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GEOPAD: GIS-Enabled Field Science Education

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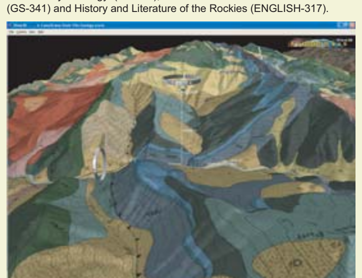
GeoPad/GeoPocket Concept

Fieldwork is a cornerstone of many scientific disciplines, particularly the natural sciences. It is generally the first-step in the scientific process of gathering, analyzing, and interpreting data. Whereas subsequent steps are typically accomplished once one has left the field, providing in-the-field access to all such capabilities significantly enhances educational and scientific practices. GeoPad and GeoPocket seek to accomplish this through the use of standard, commodity hardware and software and by the community-based development of best-practices that meet the demanding needs of the field student, instructor, and researcher.

Continuing innovation in Information Technology (IT), especially in the form of increasing performance and portability, new haptic interfaces, and advancements in Geographic Information System (GIS) and visualization software, enable in-the-field, real-time access to powerful data collection, analysis, visualization, and interpretation tools. The benefits of these innovations, however, can only be realized on a broad basis when the IT reaches a level of maturity at which users can easily employ it to enhance their learning experience and scientific activities, rather than the IT itself being a primary focus of the curriculum or a constraint on field activities.

We envision GeoPad/GeoPocket as novel combinations of these technologies that strive for that level of maturity. Generally speaking, GeoPad is a ruggedized Windows XP TabletPC and GeoPocket is a ruggedized PocketPC. They incorporate technologies such as, GIS, wireless networking, GPS, digital image capture, microphone-headset, and other supporting applications and technologies for gathering and working with spatially-referenced data.

In this poster we discuss our experience integrating GeoPads and GeoPockets in field courses, as well as preliminary results of an external, independent evaluation of their impact on curriculum and student learning in our advanced field course (GS-440). Building on our past two years experience with GS-440, we broadened the role of GeoPads for 2005, tackling new mapping projects, geophysical surveys, and field trips. We also piloted GeoPad and GeoPocket activities in our other field courses: Introductory Geology (GS-116), Environmental Science in the Rockies (GS-341) and History and Literature of the Rockies (ENGLISH-317).



Equipment

GeoPad and GeoPocket are generic concepts, built from readily-available, off-the-shelf, non-brand-specific hardware and software. The basic design criteria are derived from the needs of students, instructors and researchers for field-based access to information technology, which will augment the time spent in the field and not detract from educational or research activities.

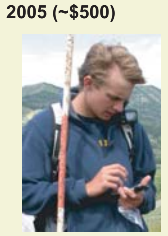
The following list represents suggsted criteria to consider when selecting hardware and software for GeoPads and GeoPockets. They are based on our experience over the last five years with a wide variety of equipment and the typical use cases described in this poster. Cost itself is certainly a key criteria as well, though it can be highly variable depending on what trade-offs you are pepared to make.

- **Ruggedized** – The unit has to functional under typical field conditions, so it should be water, dust, and drop resistant.
- **Outdoor-viewable Screen** – Readability of the display in full sunlight is a must; low-contrast images, such as aerial photos present a much greater challenge then black-and-white text or USGS topographic maps.
- **Intuitive, pen-based user interfaces** – Making maps and sketches are inherently drawing process; keyboards were rarely desired in the use-cases we've explored.
- **Integrated or wireless connectivity for peripherals** (e.g., GPS, headset, camera) – Avoid the clumsiness of a tangle of wires, and ensure the unit is easy and safe to operate and take on and off.
- **Ergonomic design** – Comfort, safety, and mobility are key requirements for carrying a unit around in the field for extended periods of time; we strongly suggest a hands-free harness.
- **Screen Resolution** – Sufficient viewing area to provide an appropriate level of contextual information; we suggest a minimum of 1024x768.
- **Performance** – Ample resources for data visualization and analysis; we suggest a minimum of 1GB RAM and a processor equivalent to a 1GHz Pentium III M or better.
- **Customizable GIS** – Simplified user-interfaces and stream-lining the mapping process is important for non-GIS-savvy users.

