Use of MicroScribe Digitizer

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1   INTRODUCTION

This document provides instructions for the use of the MicroScribe Digitizer and associated software programs for transferring digitized data. The MicroScribe Digitizer is a tool for collecting 3-dimensional coordinate data from osteometric landmarks of the cranium and mandible for estimation of sex and ancestry. This can replace or complement 2-dimensional data collection procedures.

2   SCOPE

This document applies to Anthropology Examiners and Physical Scientists in the Trace Evidence Unit (TEU) who utilize the MicroScribe Digitizer.

3   EQUIPMENT

- MicroScribe G2LX digitizer, or equivalent
- 3Skull software
- Advantage Data Architect ("ARC") software
- Fordisc 3.1 (or more recent version) software
- Cranium stand (e.g., tri-column clay and/or acrylic stand, or equivalent)
- Mandible stand (e.g., tri-column clay and/or acrylic stand, or equivalent)
- Clay
- Mirror
- Pencil
- Rubber band

4   PROCEDURE

4.1   Preparing the Digitizer

A. Check the connections between the digitizer and computer and the digitizer and the input accessory (hand switch or foot pedal) to ensure they are secure. Check the stylus tip to ensure it is secured.
B. Home the digitizer by placing the stylus in the stylus holder and pressing the white Home button in the back of the base.
C. Assess the digitizer system to ensure it is in "Normal operation" status using the LED indicator on the base (see Table 1).

Table 1: *LED status indicator (adapted from Revware Systems 2009)*

LED Status	Device Status	Details
OFF	OFF	The MicroScribe system is not powered.
RED (Flashing)	Powered	The MicroScribe system is powered but is not homed and is not communicating with the computer.
RED	Not homed	The MicroScribe system is communicating with the computer but has not been homed.
GREEN (Flashing)	Connection lost	The MicroScribe system has been homed but is not communicating with the computer.
GREEN	Normal operation	The MicroScribe system has been homed and is communicating with the computer.

4.2 Preparing the Cranium and Mandible for Digitizing

A. Mark instrumentally determined landmarks (see Appendix A) using a pencil. Other landmarks may also be marked at the discretion of the examiner.

B. If alveolon will be captured, place a thin rubber band around the alveolus.

C. Place and stabilize the cranium on the stand such that all landmarks are accessible and the digitizer arm can reach all of the landmarks. Typically, two of the three columns are positioned behind the left and right mastoid processes, and the third is positioned under the left or right molars. Clay can be used to stabilize the cranium if using an acrylic stand. The orientation of the cranium is not important.

D. Place and stabilize the mandible on the stand such that all landmarks are accessible and the digitizer arm can reach all of the landmarks. Clay can be used to stabilize the mandible on the stand. The orientation of the mandible is not important.

E. Once digitizing has begun, the positions of the cranium and mandible cannot be changed.

4.3 Preparing the 3Skull Program

A. Open the 3Skull (Ousley 2014) program so that the control screen is visible.

B. The "CATKEY" field entry is not important; "Anthro" or other generic discipline indicator can be entered. Enter the Laboratory Number into the "Individual" field.

C. Enter the initials of the examiner into the "Recorder" field.

D. Select the radio button for the "MicroScribe" digitizer.

E. Select the Coordinate Table ("coord") into which the data will be entered, which should be "3DCoords.adt" (which stores the raw x, y, and z coordinates). If it does not exist, it can be created by selecting "New."

F. Create a new Craniometric Table ("cran") file (which converts landmarks to interlandmark distances) by clicking the "New" button. The file name should be [Lab Number]cran[Initials].adt. It is recommended that a new "cran" file is created for each case.

G. Select the most current landmark table which provides the landmark ordering for 3Skull. "Lndmrk13F.ADT" is the most current file. The file version should be periodically checked and updated (along with Appendix A) as needed. If it does not

exist, it can be downloaded from http://math.mercyhurst.edu/~sousley/Software/ and saved to the "refdbs" folder within the digital 3Skull folder; then close and reopen 3Skull.

H. Select the "Start" button to begin digitizing. Once digitizing begins, it must be completed in a single session. If the 3Skull data collection screen is closed, the case cannot be reopened.

