

Office of the Medical Investigator:
Conceptual Design Document (CDD)

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April 4, 2022

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1 The Miniworld (or Universe of Discourse)

1.1 Purpose and overview

The purpose of this database is to provide the UNM Office of the Medical Examiner (OMI) and the UNM Maxwell Museum of Anthropology Osteolab (LOHO) with a means of storing and retrieving data related to cases investigated by OMI and all Collections maintained by LOHO.

OMI “investigates any death occurring in New Mexico that is sudden, violent, untimely, unexpected or where a person is found dead and the cause of death is unknown.” OMI consists of the following primary organizations: Operations, Education and Research, and Forensic Professional Services. A complete org chart can be found [here](#). OMI needs to be able to access and update records regarding their cases and the remains associated with those cases. They would also like to be able to conduct research/query the database with regard to specific questions about Biological Profiles, Trauma, Taphonomy, and Pathological Conditions.

LOHO houses four Collections of remains: OMI, Documented, Archeological, and Orthodontic. The OMI collection consists of “Doe”, or unidentified, remains. LOHO houses these remains because OMI does not have the storage space necessary to do so. Remains that are part of the DOE collection can eventually become the property of LOHO if they remain unidentified for a specified amount of time, if they are identified but never claimed by a next of kin, or if the next of kin donates the remains. LOHO needs to be able to access their own internal documentation regarding the remains and track the location of all remains in their Collections.

1.2 Scope

- Users of the database are those that work for OMI or LOHO. It does not support users external to UNM at this time.
- The database will maintain file paths to images rather than storing the images directly.
- The database will maintain file paths to case reports, text files, pdfs, and any other files of this nature rather than the files.
- The database will provide an inventory of all bones, their completeness and condition, and laboratory notes.

- The database will account for Biological Profile, Trauma, Taphonomy, Pathological Conditions, Isotopic Analysis, and DNA analysis.
- Remains will be appropriately categorized and their storage location provided.

1.3 Users

The following user list needs to be reviewed and approved by OMI and LOHO.

1.3.1 Database Administrator (DBA)

- Head of Forensic Anthropology

1.3.2 Data Designers

- Manager, Technical Analyst 2 assigned to the OMI Administration group
- IT Support Tech 2
- CS564 Graduate Students

1.3.3 End Users - Casual

- OMI Chief Medical Investigator and Assistant Chief Medical Investigator
- OMI Grief Services

1.3.4 End Users - Parametric

- OMI Investigations
- OMI Morphology
- OMI Education and Research
- OMI Forensic Professional Services
- LOHO Museum Osteolab Staff

1.3.5 Systems Analyst

- Manager, Technical Analyst 2 assigned to the OMI Administration group

1.3.6 Application Programmers

- IT Support Tech 2

2 Notation and definitions

The notation used: all upper case for the entity names, lower case for the relationship names, and the first letter capitalized for attribute names.

The description of the entities starts with a sentence which explains their meaning. Then the attributes to describe the instances are included. The relationships are also described by a sentence and a list of attributes if it has them.

Each attribute has a four-letter code which describes the type of attribute according to the four classification criteria for attributes.

The format for this code is: $(xyzw)$, where

x tells that the attribute is simple (S) or composite (C),

y tells that the attribute has a single value (S) or is multivalued (M),

z tells that the attribute is primitive (stored) (P) or derived (D), in case it is derived, an explanation of how to deduce it from other attributes or a formula/procedure must be specified, and

w tells that the attribute is fixed (F) (i. e. it must have a value that is not null) or optional (O), i.e. the domain of the attribute allows the null value.

For example, an attribute that has the *SSPF* code is a simple attribute with a single value which is primitive and fixed. An example of this kind of attribute could be the Social Security Number (SSN). On the other hand, an attribute with the *CSPO* code is a composite attribute with a single value, primitive and optional. In this case, the date of birth could be an attribute with this code. If there is a single attribute that has the key constraint, it

can be underlined. If the key constraint applies to more than one attribute or if there are several combinations of attributes with the key constraint property it is better to list them separately.

If there are attributes that are very common and are used more than once, they can be defined as general types to be used as the type of each attribute which uses the same format.

3 Conceptual Schema of the Database

The order of presentation of the conceptual schema is:

1. Assumptions
2. Entities: description and attributes.
3. Relationships: description and attributes (if they have them).
4. EER diagram
5. Explicit Integrity Constraints

An order must be chosen to present the entities and relationships. One option is to present them alphabetically; another is to start with the most important entity and continue with the entities related to it. This order will serve as a guide to follow the EER diagram.

This document can also be considered a manual *data dictionary*. Each DBMS has mechanisms for defining and querying the data dictionary used by it to access the database and that would be the *computerized data dictionary*.

3.1 Assumptions

- We call the OMI Identification Number the OMI Case Number throughout this document and assume they are one and the same.
- OMI remains that are identified but unclaimed after a certain time period may be released to LOHO.