GeoPad circa Spring 2005 (~$5300)

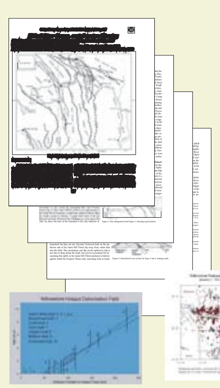
- Xplore Techologies iX104C2 AllVue
  - 1 GB RAM
  - 30 GB Hard Drive
  - 802.11b/g WiFi
  - Integrated GPS
- Accessories
  - Hands-free harness
  - Spare tablet stylus
  - Two spare batteries
  - External battery charger
  - USB Flash Drive (512MB)
- Software (not included in cost):
  - ArcGIS 9.0
  - Microsoft Office 2003
  - Microsoft OneNote 2003
  - Adobe Reader
  - Pokescope
  - iTunes
  - *etc.*
- Additional features we have evaluated (not included in above cost):
  - Bluetooth
    - Audio headset (audio notes, voice command)
    - Digital camera (wireless image transfer, direct capture)
  - GPRS modem
    - Internet connectivity in the field, where available (real-time stream gauge data, Google, reference sources, weather forecasts, access to remote resources, etc.)

GeoPocket circa Spring 2005 (~$500)

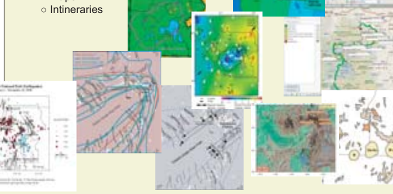


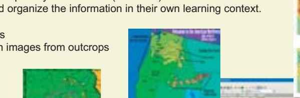
- HP iPAQ5550 Pocket PC 2003
  - 128MB
  - 802.11b
  - Bluetooth
- Accessories
  - Protective case
  - iPAQ Bluetooth GPS
  - Spare stylus
- Software (not included in cost)
  - ArcPad
  - Pocket Excel
  - Pocket Word
  - Notes
  - *etc.*

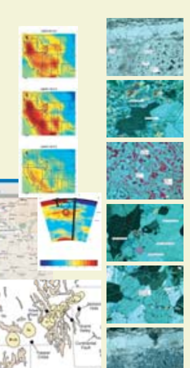
Portable Reference Shelf



- Can make a lot of reference material available; however, need to provide sufficient organization and searching capabilities for finding relevant information quickly.
- Screen-clipping capability of Notebook (OneNote) enables student to interact with and organize the information in their own learning context.
- Examples:
  - Field Guides
  - Thin-section images from outcrops
  - Papers
  - Figures
  - Maps
  - Intineraries

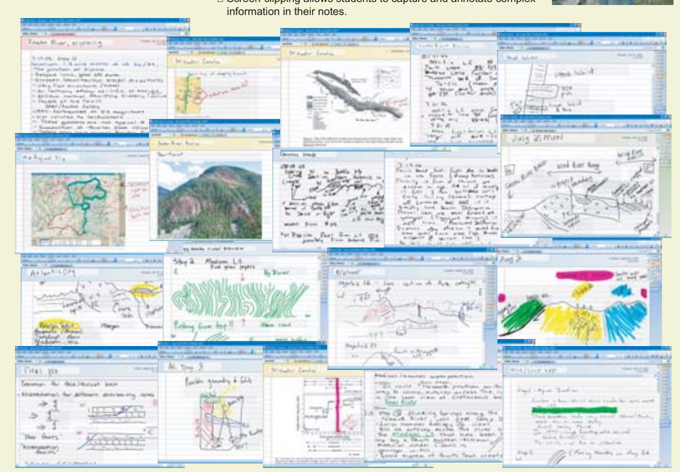






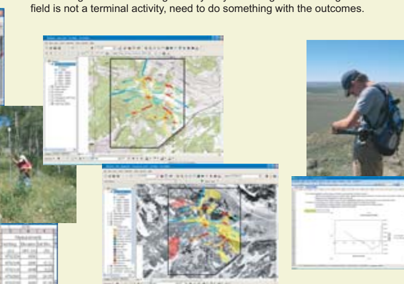
Field Notebook (Microsoft OneNote)

- Preserves intuitive interactions of a paper notebook making it easy to adopt.
- Improves upon paper notebook through extended capabilities.
  - Organization
    - Drag-and-drop coherent "chunks" to re-order notes.
    - Insert white-space, rather than cramming text in.
  - Drawing
    - Novice artists find it easier to use.
    - Advanced artists find it less flexbile.
  - "Scrapbook"
    - Screen-clipping allows students to capture and annotate complex information in their notes.



