison is often the fastest, most cost effective, scientific method of identification
- Tooth enamel is the hardest substance in the human body and contains the highest percentage of minerals, 96%
- Dental imaging is typically the most current & reliable information

Levels of Interoperability



Source: GAO analysis based on data from the Center for Information Technology Leadership.

DOD CHCS2 Dental

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- **Supports worldwide health care delivery and management**
- **Standardizes data elements using a robust, industry standard health data dictionary**
- **Standardizes and automatically codes encounters**
- **Digital Imaging**
- **Forensic Exam Support**

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DOD Dental

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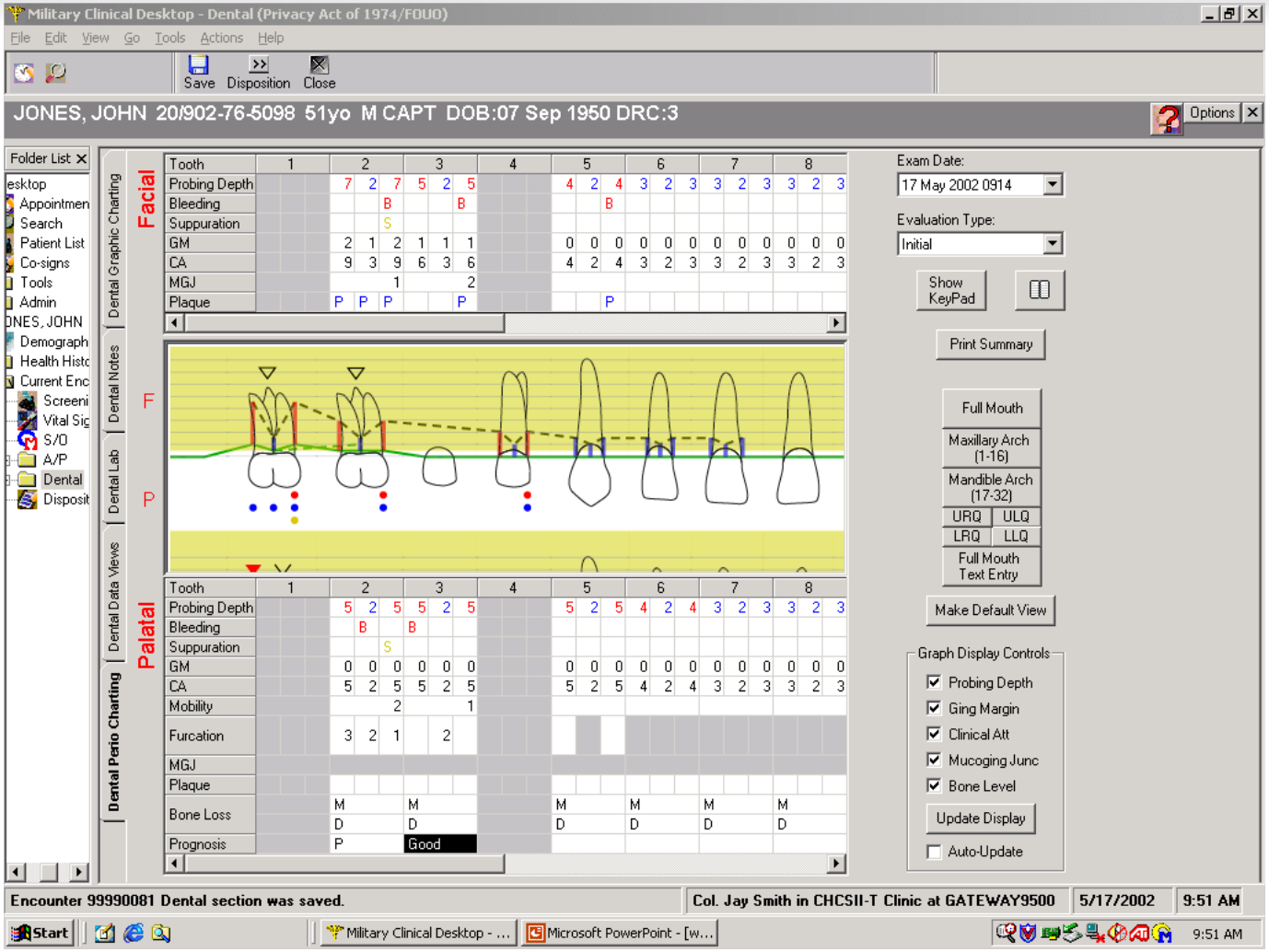