- It is possible that remains associated with an OMI case may be found to be either HISTORIC or PREHISTORIC. In that case, the remains would have an OMI case number assigned to them despite the age of the remains.
- Classification of remains as PREHISTORIC, HISTORIC, or MODERN is first performed via contextual analysis. An isotopic analysis is conducted when the age of the remains cannot be verified via contextual observations.
- While the COLLECTION entity is somewhat sparse in this diagram, it is assumed that there is enough information about each Collection that is different that an entity is justified. If this assumption is incorrect, the Collection name could be added as an Attribute on REMAINS with the possibility of a null value.
- The above assumption regarding unknown complexity/additional Attributes holds for the sub-classes of the BONE entity.
- The hyoid bone is considered to be a torso bone.
- At least one server will be made available to house CASE and REMAINS directories
- Each REMAINS will have a unique identifier that will be used to associate it with its directory containing images and documentation. OMI remains will use the OMI Case Number and LOHO remains will use the Museum Accession Number (MAN).
- The OMI IT department will play some role in building and maintaining the database.
- Life stages of a human are considered to be: infant, toddler, child, adolescent, early adult, adult, middle aged adult, and senior adult. The age ranges, in order are: 0-2, 2-4, 5-12, 13-19, 20-25, 26-39, 40-59, 60+.

3.2 Entities

The entities defined for this database are:

- BONE

- CRANIAL_BONE
 - LOWER_LIMB_BONE
 - PECTORAL_BONE
 - PELVIC_BONE
 - SPINAL_BONE
 - TORSO_BONE
 - UPPER_LIMB_BONE
- CASE
- COLLECTION
- DNA
- ESTIMATED_BIOLOGICAL_PROFILE_VALUE
- ESTIMATED_INTERVAL
- INVENTORY
 - AXIAL_SKELETON_INVENTORY
 - * CRANIAL
 - * SPINE
 - * TORSO
 - APPENDICULAR_SKELETON_INVENTORY
 - * LOWER_LIMB
 - * PECTORAL_GIRDLE
 - * PELVIC_GIRDLE
 - * UPPER_LIMB
- ISOTOPIC_ANALYSES
- METHOD
 - INTERVAL_ESTIMATION_METHOD
 - PROFILE_VALUE_ESTIMATION_METHOD
- NEXT_OF_KIN
- PATHOLOGICAL_CONDITIONS
- POST-MORTEM_INTERVAL

- REMAINS
 - HISTORIC
 - MODERN
 - * DOE
 - * IDENTIFIED
 - PREHISTORIC
- TAPHONOMY
- TRAUMA
- EMPLOYEE
 - LOHO_EMPLOYEE
 - OMI_EMPLOYEE

A detailed description of each entity follows.

BONE: The super-class entity that describes all bones. The types of bones are divided into individual body parts. Examples of bones are occipital, ulna, and radius.

Attributes: Name (text) (SSPF)
 Type (text) (SSPF)

CASE: The OMI case to include case report, notes, and associated photos.

Attributes: Omi_case_number (SSPF)
 Case_directory (filepath to case directory) (CSPF)

COLLECTION: LOHO houses remains in Collections. The OMI Collection contains all OMI "Doe", or unidentified, cases.

Attributes: Name (SSPF)
 Description (text) (SSPF)
 Location (text) (SMPF)

DNA: A DNA test performed on the remains.

Attributes: Date_analyzed (DD/MM/YYYY) (SSPF)
 Skeletal_element (text) (SSPF)

ESTIMATED_BIOLOGICAL_PROFILE: Estimated biological indicators such as sex and age.

Attributes: Estimated_age (Derived from estimation methods) (SSDF)
 Estimated_sex (Derived from estimation methods) (SSDF)
 Estimated_bioaffinity (Derived from estimation methods) (SSDF)
 Estimated_stature (Derived from estimation methods) (SSDF)

ESTIMATED_INTERVAL: The estimated post-mortem interval.

Attributes: Estimated_value (derived from estimation methods) (SSDF)

IDENTIFIED: Remains that have been identified.

Attributes: Name (FN, MI, LN) (CSPF)
 Dob (DD/MM/YYYY) (SSPF)
 City (text) (SSPO)
 State (text) (SSPO)
 Country (text) (SSPO)
 Postal_code (text) (SSPF)
 Sex (text) (SSPF)
 Bioaffinity (text) (SSPF)
 Stature (in cm) (SSPF)
 Claimed (yes/no) (SSPF)

INTERVAL_ESTIMATION_METHOD: Method used to derive the estimated post-mortem interval.

Attributes: Observations (text) (SSPF)

INVENTORY: Inventory of a remains' skeleton. INVENTORY is subdivided into multiple sub-classes so that each body part can be tracked separately.

Attributes: Total_bones_present (sum of bones in all inventories) (SSDF)
 Skeleton_percent_complete (total bones ÷ expected bones) (SSDF)

The skeleton inventory super class is broken into seven inventory sub-classes (CRANIAL, LOWER_LIMB, PECTORAL_GIRDLE, PELVIC_GIRDLE, SPINE, TORSO, and UPPER_LIMB). Each of these sub-classes is associated to the following list of attributes.

