Mobile GIS for Excavations in Andean Archaeology

The Good, Bad, & the Ugly

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Outline

• Brief overview of two mobile GIS systems for excavation/survey in the Andes

• ArcPad-based system for excavation (2006-2008) at an early colonial mission

• iPad-based mobile GIS for architectural survey (and eventual excavation) at a large planned colonial town
Case Study 1: Excavations at Malata

• Terminal prehispanic / early colonial settlement (mission)
• Three seasons of excavations (2006-2008)
• ArcPad-based mobile GIS (Tripcevich and Wernke 2010 [J. of Field Archaeology])
Reconstructing Community at Malata

- A micro-scale view of trans-conquest continuity and transformation
- Chronological considerations
- Reconstructing the site plan:
  - Inka - Initial Franciscan presence and construction of chapel
  - Growth and reorganization: "proto-reducción"
- Remapping community: network analysis
- Households: chronology, positionality, and range of activities
- 300 sq. m total excavation area
- 12 structures excavated
- Test pits (2006)
- Chapel (2007)
- Public and domestic contexts (2008)
Mapping & GIS Strategy

• Vector- & raster-based representations
  – Vectors: total station / on-screen plotting
  – Rasters: photomapping via PAP (Pole Aerial Photography)

• Attribute registry & data synchronization via customized ArcPad (running on Pocket PCs)

• Six excavation crews
Given standing architecture, a series of grids were established around structures/areas to be excavated.

Each grid was denoted with Roman Numeral.

Grid cells coded by letter/number (letter N-S, number E-W).

Within a Grid, excavation “Units” (e.g., a 4 x 4 m excavation area) were denoted by SW and NE cells.

Thus, a hierarchical provenience system: Grid>Unit>Cell (E.G. IV/C12-F15/C13)
Within each excavation unit, cultural unit of provenience was called a “locus” (each with unique ID code)
Photomapping
Photomap Image Archival System

- Hierarchical directories:
- C:\GIS_DATA
  \S_America_Atlas
  \Peru
  \Colca
  \Malata
  \Malata_photomaps
  \Grid_I
  \Unit_F6_H8
  \1075_1076_0197.jpg
ArcPad Form (Tabs)

<table>
<thead>
<tr>
<th>Surface_a</th>
<th>Surface_a</th>
<th>Surface_a</th>
<th>Surface_a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locus Num.</td>
<td>Locus Above</td>
<td>Locus Above</td>
<td>Locus Above</td>
</tr>
<tr>
<td>1198</td>
<td>1151</td>
<td>1112</td>
<td>1173</td>
</tr>
<tr>
<td>Locus Subtype</td>
<td>Locus Below</td>
<td>Locus Below</td>
<td>Locus Below</td>
</tr>
<tr>
<td>Prepared Floor</td>
<td>Munsell Hue</td>
<td>Munsell Hue</td>
<td>Munsell Hue</td>
</tr>
<tr>
<td>Medium</td>
<td>Value</td>
<td>Value</td>
<td>Value</td>
</tr>
<tr>
<td>Subdatum</td>
<td>Soil Type</td>
<td>Soil Type</td>
<td>Soil Type</td>
</tr>
<tr>
<td>SD</td>
<td>Silty Clay</td>
<td>Silty Clay</td>
<td>Silty Clay</td>
</tr>
<tr>
<td>Volume (L)</td>
<td>Soil Texture</td>
<td>Soil Texture</td>
<td>Soil Texture</td>
</tr>
<tr>
<td>88</td>
<td>Compact</td>
<td>Compact</td>
<td>Compact</td>
</tr>
<tr>
<td>Depths</td>
<td>Total Station Measurements</td>
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</tr>
<tr>
<td>Top</td>
<td>Top</td>
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<td>Bottom</td>
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<tr>
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<td>Total Station Measurements</td>
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<tr>
<td>Top</td>
<td>Bottom</td>
<td>Top</td>
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<tr>
<td>Perimeter</td>
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<td>Perimeter</td>
<td>Perimeter</td>
</tr>
<tr>
<td>Bag Inventory - Page 1</td>
<td>Bag Inventory - Page 2</td>
<td>Bag Inventory - Page 2</td>
<td>Bag Inventory - Page 2</td>
</tr>
<tr>
<td>Ceramics</td>
<td>Animal Bone</td>
<td>Animal Bone</td>
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<tr>
<td>1T</td>
<td>T</td>
<td>T</td>
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</tr>
<tr>
<td>Lithics</td>
<td>Human Bone</td>
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<tr>
<td>17</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundstone</td>
<td>Other</td>
<td>Other</td>
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<tr>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Metal</td>
<td>Other (delco)</td>
<td>Other (delco)</td>
<td>Other (delco)</td>
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<tr>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>Glass</td>
<td>Carbon</td>
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<tr>
<td>Shell</td>
<td>Soil</td>
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<tr>
<td>1</td>
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<tr>
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<td>Wall Stucco</td>
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<td>2</td>
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<td>Photos-Notes</td>
<td>Digital Notes</td>
<td>Digital Notes</td>
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<tr>
<td>Photo Numbers (84 84 84)</td>
<td>Interior burnt earth of 1192 Need TSPT</td>
<td>Interior burnt earth of 1192 Need TSPT</td>
<td>Interior burnt earth of 1192 Need TSPT</td>
</tr>
</tbody>
</table>