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VistA is an Integrated Multimedia Electronic Health Record

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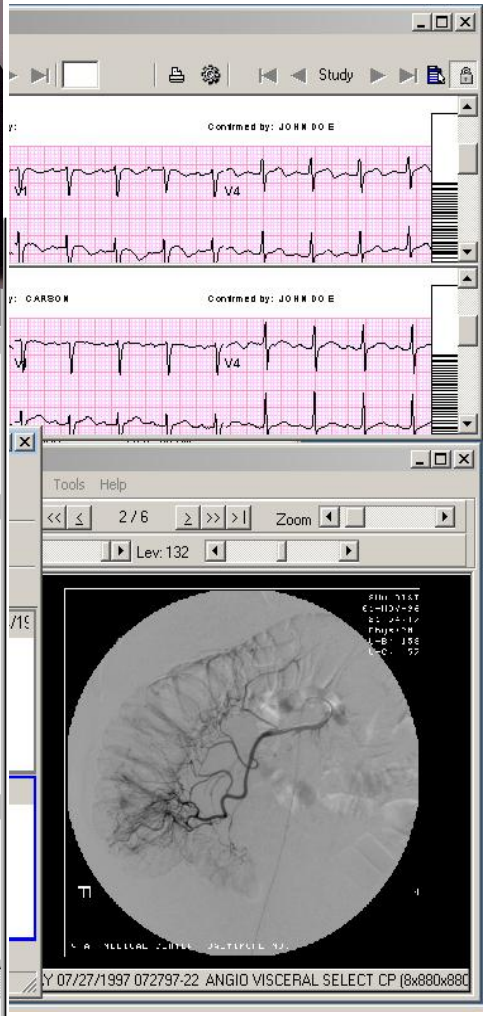

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Dental Forensic Data Supplement to ANSI

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For identification of unknown deceased, as noted by the ADA in Section **6** of Specification Number 1058: "The antemortem forensic data set should consist of:

- familial data set
- dental history data set
- tooth data set
- mouth data set
- visual image data set
- radiographic image data set

The postmortem forensic dental data set should consist of 4 components:

- tooth data set
- mouth data set
- visual image data set
- radiographic image data set."

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DICOM

- Digital Imaging and Communication in Medicine is the international medical imaging standard since 1993
- **DICOM is an ISO Standard**
- DICOM uses terms from SNOMED and other standard terminologies
- All major providers of diagnostic modalities, workstations and PACS have agreed to use DICOM between products and different vendors
- Stakeholders - Clinical, product engineering, quality assurance, system integrators, information officers, medical device regulators

Sources of Error

- **One major limitation – availability of ante-mortem dental records and their accuracy and clarity**
- **Human bias**
- **Measurements accuracy vs. precision**
  - Repeating the same error
- **Effectiveness of Medical Diagnosis**
  - Validity, Sensitivity and Specificity