Attributes: Percent_bone_type_complete (1%-100%) (SSPO)
 Bone_observed_damage (type of damage) (SMSO)
 Bone_notes (text entry) (SSPO)

ISOTOPIC_ANALYSES: Analysis of isotopes and their ratios to determine the age of a skeleton. Available analyses are: bulk carbon/nitrogen, strontium/oxygen, and radiocarbon dating.

Attributes: Date_performed (DD/MM/YYYY) (SSPF)
 Analysis_type (text) (SSPF)
 Skeletal_element (text) (SSPF)

LOHO_EMPLOYEE: A user who works with LOHO.

Attributes: Department (specific to LOHO) (SSPF)
 Job_title (specific to LOHO) (SSPF)

METHOD: This super-class entity describes all possible methods used to make determinations about the remains. Its directory (Method_directory) houses supporting paper(s) and any template forms used to make the determination. The Special_considerations attribute provides a place to record any "gotchas" regarding the studies, exceptions for when it should be used or not, or any other consideration deemed pertinent by the user.

Attributes: Name (SSPF)
 Method_directory (filepath to directory) (CSPF)
 Special_considerations (text) (SSPF)
 Measurements (specific to method) (CSPF)
 Confidence_interval (percentile) (SSPO)
 Notes (text) (SSPO)

NEXT_OF_KIN: The next of kin of an identified remains.

Attributes: Name (FN, MI, LN) (CSPF)
 Address (Street, City, State, Postal) (CSPO)
 Phone (valid phone numbers) (SSPO)
 Email (valid email) (SSPO)

OMI_EMPLOYEE: A user who works with OMI.

Attributes: Department (specific to OMI) (SSPF)
 Job_title (specific to OMI) (SSPF)

PATHOLOGICAL_CONDITIONS: Abnormal anatomical or physiological conditions and disease expression.

Attributes: Condition (text) (SSPF)
 Description (text) (SSPF)
 Signs_of_condition (text) (SSPF)

POST-MORTEM_INTERVAL: The interval between time of death and time of finding the body.

Attributes: Is_estimate (boolean)
Deceased_date (DD/MM/YYYY)
Post_mortem_interval(Deceased_date - Date_found from TAPHONOMY or from F)
Notes (text)

PROFILE_VALUE_ESTIMATION_METHOD: Method used to estimate one of the for biological profile values: age, bioaffinity, sex, and stature.

Attributes: Value_to_estimate (text) (SSPF)

REMAINS: The body of a decedent. REMAINS can belong to OMI or to LOHO. They can be classified as PREHISTORIC, HISTORIC, or MODERN.

Attributes: **Id_number** (either case number or MAN) (SSPF)
Directory (filepath) (SSPF)
Location (text) (SSPF)
Cause_of_death (text) (SMPO)

TAPHONOMIC_ALTERATION: Specific ways in which body parts and/or bones have been altered. This includes weathering, sun-bleaching, animal activity (carnivore and/or rodent) and, soil staining.

Attributes: Alteration (text) (CSPF)
Altered_body_parts (text) (CMPO)
Altered_skeletal_elements (CMPO)
Notes (text) (SSPO)

TAPHONOMY: The conditions the remains were found.

Attributes: Date_found (DD/MM/YYYY) (SSPF)
Address_found (Street, City, State, Postal) (CSPO)
Where_found (inside/outside) (SSPF)
Type_of_find (text) (SSPF)
Artifacts (text) (SMPF)

TRAUMA: Trauma observed on the remains. Can be thermal damage, sharp force, blunt force, or projectile. The number_of_instances field indicates the number of times the trauma was inflicted on a particular part of the anatomy (i.e. 5 sharp force instances to the chest)

Attributes:	Trauma (text)	(SSPF)
	Affected_body_part (text)	(SMPF)
	Number_of_instances (int)	(SSPF)
	Notes (text)	(SSPO)

EMPLOYEE: A user of the system. The employees are either OMI or LOHO staff.

Attributes:	<u>Unm_id</u> (text)	(SSPF)
	Name (FN, MI, LN)	(CSPF)

3.3 Relationships

The relationships in this schema are listed and described below.

altered_by Specific taphonic alterations are noted as altering the remains. This does not include taphonic alterations to bones.

analyzed Indicates that a DNA sample was drawn from a set of remains and analyzed.

assigned_to OMI staff member(s) assigned to a case in some sort of investigatory capacity.

conducted A skeletal inventory of a set of remains was conducted.

estimated A biological profile value is estimated for the remains.

estimated_by A biological profile value is estimated by a specified estimation method.

evaluated_by The method by which a post-mortem interval is estimated.

evidence_of Indicates that there is evidence of a specific taphonomic alteration on a particular bone. This will facilitate the building of the homunculus in the final report.

has_*_bones This indicates that the specific skeletal sub class has an inventoried bone of the type indicated by the wildcard.

has_evaluated Indicates that a post-mortem interval has an estimated post-mortem interval