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**Notes:**
- Munsell Hue: 7 SYR, 5 YR, 3
- Soil Texture: Silty Clay, Compact
- Total Station Measurements: Perimeter
- Bag Inventory: Ceramics, Lithics, Groundstone, Metal, Glass, Shell, Botanical, Animal Bone, Human Bone, Other, Other (delco), Carbon, Soil, Wall Stucco
- Digital Notes: Interior burnt earth of 1192 Need TSPT
Infant (0–3 yrs)
Child (3–12)
Adult (25+)

Photomap: Extended supine adult in front of altar platform
The Good

• Drastically cut down data entry during evenings/weekends. Attribute tables basically ready for analysis.

• Speed: photomapping quickly captures imagery (compared to plotting with total station)

• More data, better documentation: raster & vector maps for all contexts
The Bad

- Notetaking hindered by interface
- Length of forms (though not long on paper) led some crew chiefs to rush through some parts
- Lack of one-to-many relationships limited functionality (especially for photos, Harris Matrix relations)
- Georeferencing of PAP images not possible in ArcPad. Must be done centrally (ArcMap) and later distributed
- Form editing/data synchronization cumbersome
The Ugly

- No integration with total station (junk geometry drawn on screen, later replaced in ArcMap)
- Clunky Windows Mobile interface
- Screens not very readable in bright sunlight
- Not a true 3D system. A series of plan views. Profiles still done on paper.
Case Study 2: Survey and Excavations at Mawchu Llacta
Mapping & GIS Strategy

• Establish ground control points
• Fly UAV over site (frame rate = 0.5 sec)
• Mosaic/orthorectify imagery via Agisoft Photoscan
• Digitize & record attributes for structures/walls/features/lichenometry on iPads via Garafa GISPro
• Four survey crews
GCPs

- $N = 53$
UAV Video
Sample (Low Res) Section of Mosaic
Muro 1 casi no conserva su altura, muro 5 ha colapsado en el centro pero conserva vano parcialmente

Forma
Cuadrangular

Forma_desc

Esq_ext_fe
Angular-ligada

Esq_int_fe
Redondeada

Rasgo_piso
no

Divisiones
0

Division_1

Temp_const
Colonial temprano
The Good

• Interface is much better
  – Still, for longform notes, I still think there is no substitute for pen and paper in the field

• Flexible. New attributes and dropdown menu items could be added by users in the field.

• Allows for georeferencing of images in the field, on screen (will be very useful for excavations)
The Bad

• No automated synchronization. We had to manually keep track of which teams had which batches of codes

• Also means that once data is synchronized and converted to shapefile, input form is lost and any edits must be manually tracked

• It’s iOS (locked down, difficult)

• It’s expensive ($300 per iPad)
The Ugly

• No desktop application. Loss of data forms when exporting to shapefile

• Notes that exceeded 255 characters were truncated (!)

• Projection problems (UTM nomenclature is different, and the projection changes slightly between GISPro/ArcMap)
Concluding Thoughts

• A successful FAIMS will require at least five capabilities:
• Minimal interface impedances, GUI, touch-based
• Flexible, field editable DB design w/ “any to any” capabilities
• Image management w/geo-/orthorectification
• Direct, live link w/total stations, other field instruments
• Easily managed data sync system
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