Lack of Standard Interface

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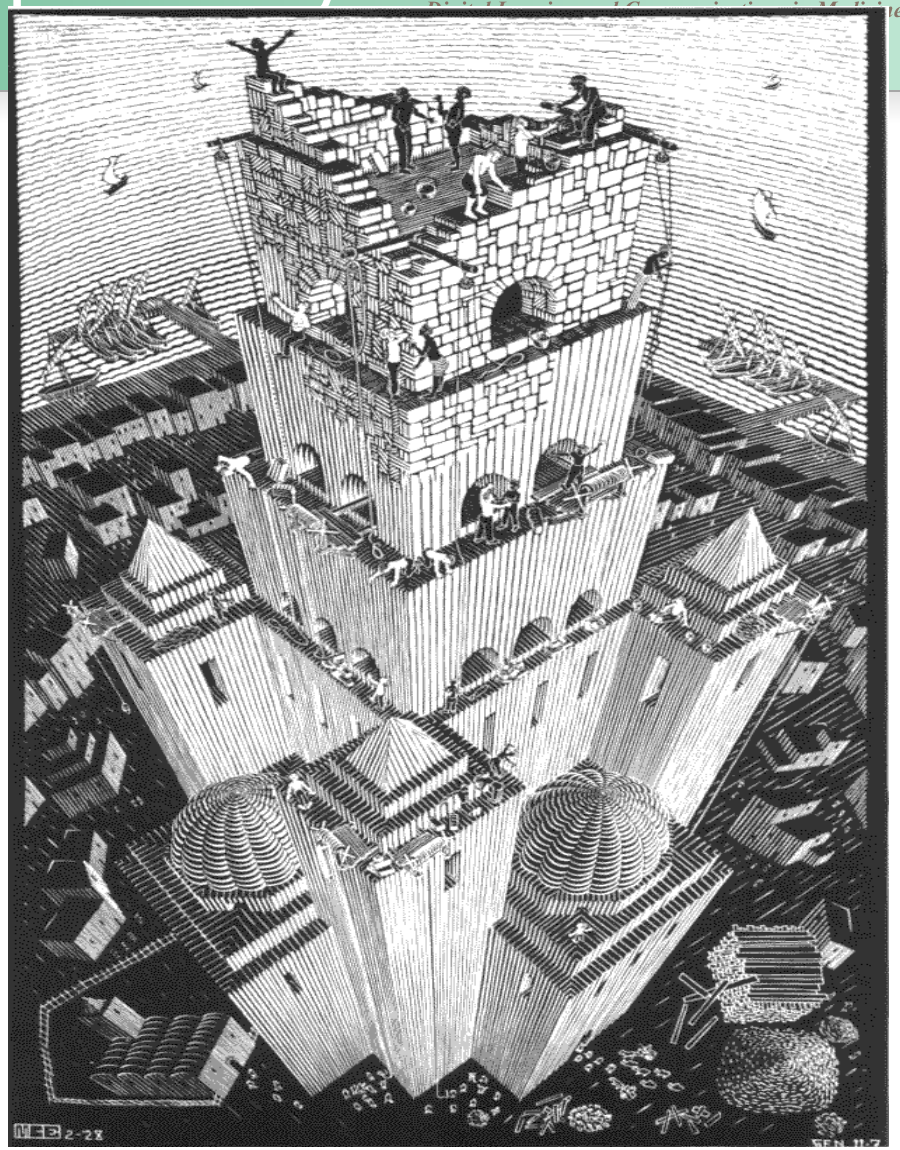
- Inhibits Interoperability
- Costs More
- Slows Adoption of new technologies
- Introduces errors and risk
- Proprietary interfaces mean vendor lock-in and an inflexible environment for any changes
- Less effective and efficient
- Each major forensic dental systems uses different coding and terminology
  - NIST provides interpreter

The Challenge of Interoperability

- **Unwillingness of healthcare providers**
  - Psychological and cultural issues
  - Resistance to change Lack of enterprise vision, Loss of control, Perceived risk
- **Unwillingness of vendors**
  - Proprietary systems and formats
  - Loss of competitive advantage
  - Technical obstacles



Initial Findings

- 80% of the time there either was nothing there, or sometimes illegal empty values or garbage dummy values
- One vendor used Body Part Examined data element at the Series level
- Some vendors used older coding scheme
- Some vendors used Primary Anatomic Sequence

A triplet of codes schema

- **Rather than using a single string value Body Part Examined, a triplet of codes schema (e.g., SRT for SNOMED), code value (e.g., T-D1213) and code meaning (e.g., “Jaw Region") were used in a data element called Anatomic Region Sequence**
- **Over the past 15 years, all subsequent new DICOM image objects have been defined to use the Anatomic Region Sequence**

Why use Anatomic Region Sequence?