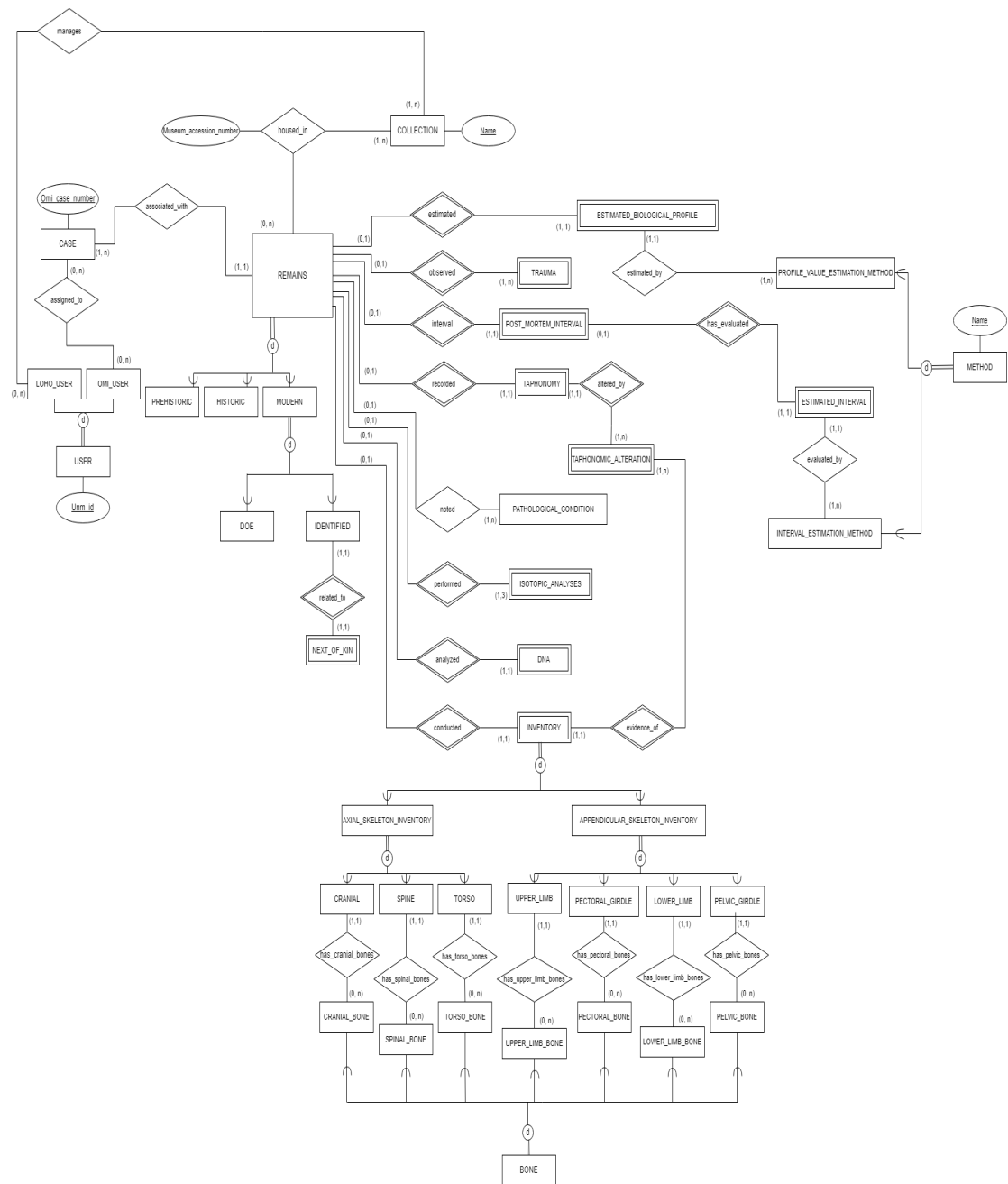


Figure 1: OMI Database EER

housed_in Remains belong to a LOHO Collection, whether for storage (OMI DOE) or because they are museum property.

Attributes: Museum_accension_number (CMPF)
Date_acquired (dd/mm/yyyy) (CSPF)

interval The association of a post-mortem interval with a set of remains.

manages LOHO staff member(s) responsible for managing and overseeing a Collection.

noted Any noted pathological conditions affecting a set of remains.

observed A type of trauma is observed on the remains.

performed Indicates that at least one isotopic analysis was conducted on a set of remains.

recorded The taphonomy of a set of remains is recorded to its record.

related_to Identifies the next of kin of an identified set of remains.

3.4 Explicit Integrity Constraints

These integrity constraints are applicable to the provided EER diagram.

1. If remains are "housed_in" a LOHO Collection, they are of the following possible categories:
 - OMI DOE remains that are released to LOHO for storage only. These remains are housed in the OMI Collection.
 - OMI DOE remains that are released to LOHO for storage and then later donated to LOHO will retain their OMI case number but be re-assigned from the OMI Collection to an appropriate collection.
 - OMI Identified remains that are unclaimed.
 - Remains that are acquired by LOHO through some other means.
2. Remains in the OMI Category belong to OMI and not to LOHO.
3. There is no overlap between OMI staff and LOHO staff.
4. Any remains in a Collection that is not OMI belong to the museum.

