

DICOM WG 22 Dentistry



Reducing Dental Forensic Errors by using DICOM & SNOMED

International Forensics Symposium on Error Management

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SAN Business Consultants

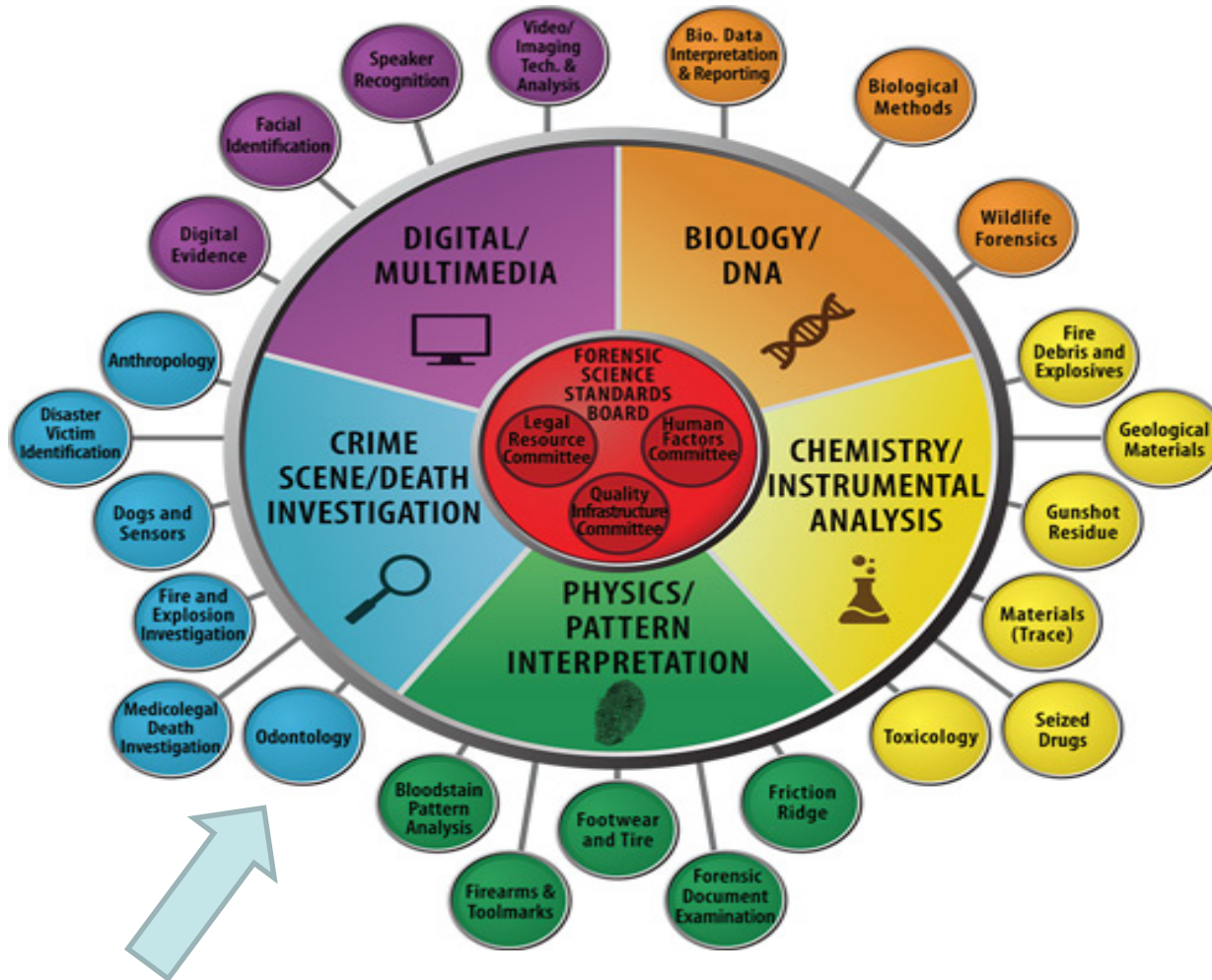
July 2015



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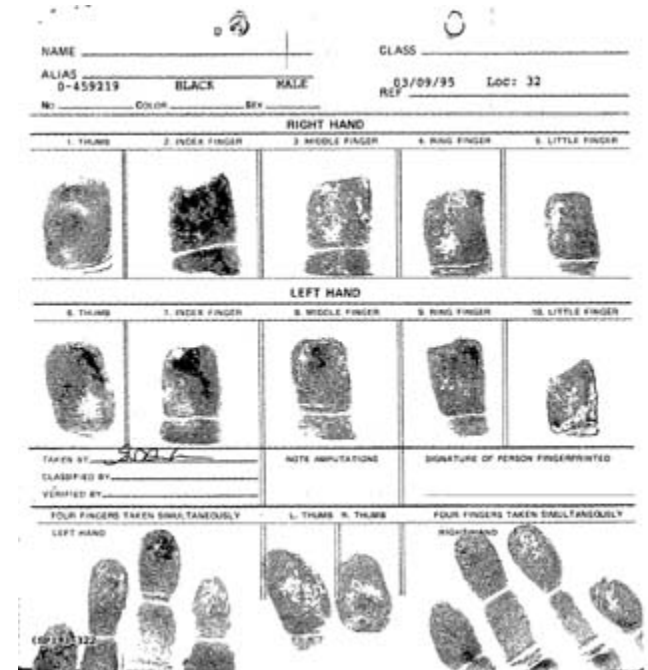


Forensic Odontology



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



A standard FBI fingerprint card form. The top section contains fields for NAME, CLASS, ALIAS (0-459219), RACE (BLACK), SEX (MALE), REF (03/09/95), and LOC (32). Below this are fields for No., Color, and Sex. The main body of the card is divided into two sections: RIGHT HAND and LEFT HAND. Each