- Body Part Examined is at Series Level
- Text limited to 16 characters
- Not a Comprehensive list

- Anatomic Macros are at Image level
- Choose from more Comprehensive anatomic listing
- There are 2 Billion possibilities in charting adult dentition
- Even identical twins are not necessarily dentally identical

Typical Forensic Use Case

- **A need arises for an orthodontic provider to transfer images to other parties. This use case scenario describes a particular situation:**
  - transferring records to a LEA (Legal Enforcement Agency)
    - for forensic identification;
    - for facial/dental identification;
- **Both parties agree on this specific image layout for analysis, comparison, collection, preservation and presentation of evidence. A consistent DICOM Structured Display layout will greatly facilitate the analysis by the LEA personnel for their purposes.**
- **It is required that all images that populate a particular structured display are acquired on the same date.**
- **Given that proper consent and legal requirements have been met, the image acquiring orthodontic provider will oversee the secure export of images in this DICOM Structured Display layout.**
- **The image acquiring orthodontic provider or staff will then initialize the transfer of the exported DICOM Structured Display image set to the other party.**
- **The receiving party imports the DICOM Structured Display image set and visualizes the images in the same layout.**

CP 1444

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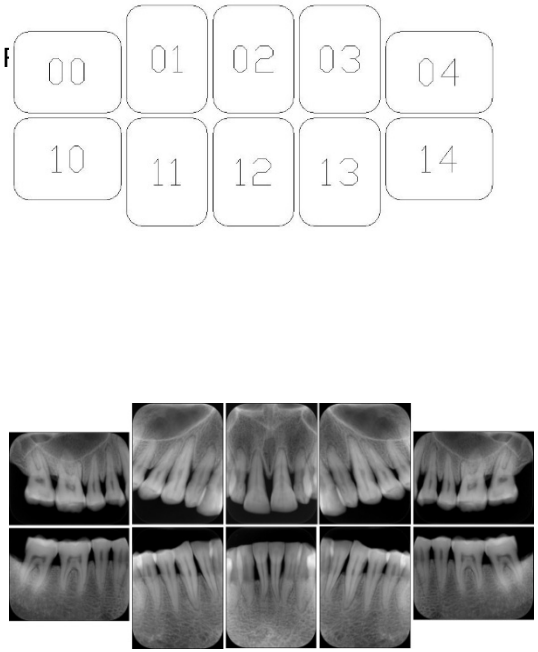
Hanging Protocol Name	10 Standard A-- Dental Image Layout	Image Location Code	ISO Teeth Designation (typical)
JSOMR DL-S001A		00	18, 17, 16, 15
		01	14, 13, 12
		02	12, 11, 21, 22
		03	22, 23, 24
		04	25, 26, 27, 28
		10	48, 47, 46, 45
		11	44, 43, 42
		12	42, 41, 31, 32
		13	32, 33, 34
		14	35, 36, 37, 38

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Why today is important

- **There is great interest in the DICOM community toward making a contribution in using color imaging**
  - WG 22 has a DICOM work item regarding Visible Light
  - ADA Technical Report 1050, Implementation Guidelines for DICOM in Dental Photography and Endoscopy

American Board of Orthodontics (ABO-1)