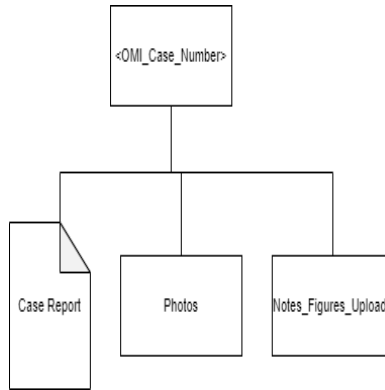


Figure 2: OMI Case Directory Structure

5. CASE directories have the above file structure:
6. REMAINS have the following file structure:

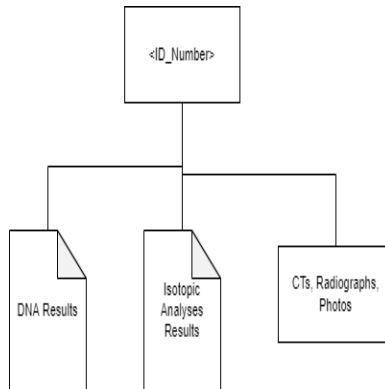


Figure 3: REMAINS Directory Structure

7. METHOD has the following file structure:
8. If multiple OMI cases are associated with the same set of remains, the cases will be consolidated and the remains' inventory will be updated to accurately reflect the total collection of bones.
9. The maximum number of bones an inventory may have is 300.
10. If an Inventory has more than 206 bones than the Life_stage of the associated remains cannot have the value "adult", "middle-aged adult",

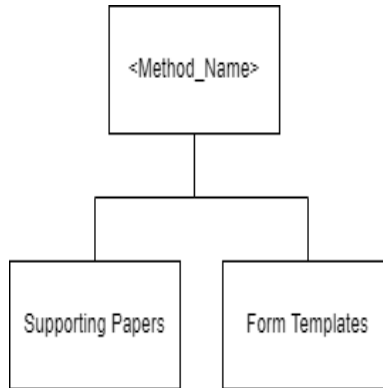


Figure 4: METHOD Directory Structure

or "senior adult" unless there is an associated Pathological Condition that accounts for the extra bones.

11. A Taphonomic Alteration associated with a Taphonomy must select at least one Altered_body_part. Similarly, a Taphonomic Alteration associated with an Inventory must select at least one Altered_skeletal_element.

4 Example Queries

A list of the most important queries

1. All OMI or LOHO remains with all biophysical properties.
2. All LOHO remains by collection and location.
3. All open OMI cases grouped by assigned OMI employee.
4. All OMI or LOHO remains with DNA analysis completed and link to said analysis.
5. All unidentified OMI remains.
6. OMI cases by cause of death and trauma type.

5 Possible extensions and additional comments

5.1 Possible extensions

Extracting some data from the case files would allow us to build out more complex queries targeted to use by law enforcement. For example, adding the location of where the remains were discovered could allow for queries to be grouped by trauma type, cause of death, and location. This could potentially help to identify overlap between victims that could indicate a commonality in perpetrator.

5.2 Supported applications

The database will support a number of applications to include:

(a) Case Report View:

A web application wherein users can view and print case summaries, in-depth case findings, photos, and final reports.

Part of this application is a “homunculus builder” that will generate a homunculus based on data in the database.

(b) Case Builder:

A web application for data entry.

(c) Anthropological Research Tool:

A web application to allow OMI, LOHO, and members of the UNM Anthropology Department (ANTH) to request data using various query forms.

(d) Biophysical Metrics

A web application that allows for the comparison of the estimated biophysical profile (Age, Sex, Stature, and Bioaffinity/Ancestry) to the actual biophysical profile if/when an asset is positively identified.

(e) Machine Learning Analysis

Machine learning algorithms could be applied to the data in order to identify patterns and potential connections between victims which may be helpful especially for DOE cases.

6 Logical Relational Schema (LRS)

The conceptual schema described for the OMI Database is mapped into the Relational Schema presented in this section. All the attributes underlined in the same Relation belong to the primary key. By default all the attributes that do not belong to the primary key or are not a directory filepath may be null, unless explicitly specified that they cannot be null.

BIOLOGICAL_PROFILE(*id*, *Remains_id*, *Last_name*, *First_name*, *Middle_initial*, *Age*, *Bioaffinity*, *Sex*, *Stature*, *Postal_code*)

The only fields that may be NULL are Middle.initial and Postal.code.

Domains:	<i>id</i>	integer generated automatically
	<i>Remains_id</i>	ID from the REMAINS relation
	<i>Last_name</i>	Name of identified person
	<i>First_name</i>	Name of identified person
	<i>Middle_initial</i>	Name of identified person
	<i>Age</i>	integer value in months
	<i>Bioaffinity</i>	African (Black), Asian, European (White), Hispanic, Native American
	<i>Stature</i>	height in cm
	<i>Postal_code</i>	if known

Foreign Keys: *Remains_id*

BIOLOGICAL_PROFILE_VALUE_ESTIMATION(*Id*, *Remains_id*, *Estimation_method*, *Measurements*)

No fields in this Relation may be Null.