section contains five individual fingerprint impressions labeled 1 through 5 (THUMB, INDEX FINGER, MIDDLE FINGER, RING FINGER, LITTLE FINGER). At the bottom, there are fields for TAKER BY (30217), CLASSIFIED BY, VERIFIED BY, NOTE AMPUTATIONS, and SIGNATURE OF PERSON FINGERPRINTED. The bottom-most section shows four simultaneous impressions for the LEFT HAND and RIGHT HAND.

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)

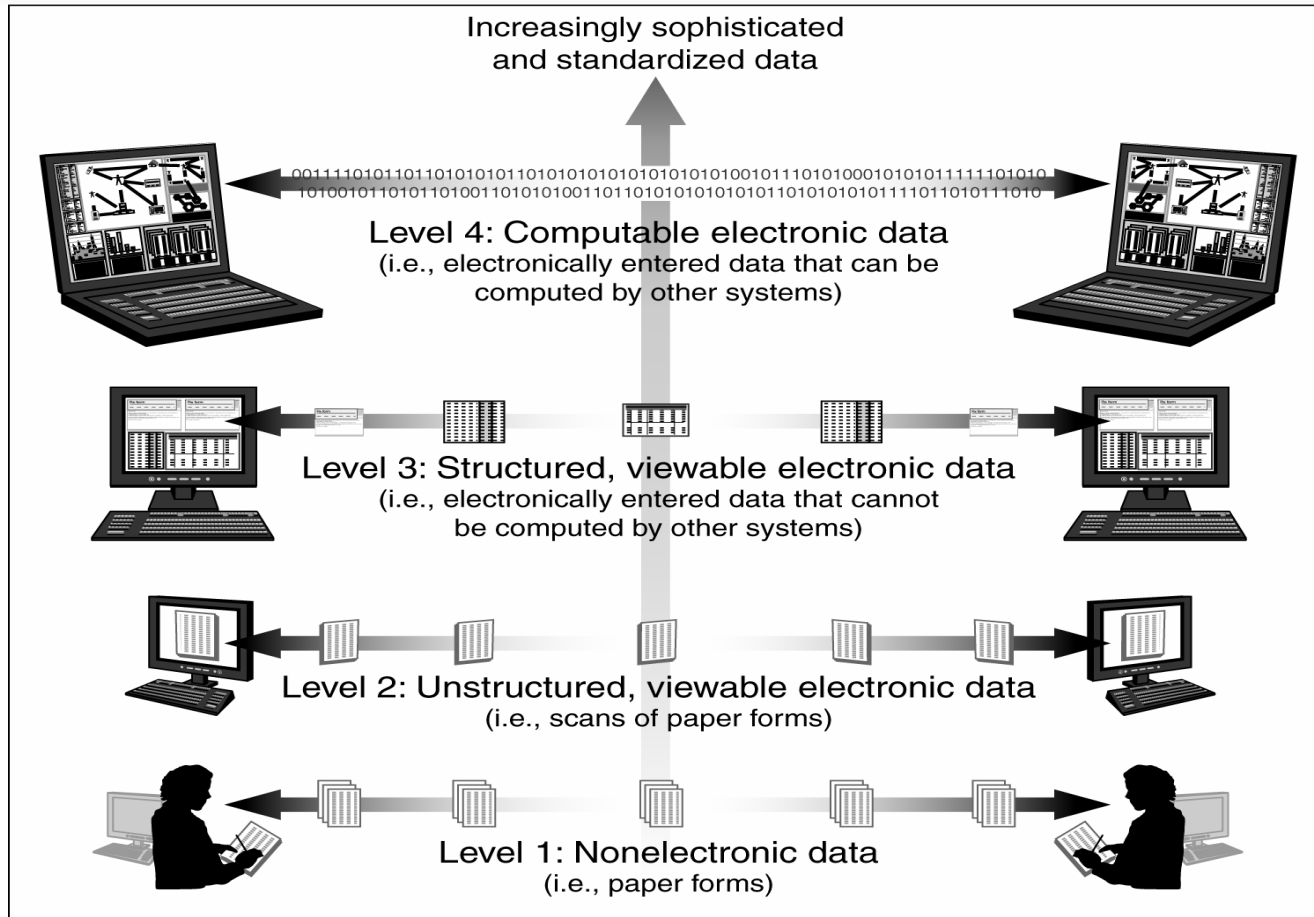
- NYC was able to identify remains for about 1,600 (just over half) of the World Trade Center victims
 - 500 identified by dental comparison
- The medical examiner's office collected about 10,000 unidentified bone and tissue fragments that cannot be matched