4.4   Digitizing the Cranium and Mandible

A. The digitizer should be tested prior to each digitizing session. To test, after clicking the "Start" button, click the "Test" button. Collect two data points from a ruler or caliper by placing the stylus tip at the first point and pressing the capture button on the input accessory. The yellow "Ready" label should then be displayed. Next, move the stylus tip to a second point and press the capture button. The calculated distance will be displayed in mm and should correspond to the distance between the two points on the ruler or caliper. Testing can be repeated. To end the test mode, click the "Test" button again.

B. If the cranium has any anomalies that may skew collected data (e.g., trauma, pathology, taphonomy, missing bone, etc.), the "Cranial reshaping" field should be changed from "N" (indicating no anomalies) to "Y" (indicating anomalies). The "Comments" field can be used to clarify the anomalies.

C. To begin digitizing, click the "X" coordinate field for the first measurement. The 3Skull program will then navigate the examiner through the osteometric points (see Appendix A). To collect each point, place the stylus onto the landmark and press the capture button. 3Skull will then automatically advance to the next landmark. Landmarks are as defined by Langley et al. (2016) which are derived from Howells (1973) and Martin &Knussmann (1988) unless otherwise noted. Fleishman & Crowder (2018) provide some useful tips and guidance for collecting certain landmarks.

D. Landmarks can be skipped (for example if they are not present) or recaptured (for example of the point was collected in error) using the manual controls to advance or go back. The "Erase XYZ" button removes the previous data point. If the field is not highlighted in green, the "X" coordinate will need be clicked to recapture the measurement.

E. Estimated measurements (for example due to missing or damaged bone) are not generally advised but may be used at the discretion of the examiner. Measurements that are estimated can be noted in 3Skull using the "Comments" field.

F. After osteometric landmarks for the cranium are captured, the program will advance to mandibular landmarks. The same procedures are followed as for the cranium.

G. Interlandmark distances and angles from the mandible can also be acquired using calipers and/or mandibulometer and manually entered into 3Skull in the "Data Review" field.

H. Arcs can be captured at any time during the data collection process, but it is recommended that they be captured following collection of osteometric landmarks. Arcs are collected by positioning the stylus on the starting point of the arc (see Appendix A), pressing and releasing the capture button, carefully dragging the stylus

across the surface of the bone to the terminal point of the arc, and then pressing and releasing the capture button again. Be sure the field turns back to yellow (indicating the digitizer is no longer collecting points) before removing the stylus from the terminal point.

I.   Once landmarks and arcs have been captured, save the data to the previously configured database files in the 3Skull folder by clicking "Add to DBs."

J.   3Skull will then perform a measurement check for outliers and possible errors. If there are no errors, the "Data Review" screen will be populated, and the program can be closed by clicking "OK." If errors are noted, manual navigation can be used to retake measurements. If 3Skull continues to indicate an error but the data point is believed to be correct, the "Skip Meas. Check" box can be selected.

K.   Open the ARC software and select the appropriate "cran" file through the path C:\Program Files\3Skull\data. Check to ensure that the data were converted to measurements. Export the measurements to a new (*.adt) table.

4.5   Importing Data into FORDISC

A.   Open FORDISC (Jantz & Ousley 2005) and open the exported table. The measurements from the table should populate the FORDISC input screen.

B.   Analyze data using standard procedures for FORDISC (Ousley & Jantz 2012, Jantz & Ousley 2017).

C.   The FORDISC file can be saved to the desktop or USB drive.

5   LIMITATIONS

The conclusions that can be reached from anthropological examinations are dependent on the condition and completeness of the submitted material. Limitations specific to particular examination may be found in the relevant procedures.

6   SAFETY

- While working with physical evidence, laboratory personnel will wear at least the minimum appropriate protective attire (e.g., laboratory coat, safety glasses, protective gloves).
- Universal precautions will be followed.
- Exposure to physical, biological, and chemical hazards may be associated with the examination techniques performed. Safety procedures related to specific materials, instruments or equipment will be followed. Refer to the FBI Laboratory Safety Manual for guidance.