Domains:	<i>Remains_id</i>	ID from the REMAINS relation
	<i>Estimation_method</i>	Name of method from METHOD relation
	<i>Measurements</i>	Measurements associated with the method being applied

Foreign Keys: *Remains_id* and *Estimation_method*

BONE(Id, *Bone_name*, *Part_of_skeleton*)

Parts of the skeleton are: Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle.

No fields may be null.

Domains:	id	automatically generated integer
	Bone_name	Valid bone name (see Appendix)
	Part_of_skeleton	Valid section of skeleton (see list above)

COLLECTION(Name, *Description*, *Location*, *Managed_by_employee*)

Domains:	Name	Name of the collection
	Description	Description of the type of remains the collection houses
	Location	Primary building and room where the collection is housed
	Managed_by_employee	Maxwell/LOHO employee id of person who manages the collection

Foreign Keys: Managed_by_employee

CRANIAL_INVENTORY(*Inventory_id*, Id, *Bone*, *Part_of_skeleton*, *Percent_bone_complete*, *Taphonomic_alteration*, *Trauma*, *Bone_observed_damage*, *Notes*)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

DNA(*Analysis_id*, *Remains_id*, *Date_analyzed*, *Skeletal_element*, *Part_of_Skeleton*)

No fields may be null

Domains:	Analysis_id	Auto-generated key
	Remains_id	ID from the REMAINS relation
	Date_analyzed	Date analysis was performed
	Skeletal_element	Bone name where the sample was drawn
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle

Foreign Keys: Remains_id, Skeletal_element, and Remains_id

EMPLOYEE(*Unm_id*, *Last_name*, *First_name*, *Middle_initial*, *Department*, *Organization*)

If the Department is Maxwell, the Organization is limited to only be LOHO.

Domains:	Unm_id	Employee's UNM ID number
	Last_name	Employee's last name
	First_name	Employee's first name
	Middle_initial	Employee's middle initial(s)
	Department	OMI or Maxwell
	Organization	OMI organization or LOHO if Maxwell

ESTIMATED_BIOLOGICAL_PROFILE(*Remains_id*, *Profile_id*, *Estimated_age*, *Estimated_bioaffinity*, *Estimated_sex*, *Estimated_stature*)

No fields may be null

Domains:	Profile_id	Auto-generated key
	Remains_id	ID from the REMAINS relation
	Estimated_age	Age range (e.g. 15 - 25 years)
	Estimated_bioaffinity	African (Black), Asian, European (White), Hispanic, Native American
	Estimated_sex	Male, Female, Undetermined
	Estimated_stature	Height in cm

Foreign Keys: Remains_id

ESTIMATED_POST-MORTEM_INTERVAL(Id, *Remains_id*, *Estimation_method*, *Observations*)

No fields may be Null.

Domains:	Id	automatically generated integer
	Remains_id	ID from the REMAINS relation
	Estimation_method	Method used to estimate the interval
	Observations	Observations that justify the estimation

Foreign Keys: Remains_id and Estimation_method

INVENTORY(Id, *Remains_id*, *Total_bones_present*, *Expected_bones*)

No fields may be null.

Domains:	Inventory_id	Auto-generated key
	Remains_id	ID from the REMAINS relation
	Total_bones_present	Count of total bones present per each of the sub-class inventories < 301
	Expected_bones	206 >= <i>Expected_bones</i> <= 300

Foreign Keys: Remains_id

ISOTOPIC_ANALYSIS(*Analysis_id*, *Remains_id*, *Analysis_type*, *Date_performed*, *Skeletal_element*)

No fields may be null

Domains:	Remains_id	ID from the REMAINS relation
	Analysis_type	Bulk carbon/nitrogen, strontium/oxygen, radiocarbon dating
	Date_analyzed	Date analysis was performed
	Skeletal_element	Bone name where the sample was drawn
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle

Foreign Keys: Remains_id, Skeletal_element, and Part_of_skeleton

LOWER_LIMB_INVENTORY(*Inventory_id*, *Id*, *Bone*, *Part_of_skeleton*, *Percent_bone_complete*, *Taphonomic_alteration*, *Trauma*, *Bone_observed_damage*, *Notes*)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

METHOD(*Method_ame*, *Method_directory*, *Special_considerations*, *Used_to_estimate_value*, *Measurements*, *Confidence_interval*, *Notes*)

Method_directory and Measurements may not be Null.