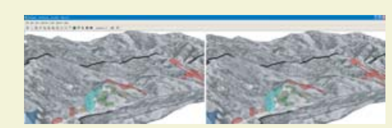
Data Collection and Analysis

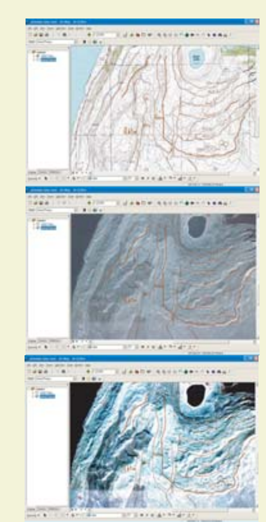
- Gathering data in the filed using GeoPad can take a little longer, however, data can be put to immediate, in-field use.
- Processing data in the field generally only advantageous if seeing results in field is not a terminal activity, need to do something with the outcomes.

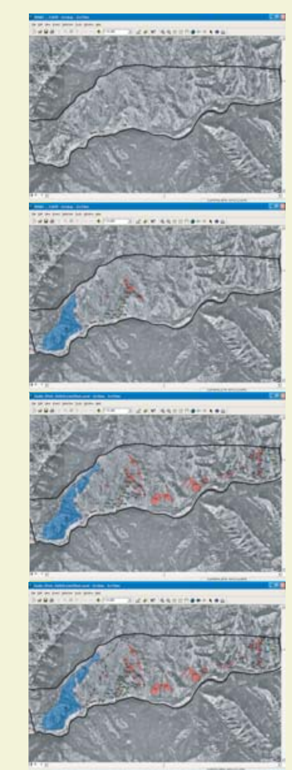


Mapping (ArcGIS: ArcMap and ArcScene)

- Sketching Approach -- Annotate the map directly with a wide variety of drawing tools.
  - Capture notes quickly and directly on map.
- Cartographic Approach -- Record data on map using symbologies and personal geodatabases.
  - Reduces data collection errors through situation-specific interfaces and immediate feedback of cartographic symbology.
  - Enhances readability of field or rough map.
- Zooming and Panning are key functionality not available with paper maps; helps students work more easily with both large mapping areas and complex, small-scale localities.
- Ability to interact and visualize data in ways not possible using traditional mapping methods (*e.g.*, 3D).
- Large-format prints of field maps during the final classroom phase helps convey both detail and complete context simultaneously, aiding in production of the final map, either on paper or on the computer.







Evaluation and Assessment

An independent, external team (Eric Dey and Helen Burns from the University of Michigan, School of Education) evaluated the impact of GeoPad use in our advanced field course (GS-440) this past summer. This assessment included field observations, interviews, and a spatial-reasoning pre- and post- test. The preliminary results are summarized as follows:

Students had a very positive experience, based primarily on the enhanced capabilities that they were able to use on the GeoPad. There is always the possibility that apparent effects of educational innovations receive a temporary benefit from the perceived novelty of the approach, especially when dealing with new technologies. In this case, however, field observations and interviews indicate that **student reactions are based more on utility considerations, rather than the novelty of the technology**. In the interviews, students routinely drew comparisons between the GeoPad and the traditional mapboards used in earlier field assignments on the basis of enhanced capability, as opposed to convenience issues (e.g., carrying Tablet PCs rather than cumbersome mapboards) and coolness factors.

The GeoPad capabilities students appreciated most included the ability to overlay different mapping elements to enhance visualization of both location and identification of geologic features. Students made regular mention of how the **general capabilities of GeoPad enhanced their ability to see** – **to visualize** – the different geologic structures within the mapping region.

Students did have a number of **issues with the stability of the technologies** inherent in GeoPad. Although these issues were reduced and nearly eliminated by the end of the field experience, student work was routinely interrupted by intermittent hardware failures and system resets. In querying students about these issues during the interview it was interesting to observe that they took these challenges as matter of course. Rather than attaching them to limitations of the GeoPad project, students viewed this as a standard – and unavoidable – complication of using computers in any setting. This reinforces the notion that **students are not reacting (positively or negatively) to the novelty aspect of GeoPad, but rather positively to the capabilities associated with it**.

A pre- and post- test of student spatial-reasoning skills was also administered to the students. The results of this assessment suggest that students' spatial reasoning abilities may have remained relatively stable during the study period. There was certainly **no evidence that these abilities were harmed by their experience**. In order to develop a better understanding of how GeoPad might in fact be contributing to the development of spatial reasoning abilities, the assessment items need to be more definitely tied to the field experience. This can be done through a post-hoc analysis completed by the educational researchers working with the geosciences professors. The results of this analysis can provide more information for the present evaluation. In addition, the information can be used to revise and improve the assessment for use in evaluating future field camp experiences involving GeoPad.

Interested in participating in a large-scale study using this assessment?

Acknowledgements

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GS-440 Geology Field Course | GS-341 Environmental Science in the Rockies | GS-116 Introductory Geology | English-317 History and Literature of the Rockies