7   REFERENCES

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Jantz, R.L., Ousley, S.D. Introduction to FORDISC 3 and Human Variation Statistics. In: Langley NR and Tersigni-Tarrant MTA, Forensic Anthropology: A Comprehensive Introduction, Second Edition. Boca Raton: CRC Press, p. 255-270, 2017.

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8   REVISION HISTORY

Revision	Issued	Changes
00	08/02/2021	Original document issued.
01	01/28/2022	Formatting and language changes to conform to new template.

The most recent landmark list for 3Skull is "**Lndmrk13F**" (as of November 2018) and contains a total of 111 landmarks. Shaded landmarks are instrumentally determined and must be marked prior to digitizing.

Cranium Landmarks

#	Landmark	Measurement	Brief Description
1	Prosthion-Howells	BPL, NPH	Midline point at the most anterior point on the alveolar process of the maxillae.
2	Prosthion-Martin	UFHT	Midline point at the inferior tip of the alveolar process of the maxillae
3	Subspinale	SSR, SSS	The deepest point seen in the profile below the anterior nasal spine.
4	Alare L	NLB	The most lateral point on the margin of the nasal aperture taken on the anterior surface.
5	Most inferior nasal border L	NLH	Actual floor of the nasal cavity, taken inside the nasal aperture if there is guttering or the stylus will fit into the nasal aperture. If there is a nasal sill, place stylus on the anterior surface of the maxilla to approximate the location of nasal floor.
6	Most inferior nasal border R	NLH	
7	Alare R	NLB	The most lateral point on the margin of the nasal aperture taken on the anterior surface.
8	Zygoorbitale L	MOW, IML, XML	The intersection of the orbital margin and the zygomaticomaxillary suture.
9	Nasale inferius L		The most inferior point where the nasal touches the maxilla.
10	Nasale inferius R		
11	Zygoorbitale R	MOW, IML, XML	The intersection of the orbital margin and the zygomaticomaxillary suture.
12	Lower orbital border L/R	OBH (inf. point)	The height between the upper and lower borders of the left orbit, perpendicular to the long axis of the orbit and bisecting it. Internal measurement.
13	Upper orbital border L/R	OBH (sup. point)	
14	Cheek height superior point L/R	WMH	The minimum distance, in any direction, from the lower border of the orbit to the lower margin of the maxilla, medial to the masseter attachment.

15	Cheek height inferior point L/R	WMH	
16	Ectoconchion L	OBB, EKB	The intersection of the most anterior surface of the lateral border of the orbit and a line bisecting the orbit along its long axis.
17	Dacryon L	OBB, DKB	Anterior border of the junction of the lacrimal and frontal. Apex of lacrimal fossa on the frontal bone.
18	Nasale superius L		The most superior point where the nasal touches the maxilla.
19	Nasomaxillary suture pinch L	WNB	The minimum transverse breadth across the two nasal bones.
20	Nasomaxillary suture pinch R	WNB	
21	Nasale superius R		The most superior point where the nasal touches the maxilla.
22	Dacryon R	DKB	Anterior border of the junction of the lacrimal and frontal. Apex of lacrimal fossa on the frontal bone.
23	Ectoconchion R	EKB	The intersection of the most anterior surface of the lateral border of the orbit and a line bisecting the orbit along its long axis.
24	Zygion R	ZYB	Maximum lateral extent of the zygomatic arch.
25	Zygotemporale inferior R	IML, XML	Point at the inferior zygotemporal suture on the zygomatic process.
26	Zygotemporale superior R	IML, XML	Point at the superior zygotemporal suture on the zygomatic process.
27	Zygomaxillare R	ZMB	Intersection of zygomaxillary suture and limit of the attachment of the masseter muscle, on the facial (most anteriorly projecting) surface of the zygomaxillary suture.
28	Zygomaxillare L	ZMB, IML	
29	Zygotemporale superior L		Point at the superior zygotemporal suture on the zygomatic process.
30	Zygotemporale inferior L	IML, XML	Point at the inferior zygotemporal suture on the zygomatic process.
31	Zygion L	ZYB	Maximum lateral extent of the zygomatic arch.
32	Jugale L	JUB	Deepest curvature of the zygomatic angle, taken laterally, not on the margin.
33	Marginal process lateral L		Point at the lateral-most aspect of the marginal process of the zygomatic.