Domains:	Method_name	Name of the method
	Method_directory	Filepath to directory that holds method files
	Special_considerations	Considerations that may make the method inapplicable to special cases
	Used_to_estimate_value	(Age, Bioaffinity, Sex, Stature) or Post-mortem interval
	Measurements	Measurements associated with the method
	Confidence_interval	What is the CI for results returned using this method
	Notes	Any other items of relevance regarding the method

NEXT_OF_KIN(Id_number, Last_name, First_name, Middle_initial, Street, City, State, Country, Postal_code, Phone, Email, Remains_id)

Domains:	Id_number	Number from some sort of state-issued identification
	Last_name	NOK's last name
	First_name	NOK's first name
	Middle_initial	NOK's middle initial(s)
	Street	NOK's Street address
	City	NOK's city
	State	NOK's state
	Country	NOK's country
	Postal_code	NOK's postal code
	Phone	NOK's phone number X-XXX-XXX-XXXX
	Email	Valid email address for NOK
	Remains_id	ID of remains associated with the NOK

Foreign Keys: Remains_id

OBSERVED_PATHOLOGY(Id, Remains_id, Trauma, Pathology, Notes)

Only Notes may be NULL.

Domains:	Id	Automatically generated integer
	Remains_id	ID from the REMAINS relation
	Pathology	valid entry from PATHOLOGICAL_CONDITIONS relation
	Notes	Any other important details about the trauma

Foreign Keys: Remains_id

OMI_CASE(Omi_case_number, Case_directory, Assigned_to_employee)

The only field that can be null is the Assigned_to_employee.

Domains:	Omi_case_number	Valid alpha-numeric designation
	Case_directory	Filepath to directory that houses case files
	Assigned_to_employee	OMI employee id assigned to case

Foreign Keys: Assigned_to_employee

PATHOLOGICAL_CONDITION(Condition, Description, Signs_of_condition)

No fields in this Relation may be Null.

Domains:	Condition	Name of the pathological condition
	Description	Description of the pathological condition
	Signs_of_condition	How you can tell that someone has this condition

PECTORAL_GIRDLE_INVENTORY(Inventory_id, Id, Bone, Part_of_skeleton, Percent_bone_complete, Taphonomic_alteration, Trauma, Bone_observed_damage, Notes)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

PELVIC_GIRDLE_INVENTORY(*Inventory_id*, *Id*, *Bone*, *Part_of_skeleton*, *Percent_bone_complete*, *Taphonomic_alteration*, *Trauma*, *Bone_observed_damage*, *Notes*)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

POST-MORTEM INTERVAL(*Id, Is_estimated, Deceased_date, Post-mortem_interval, Notes*)

The only fields that may be null here are Deceased_date and Notes.
Deceased_date is Null only if Is_estimated is False.

Domains:	Interval_id	Auto-generated key
	Remains_id	ID from the REMAINS relation
	Is_estimated	Boolean indicating if estimated or known interval
	Deceased_date	Date of death
	Post-mortem_interval	Estimated or known time between death and discovery in weeks
	Notes	Notes regarding the interval analysis

Foreign Keys: Remains_id

REMAINS(*Id, Directory, Location, Cause_of_death, Isotopic_analysis_performed, DNA_analyzed, Trauma_observed, Pathological_condition_observed, Collection, Musuem_assencion_number, Omi_case_number*)

The attributes allowed to be NULL are Collection, Musuem_assencion_number, and Omi_case_number.

Domains:	Id	Automatically generated integer
	Directory	Filepath to directory housing remains' files
	Location	Location where the remains are stored
	Cause_of_death	Accidental, Homicide, Natural, or Suicide pathological conditions
	Isotopic_analysis_performed	Boolean indicating if this analysis was performed
	DNA_analyzed	Boolean indicating if DNA was analyzed
	Trauma_observed	Boolean indicating if Trauma is observed
	Pathological_condition_observed	Boolean indicating observation
	Collection	Collection where remains are housed
	Musuem_assencion_number	alpha-numeric designation indicating ownership
	Omi_case_number	valid case number from OMI_CASE relation

Foreign Keys: Collection and Omi_case_number

SPINE_INVENTORY(*Inventory_id*, *Id*, *Bone*, *Part_of_skeleton*, *Percent_bone_complete*, *Taphonomic_alteration*, *Trauma*, *Bone_observed_damage*, *Notes*)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

TAPHONOMIC_ALTERATION_TO_REMAINS(*Id*, *Remains_id*, *Taphonomic_alteration*, *Altered_body_part*, *Notes*)

Only Notes may be NULL.

Domains:	Id	Automatically generated integer
	Remains_id	id from the REMAINS relation
	Alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Altered_body_parts	Body parts affected by alteration
	Notes	Any other important details about the alteration

Foreign Keys: Remains_id

TRAUMA_ON_REMAINS(*Id*, *Remains_id*, *Trauma*, *Affected_body_part*, *Trauma_count*, *Notes*)

Only Notes may be NULL.

Domains:	Id	Automatically generated integer
	Remains_id	ID from the REMAINS relation
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Affected_body_parts	Body part affected by trauma
	Trauma_count	Number of times the trauma is observed in the body part
	Notes	Any other important details about the trauma

Foreign Keys: Remains_id

TORSO_INVENTORY(*Inventory_id*, *Id*, *Bone*, *Part_of_skeleton*, *Percent_bone_complete*, *Taphonomic_alteration*, *Trauma*, *Bone_observed_damage*, *Notes*)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

UPPER_LIMB_INVENTORY(*Inventory_id*, *Id*, *Bone*, *Part_of_skeleton*, *Percent_bone_complete*, *Taphonomic_alteration*, *Trauma*, *Bone_observed_damage*, *Notes*)

The only attributes that can be Null are Bone_observed_damage, Taphonomic_alteration, Trauma, and Notes.