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

Why Dental Informatics is Important

- 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.

- **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**



Military Clinical Desktop - Dental (Privacy Act of 1974/FOUO)

File Edit View Go Tools Actions Help

Save Disposition Close

JONES, JOHN 20/902-76-5098 51yo M CAPT DOB:07 Sep 1950 DRC:3

Folder List

- Desktop
- Appointment
- Search
- Patient List
- Co-signs
- Tools
- Admin
- JONES, JOHN
- Demograph
- Health Histc
- Current Enc
- Screeni
- Vital Sic
- S/D
- A/P
- Dental
- Disposit

Dental Graphic Charting

Tooth	1	2	3	4	5	6	7	8
Probing Depth		7 2 7 5 2 5			4 2 4 3 2 3			3 2 3
Bleeding		B	B		B			
Suppuration		S						
GM		2 1 2 1 1 1			0 0 0 0 0 0			0 0 0
CA		9 3 9 6 3 6			4 2 4 3 2 3			3 3 2 3
MGJ		1	2					
Plaque		P P P	P		P			

Exam Date: 17 May 2002 0914

Evaluation Type: Initial

Show KeyPad

Print Summary

Full Mouth

Maxillary Arch (1-16)

Mandible Arch (17-32)

URQ ULQ

LRQ LLQ

Full Mouth Text Entry

Make Default View

Graph Display Controls

- Probing Depth
- Ging Margin
- Clinical Att
- Mucoging Junc
- Bone Level

Update Display

Auto-Update

Dental Notes

Dental Lab

Dental Data Views

Dental Perio Charting

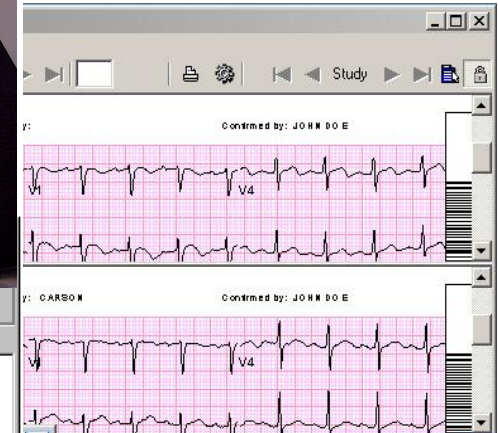
Tooth	1	2	3	4	5	6	7	8
Probing Depth		5 2 5 5 2 5			5 2 5 4 2 4			3 3 3 2 3
Bleeding		B	B					
Suppuration		S						
GM		0 0 0 0 0 0			0 0 0 0 0 0			0 0 0 0 0 0
CA		5 2 5 5 2 5			5 2 5 4 2 4			3 3 3 2 3
Mobility		2	1					
Furcation		3 2 1 2						
MGJ								
Plaque								
Bone Loss		M M			M M			M M
Prognosis		D D			D D			D D

Encounter 99990081 Dental section was saved.