34	Frontomalaretemporale L	UFBR	Point where the frontozygomatic suture crosses the temporal line.
35	Frontomalare anterior L	FMB, NAS	Point where the frontozygomatic suture intersects with the orbit.
36	Frontotemporale L	WFB	Point generally anterior and medial along the temporal line (minimum frontal breadth).
37	Sphenofrontale L		Point where the sphenoid, frontal, and zygomatic sutures intersect.
38	Sphenion L		The anterior tip of the parietal (the intersection of the parietal and sphenoid at the coronal suture).
39	Krotaphion L		The superior-posterior tip of the greater wing of the sphenoid.
40	Maximum frontal point L	XFB	Instrumentally-determined, maximum frontal breadth; on the coronal suture.
41	Stephanion L	STB, STS	Point where the coronal suture crosses the temporal line (left and right).
42	Stephanion R	STB, STS	
43	Maximum frontal point R	XFB	Instrumentally-determined, maximum frontal breadth; on the coronal suture.
44	Krotaphion R		The superior-posterior tip of the greater wing of the sphenoid.
45	Sphenion R		The anterior tip of the parietal.
46	Sphenofrontale R		Point where the sphenoid, frontal, and zygomatic sutures intersect.
47	Frontotemporale R	WFB	Point generally anterior and medial along the temporal line on the frontal bone that, when paired with Frontotemporale L, measures the minimum frontal breadth.
48	Frontomalare anterior R	FMB, NAS	Point where the frontozygomatic suture intersects with the orbit. Point is taken anterior.
49	Frontomalaretemporale R	UFBR	Point where the frontozygomatic suture crosses the temporal line. This is taken on the frontozygomatic suture at the most lateral point – wherever that point may be.
50	Marginal process lateral R		Point at the lateral-most aspect of the marginal process of the zygomatic.
51	Jugale R	JUB	Deepest curvature of the zygomatic angle, taken laterally, not on the margin.

52	Nasion	NOL, NLH, NAS	Point of intersection of the nasofrontal suture and the mid-sagittal plane, on the frontal bone.
53	Glabella	GOL	The most forwardly projection point in the mid-sagittal plane at the lower margin of the frontal bone.
54	Supraglabellare	GLS	The point at which the convex profile of the frontal bone changes to join the prominence of the glabellar region.
55	Bregma	FRC, PAC, BBH	Point where the coronal and sagittal sutures intersect.
56	Lambda	PAC, OCC	Point where the sagittal and lambdoidal sutures meet.
57	Asterion L	ASB	The point where the lambdoidal, parietomastoid, and occipitomastoid sutures meet.
58	Eurion L	XCB	Instrumentally-determined, ectocranial point of greatest cranial breadth.
59	Radiometer point L	radii NAR, BRR.	Taken inside the EAM, "floating." Refer to section 9.7 for instructions.
60	Porion L	MDH	Point at the most superior aspect of the EAM.
61	Mastoideale L	MDH	Point at the most inferior tip of the mastoid.
62	Radiculare L	AUB	Deepest point on the zygomatic root (bi-auricular breadth).
63	Radiculare R	AUB	
64	Radiometer point R	radii NAR, BRR.	Taken inside the EAM, "floating." Refer to section 9.7 for instructions
65	Porion R	MDH	Point at the most superior aspect of the EAM.
66	Mastoideale R	MDH	Point at the most inferior tip of the mastoid.
67	Eurion R	XCB	Instrumentally-determined, ectocranial point of greatest cranial breadth.
68	Asterion R	ASB	The point where the lambdoidal, parietomastoid, and occipitomastoid sutures meet.
69	Opisthion	FOL	Midline point at the posterior margin of the foramen magnum.
70	Basion	BBH, BNL	Midline point at the anterior margin of the foramen magnum.
71	FOB Point R	FOB	Foramen magnum breadth.
72	FOB Point L	FOB	

73	Hormion		The most posterior midline point on the vomer.
74	Alveolon	MAL	Use rubber band. Point on the interpalatal suture where the line drawn between the posterior ends of the alveolar ridges crosses the midline.
75	Staurion		The point at the intersection of the median and transverse palatine sutures.
76	Ectomolare L	MAB	Widest part of the alveolar maxilla, around M2.
77	M1 Anterior Point L	AVR	Anterior/mesial margin of the left first molar, on the alveolus.
78	Ectomolare R	MAB	Widest part of the alveolar maxilla, around M2.