Domains:	Inventory_id	ID from the INVENTORY relation
	Id	Automatically generated integer id
	Bone	Cranial Bone (See Appendix)
	Part_of_skeleton	Cranial, Spine, Torso, Upper Limb, Lower Limb, Pelvic Girdle, and Pectoral Girdle
	Percent_bone_complete	1% - 100%
	Taphonomic_alteration	Weathering, sun-bleaching, carnivore activity, rodent activity, soil staining
	Trauma	Thermal damage, sharp force, blunt force, or projectile
	Bone_observed_damage	Any non-taphonomic damage such as cut marks
	Bone_notes	Any other important details about the bone

Foreign Keys: Inventory_id, Bone, and Part_of_skeleton

6.1 Additional Integrity Constraints for the relational schema

- All bone names in sub-class inventories must have the same skeleton part as the name of the sub-class.
- Body parts are: Head, Face, Neck, Chest, Back, Genitals, Arms, Hands, Legs, Feet, Abdomen with left and right distinctions as appropriate.
- The PROFILE_VALUE_ESTIMATION_METHOD relation must be broken down into individual method estimations to better normalize the data. An example table, phenice_estimation is available in the SQL example tables. Other tables should be build with the assistance of the product owners.
- There is some redundancy in the presence of Part_of_skeleton across multiple tables. This was done as a work around to Oracle SQL limitations in not being able to use a SELECT query to limit column values. It should be revisited.

7 Appendix

7.1 List of Bones

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Cranial (28)	Torso (50)	UPPER LIMB (60)
Paired Bones, left and right	Paired Bones, left and right	Paired Bones, left and right
1 Nasal	1 Rib 1	1 Humerus
2 Lacrimal	2 Rib 2	2 Radius
3 Inferior Nasal Concha	3 Rib 3	3 Ulna
4 Maxillary	4 Rib 4	4 Scaphoid
5 Zygomatic	5 Rib 5	5 Lunate
6 Temporal	6 Rib 6	6 Triquetrum
7 Palatine	7 Rib 7	7 Pisiform
8 Parietal	8 Rib 8 (False)	8 Hamate
9 Malleus	9 Rib 9 (False)	9 Capitate
10 Incus	10 Rib 10 (False)	10 Trapezoid
11 Stapes	11 Rib 11 (Floating)	11 Trapezium
Individual Bones	12 Rib 12 (Floating)	12 Metacarpal 1
1 Frontal	Individual Bones	13 Proximal Phalange 1
2 Ethmoid	1 Hyoid	14 Distal Phalange 1
3 Vomer	2 Sternum	15 Metacarpal 2
4 Sphenoid	SPINE (24)	16 Proximal Phalange 2
5 Mandible	1 Cervical Vertebrae 1 (atlas)	17 Middle Phalange 2
6 Occipital	2 C2 (axis)	18 Distal Phalange 2
	3 C3	19 Metacarpal 3
	4 C4	20 Proximal Phalange 3
	5 C5	21 Middle Phalange 3
	6 C6	22 Distal Phalange 3
	7 C7	23 Metacarpal 4
	8 Thoracic Vertebrae 1	24 Proximal Phalange 4
	9 T2	25 Middle Phalange 4
	10 T3	26 Distal Phalange 4
	11 T4	27 Metacarpal 5
	12 T5	28 Proximal Phalange 5
	13 T6	29 Middle Phalange 5
	14 T7	30 Distal Phalange 5
	15 T8	
	16 T9	
	17 T10	
	18 T11	
	19 T12	
	20 Lumbar Vertebrae 1	
	21 L2	
	22 L3	
	23 L4	
	24 L5	

PECTORAL GIRDLE (4)	LOWER LIMB (60)
Paired Bones, left and right	Paired Bones, left and right
1 Scapula	1 Femur
2 Clavicle	2 Patella
	3 Tibia
	4 Fibula
PELVIC GIRDLE (4)	5 Talus
Paired Bones, left and right	6 Calcaneus
1 Hip	7 Navicular
Individual Bones	8 Medial Cuneiform
1 Sacrum	9 Middle Cuneiform
2 Coccyx	10 Lateral Cuneiform
	11 Cuboid
	12 Metatarsal 1
	13 Proximal Phalange 1
	14 Distal Phalange 1
	15 Metatarsal 2
	16 Proximal Phalange 2
	17 Middle Phalange 2
	18 Distal Phalange 2
	19 Metatarsal 3
	20 Proximal Phalange 3
	21 Middle Phalange 3
	22 Distal Phalange 3
	23 Metatarsal 4
	24 Proximal Phalange 4
	25 Middle Phalange 4
	26 Distal Phalange 4
	27 Metatarsal 5
	28 Proximal Phalange 5
	29 Middle Phalange 5
	30 Distal Phalange 5