Col. Jay Smith in CHCSII-T Clinic at GATEWAY9500 5/17/2002 9:51 AM

Start Military Clinical Desktop - ... Microsoft PowerPoint - [w... 9:51 AM

VistA is an Integrated Multimedia Electronic Health Record



File Edit View Tools Help

MADTL, F F **Visit Not Selected** Primary Care Team Unassigned Remote Data Postings AD

500-50-5000 Provider: FRANK,STUART .1924 (77)

Active Problems Allergies / Adverse Reactions Postings

Diverticulosis, Colonic Hemorrhage of Gastrointestinal Tract Penicillin Allergies Advance Directive Jul 28,97

Active Medications Clinical Reminders Due Date

Clonidine 0.2mg Tab Pending Hepatitis C Risk Assessment DUE NOW
 Methyldopa 500 Hctz 30mg Tab Pending Influenza Vaccine DUE NOW
 Dexamethasone 4mg S.T. Pending Flexisigmoidoscopy DUE NOW
 Clonidine 0.1mg Tabs Pending Tobacco Cessation Education DUE NOW
 Allopurinol 100mg Tab Pending
 Methyldopa 500 Hctz 30mg Tab Pending

Recent Lab Results Vitals

No orders found. T 98 F Oct 26,98
 P 86 Oct 26,98
 R 18 Oct 26,98
 BP 120/75 Apr 28,99
 HT 58 in Oct 26,98
 WT 140 lb Oct 26,98

Cover Sheet / Problems / Meds / Orders / Notes / Consults / D/C Summ / Labs / Reports /

Tools Help

<< < 2 / 6 > >> | Zoom

Lev: 132

7/19

Y: 07/27/1997 07:27:22 ANGIO VISCERAL SELECT CP (8x800x880)



Business Consultants LLP

Dental Forensic Data Supplement to ANSI

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.”

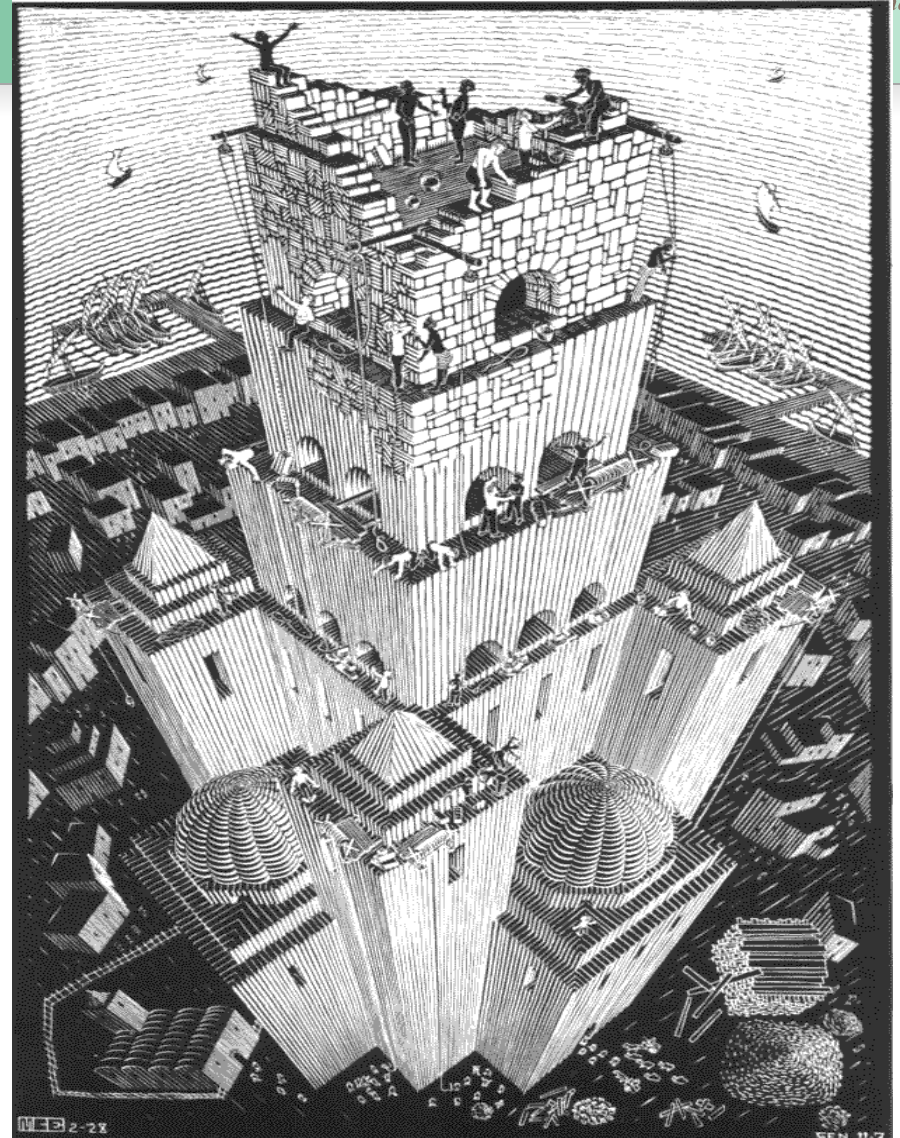
- Digital Imaging and Communication in Medicine is the international medical imaging standard since 1993
- **DICOM is an ISO Standard**
- DICOM uses terms from SNOMED and other standard terminologies
- All major providers of diagnostic modalities, workstations and PACS have agreed to use DICOM between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