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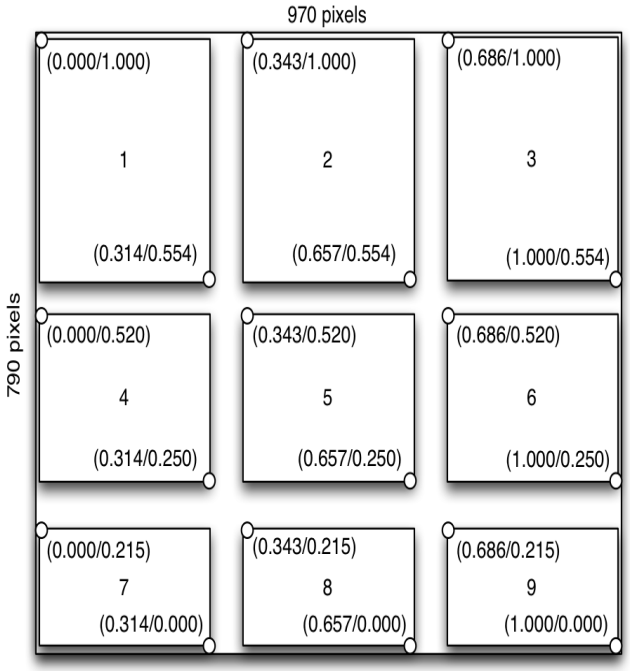
Layout



* Diagram is not drawn to scale. Refer to values specified in diagram.
* There shall be no outer border.
* Background color shall be white.

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Reference

ABO-2

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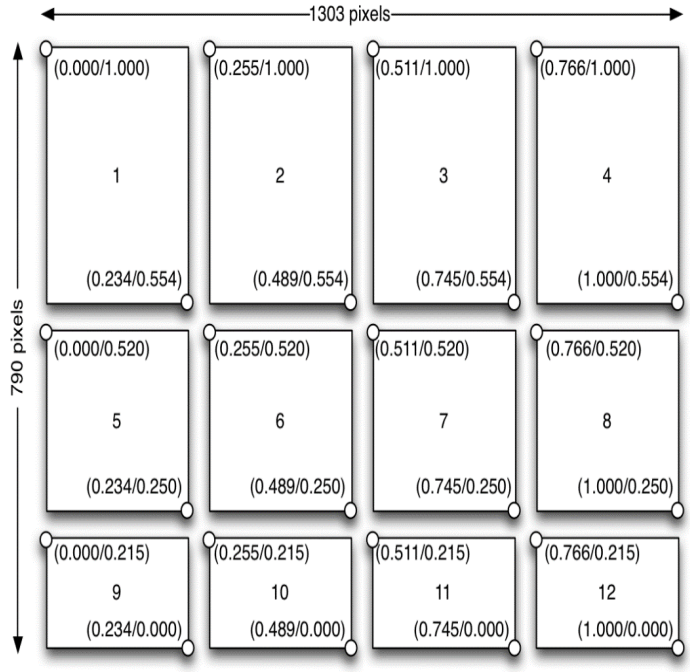
Layout



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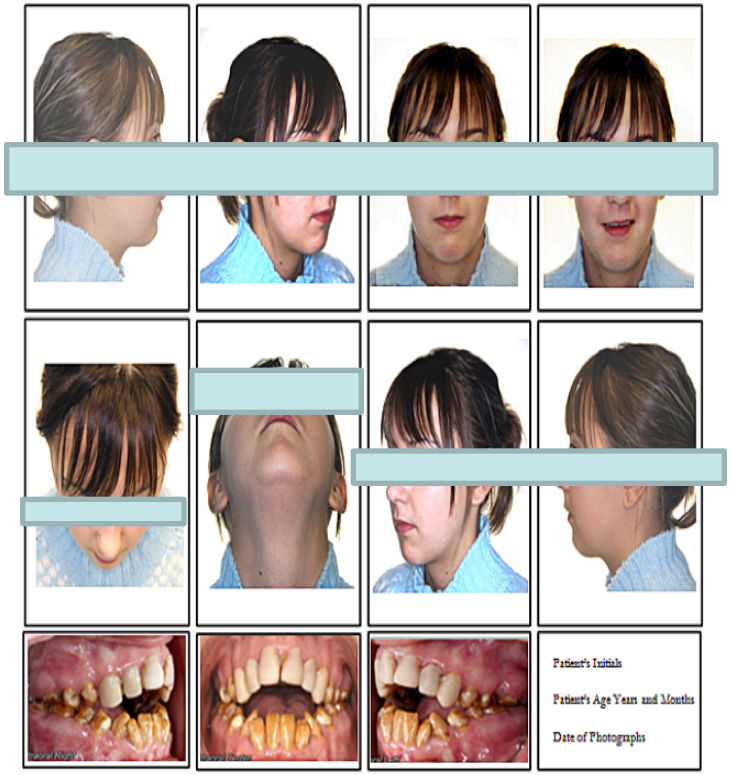
Reference