Mandible Landmarks

#	Landmark	Measurement	Brief Definition
79	Pogonion	XRL, MAN	Most anterior midline point on the chin of the mandible.
80	Gnathion	GNI	The most inferior midline point on the mandible.
81	Infradentale	GNI	The midline point on the alveolar bone between the two central mandibular incisors.
82	HMF inferior point L/R	HMF	Mandibular body height at the mental foramen.
83	HMF superior point L/R	HMF	
84	TMF buccal point L/R	TMF	Mandibular body breadth at the mental foramen.
85	TMF lingual point L/R	TMF	
86	Gonion L	GOG	The most lateral external point at the junction of the horizontal and ascending rami.
87	Mandibular angle base L	MAN	Point on the posterior base of the mandible as if you were measuring ramus height with a mandibulometer.
88	Coronion L		Point at the tip of the coronoid process of the mandible.
89	Inf mandibular notch point L		Lowest point between condyle and coronion.
90	Condylionlaterale L	BCB	Lateral-most projection of the mandibular condyle.
91	Sup condyle L		Highest point on the mandibular condyle.
92	Sup condyle post L	CDL, MAN	Perpendicular to the highest point on the mandibular condyle as if it were sitting in a mandibulometer.
93	Condylionmediale L		Medial-most projection of the mandibular condyle.
94	Condylionmediale R		Medial-most projection of the mandibular condyle.
95	Sup condyle R		Highest point on the mandibular condyle.
96	Sup condyle post R		Perpendicular to the highest point on the mandibular condyle as if it were sitting in a mandibulometer.
97	Condylionlaterale R	BCB	Lateral-most projection of the mandibular condyle.

98	Inf mandibular notch point R		Lowest point between condyle and coronion.
99	Coronion R		Point at the tip of the coronoid process of the mandible.
100	Mandibular angle base R	MAN	Point on the posterior base of the mandible as if you were measuring ramus height with a mandibulometer.
101	Gonion R	GOG	The most lateral external point at the junction of the horizontal and ascending rami.
102	WRB posterior point (R or L)	WRB	Minimum ramus breadth.
103	WRB anterior point (R or L)	WRB	

Calculated Points (No Need to Digitize)

#	Landmark	Measurement	Brief Definition
104	Nasal bone elevation	SIS, SIA	Calculated from nasal arc.
105	Deepest point on nasal bone profile	NDS, NDA	Calculated from nasal arc.
106	Max malar projection point L/R	MLS	Calculated from malar arc.
107	Metopion	FRF, FRS	Instrumentally-determined, point where the frontal's elevation above the chord from nasion to bregma is greatest.
108	Parietal subtense point	PAF, PAS	The maximum subtense, at the highest point on the convexity of the parietal bones, within the bregma-lambda chord, in midline.
109	Vertex radius point	VRR	Instrumentally-determined, the highest point at midline when the skull is in Frankfurt Horizontal.
110	Opisthocranion	GOL	Instrumentally-determined, the furthest point from glabella in midline.
111	Occipital subtense point	OCF, OCS	The maximum subtense, at the highest point on the convexity along the lambda-opisthion chord, in midline.

Arcs

#	Arc	Measurement	Quick Description
1	Frontal Arc	FRA	From bregma to nasion. (P to A)
2	Parietal Arc	PAA	From lambda to bregma. (P to A)
3	Occipital Arc	OCA	From opisthion to lambda. (A to P)
4	Malar Arc	MAA	From zygoorbitale to zygotemporale*inferior*. (M to L)
5	Nasal Arc	NAA	From nasion to rhinion. (S to I)