- **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

- 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

- **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



- **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?

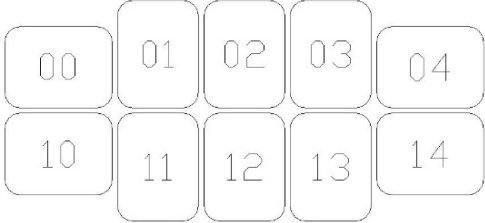
- Body Part Examined is at Series Level
- Text limited to 16 characters
- Not a Comprehensive list
- Anatomic Macros are at Image level
- Choose from more Comprehensive anatomic listing
- There are 2 Billion possibilities in charting adult dentition
- Even identical twins are not necessarily dentally 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.**

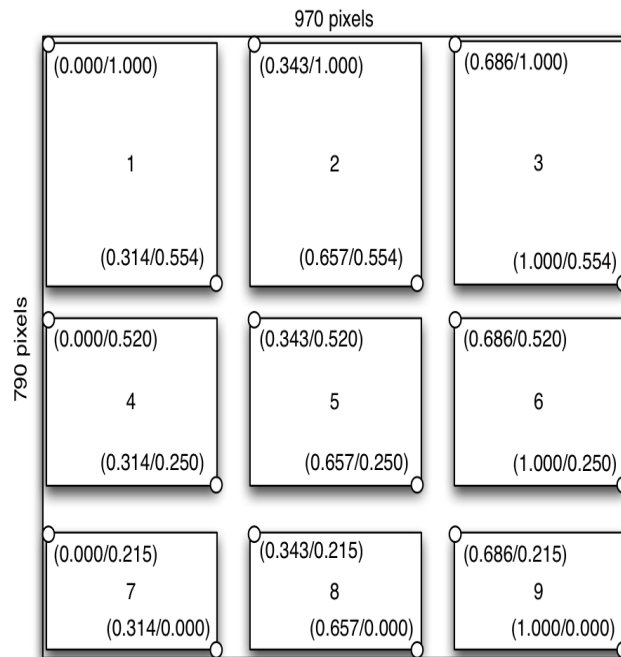


Hanging Protocol Name	10 Standard A-- Dental Image Layout	Image Location Code	ISO Teeth Designation (typical)
JSOMR DL-S001A		00	18, 17, 16, 15
		01	14, 13, 12
		02	12, 11, 21, 22
		03	22, 23, 24
		04	25, 26, 27, 28
		10	48, 47, 46, 45
		11	44, 43, 42
		12	42, 41, 31, 32
		13	32, 33, 34
		14	35, 36,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

- **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)

Layout



* Diagram is not drawn to scale. Refer to values specified in diagram.

* There shall be no outer border.