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ABO-3

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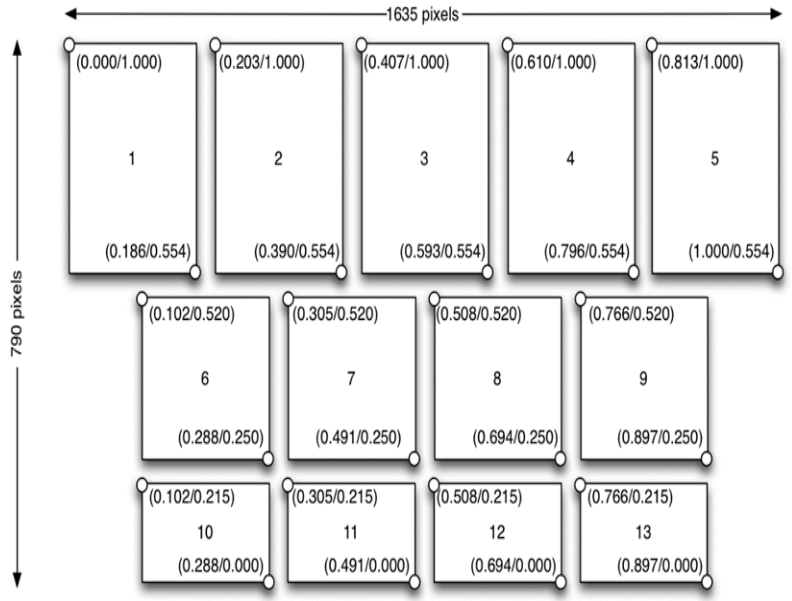
Layout



* Diagram is not drawn to scale. Refer to values specified in diagram.
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* Background color shall be white

Reference

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Next Steps

- **Many of the issues and variability are due to human factors**
  - Education & Training required
  - ADA 2015 is featuring live demos of Disaster Victim Identification
  - Learn about collection and coding of forensic dental data for exchange between national and international agencies
  - Discover the latest technologies and techniques in forensic dentistry and how dental information is used from missing persons to mass fatality incidents
  - Calibration between capture & display

Next Steps

- **Determine where in the total imaging system we can make an improvement**
  - DICOM Acquisition Context Profile
    - Additional SNOMED attributes are captured in dental photographs
  - Engage storage & modality vendors
  - Color Display Function
- **Investigate IHE Consistent Presentation of *Color* Imaging**

Volume, Value and Velocity

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Volume of Data

Reference data is growing exponentially and is being stored for long periods of time.

Value of Information

Image data is actively referenced, and must be stored and protected for life to meet clinical, forensic and regulatory requirements.

Velocity of Change

Address the demands for increased storage and higher performance.

DICOM / ADA References

- **DICOM Standard**
- **Structured Display (DICOM Supplement 123)**
  - DICOM CP 375
  - DICOM CP 1444
- **ADA TR 1023 DICOM for Dentistry**
- **ADA TR 1051 DICOM for Institutional Dentistry**
- **ADA TR 1058 – Forensic Dental Data Set**

Odontology References

- **Forensic Odontology: An Essential Guide, by** Catherine Adams, Romina Carabott, Sam Evans
- Manual of Forensic Odontology by David R. Senn , Richard A. Weems, Fifth Edition, **2013**
- **ADA TRs**

Forensic References

- Forensic radiology by B. G. Brogdon
- Forensic Dentistry by Paul G. Stimson Curtis A. Mertz, 1997.
- Dental Perspectives on Human Evolution: State of the Art Research in Dental Paleoanthropology by Shara E. Bailey