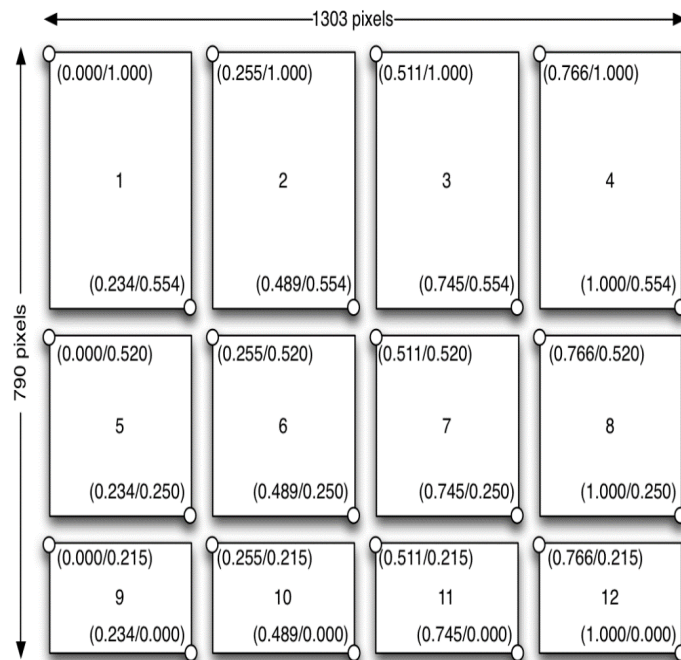
* Background color shall be white.

Reference



ABO-2

Layout

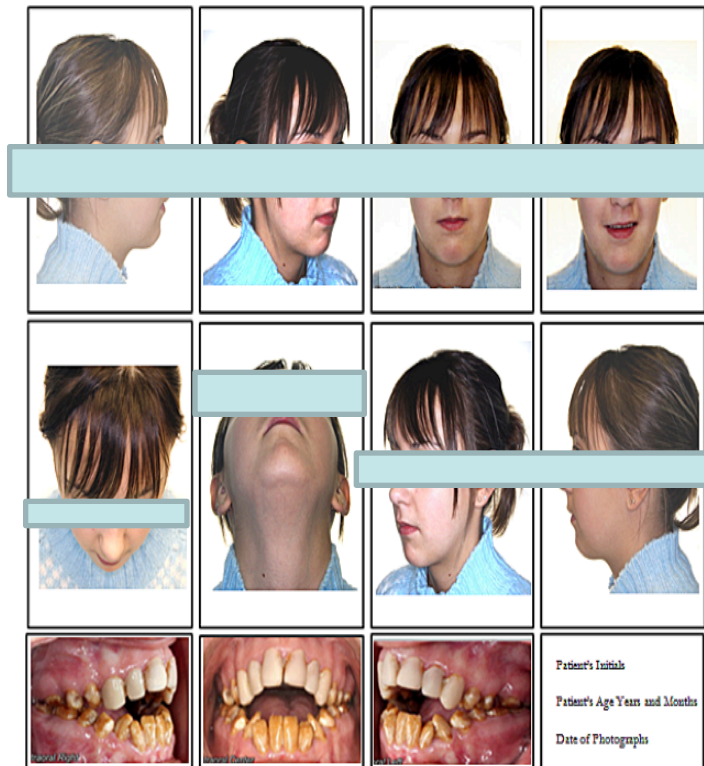


* Diagram is not drawn to scale. Refer to values specified in diagram.

* There shall be no outer border

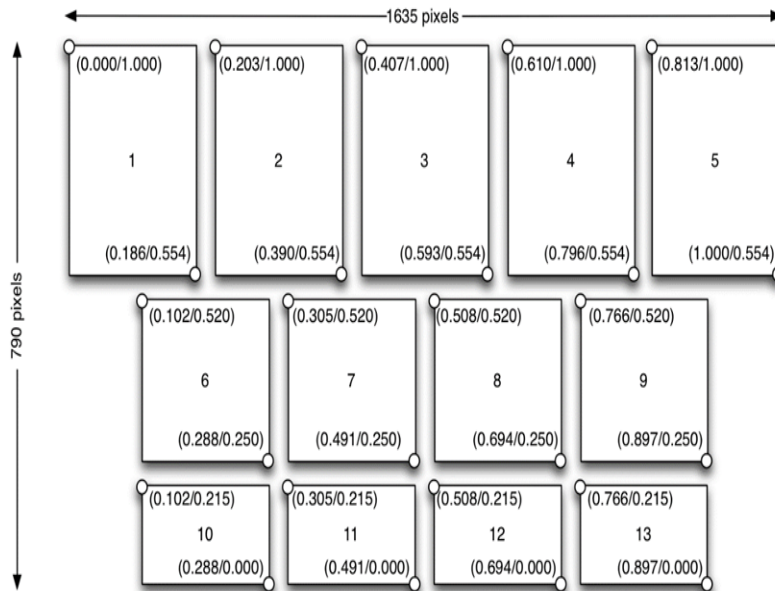
* Background color shall be white

Reference



ABO-3

Layout



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

Reference



- **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

- **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 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 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**

- **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 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**