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USING COMPUTERS IN ADVERSE FIELD CONDITIONS

TALES FROM THE EGYPTIAN DESERT

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For more than 15 years, we have been using computers and an array of computer-assisted devices in the context of our fieldwork at various French Paleolithic sites, and in the process, we have confronted a number of issues. Most have to do with power—the fact that France uses 220 volts instead of American 110 volts and the problem of getting power to the sites. As many of our colleagues like to point out, however, France does not present the roughest field conditions, whether we are talking about cuisine or computers. So, we have to admit that these sorts of problems have not been particularly difficult to solve. What if, on the other hand, we went to someplace very remote and with extreme conditions? Someplace like Egypt, for example?

Recently, we started a new project of survey and excavation in the high desert of Upper Egypt near the historic period site of Abydos. This environment provided entirely different challenges to the use of electronic equipment: our camp was 5 km from the nearest source of power and situated directly on a sand dune, and sand and dust were blowing all the time, thanks to the windy conditions. Far from being an ideal situation for computers and any sort of electronic gear, these conditions raised the question of whether or not we could even use our technology there. In fact, more than once, we received negative reviews in grant applications because people believed that it simply could not be done.

We are pleased to report that our four-week season this past December and January was a success, although we did run into a few problems, and some things did not work as well as we had hoped. Our purpose in this article is to share our experiences with others who work under similar conditions.

Sand

Sand was, by far, the biggest challenge for all of our equipment, particularly anything with moving parts. Within hours, sand would get into floppy disks and render them useless, and after a few days, several of the tent zippers no longer closed. While we took care to store our equipment in plastic bags or other closed containers, it was impossible to eliminate the sand problem entirely.

With our digital cameras, the weakest spot was the zoom lens. Though our Kodak DC4800, which is already fairly old, lasted the whole season, it did not sound good by the end. It would probably be better to have a digital camera with interchangeable lenses and either a manual zoom lens (that can at least grind through whatever sand gets in) or a set of varying fixed-focal-length lenses. While such cameras will eventually become commonplace, they are still extremely expensive. The best solution, for now, is to take two or even three moderate to inexpensive digital cameras so that when one fails, you can just switch to another.

Of particular concern for our project was the total station. While total stations are generally designed for rigorous field conditions, most of them are vulnerable to sand. The best solution is to take instruments that are "all weather," which generally means that that they are waterproof. While rain was not our concern in Egypt, the same technology that keeps out water will also keep out sand. We used a weatherized Topcon GTS-229 that did extremely well despite the fact that plenty of sand got into the backpack in which it was stored. All of the critical moving parts (the horizontal and vertical lens movement and the focus) showed absolutely no effects of sand, and although the leveling screws did occasionally grind a bit, eventually the sand worked itself free.

Computers were another concern. We had three laptops that, in addition to storing all of our data and images, also served as data-entry machines; two Compaq iPAQ hand-held computers that were used for GPS recording (Figure 1); and three HP hand-held computers (which look like small laptops without hard-drives) that were used as total station data collectors.

The weak spots on a laptop are, again, the mechanical elements: the keyboard and the hinge on which the screen pivots. The best solution to protect the keyboard from dust and grit is to purchase a cover molded to fit particular laptop models, although we simply taped clear plastic over our keyboards. Care has to be taken to not cover cooling vents, and it should be kept in mind that putting plastic over the computer can make it get too hot, especially when exposed to the sun. Unfortunately, part of the ventilation system can involve pulling air through the keyboard, so this is a risk. Covering the mouse pad is also important, and we have found that touch pads work perfectly well when covered with plastic. The same is not always true if the laptop has an eraser-head joystick tucked into the keyboard. One of our HP hand-held computers had a custom-made keyboard protector, but the others held up well to field conditions without a plastic covering.

Pivoting screens are another story. The HP that we consistently used in Egypt now makes a grinding noise when it is opened or closed, although it still functions. The laptop screens held up well this time, but in the past we have had problems with screens, apparently from grit entering the hinges. Unfortunately, we have not found a way to prevent this problem.

At first glance, the iPAQ computers would seem to be the most delicate and vulnerable to the elements. Their buttons may or may not be weatherproofed, they have several ports and openings on the bottom that we did not seal, and the audio plug and stylus holder on the top look like perfect entryways for sand. Nonetheless, after weeks of use (and being dropped in the sand) these computers showed no signs of problems. To protect the touch screen, we purchased screen protectors (thin films of plastic that adhere to the glass screen). Judging by the marks and abrasion evident by the end of the season, this was a worthwhile investment, and the screen protectors did not negatively impact the performance of the touch screens. The only lasting sign of any sand damage is a grinding noise when the iPAQ is slotted into the expansion pack. Although sealed, weatherproofed containers can be purchased for these computers, it is not apparent that they could be used with the expansion pack and GPS unit attached (see Figure 1). We did store the iPAQs in plastic bags when they were not being used. In all respects, these units did remarkably well, and, in fact, we plan on replacing the HP-200 with iPAQs as total station data collectors in the near future.

Figure 1: Using a Compaq iPAQ as a GPS in the field. The iPAQ is protected by the expansion pack in which it rests. The GPS unit is the small rectangular piece attached to the top of the unit. ESRI's ArcPad software running on Windows CE was used to record GPS points and to view our GIS layers in the field.

In addition to the iPAQ GPS units, we also used an inexpensive Garmin GPS. Most GPS units, including this one, are already fairly rugged. Since boating applications are a large component of their market, their built-in water protection turned into sand protection for us. All of the buttons on our unit were sealed, and the sun had no adverse effect on its monochromatic screen.

The electronic equipment that did have problems in the desert were the electronic calipers. These are extremely susceptible to grit, even the limited amount that comes off washed stone tools in a clean lab in France. Grit makes them difficult to slide back and forth and scratches the surface of the calipers, which over time can ruin them. We have not found a particularly good solution to this problem. We rested the calipers on the edge of our computers to keep them off of gritty surfaces, and we cleaned and oiled them as needed. Other than that, our main advice is to take along backups.

Figure 2: The authors using a Topcon total station, powered by a car battery and two solar panels linked together in series, while piece-proveniencing artifacts at ASPS Site 46A. Dibble (on the right) is holding the HP-200 data collector. Photo courtesy of Jason Cooper.

Power

Aside from sand, the other challenge to using computer equipment in the desert was access to power. In France, our "camp" is usually only a couple of minutes from the site, and it is easy to run back to charge a battery. Even better, we are almost always able to bring electricity directly into the site via an "extension cord" to a temporary meter installed on a nearby power line. In Egypt, the nearest power (at the Abydos dig house) was a 45-minute trip by camel, and a 5-km extension cord was out of the question. We solved this problem with solar panels and several 12-volt car batteries (which were sent back daily to the dig house for recharging).

Every piece of equipment we used worked either on its own internal battery or on standard AA or 9-volt batteries. For items that worked with standard batteries (walkie-talkies, the Garmin GPS unit, the HP hand-held computers), we initially tried using NiMH batteries with solar battery chargers. Yet, despite cloudless skies nearly every day, this solution proved unworkable. It took 12 hours to fully charge four batteries, and even at Egypt's relatively low latitude, there were not that many hours of sunlight in a midwinter day, and the panels had to be constantly turned to keep them in direct sunlight. For the most part, we simply purchased large quantities of standard AA batteries, relying on the solar rechargeables for backup.

Charging internal batteries was potentially the most difficult problem, and several pieces of equipment (the iPAQ computers, laptops, total station, and digital camera) had this kind of configuration. The solution we adopted was based on a combination of 12-volt automobile batteries and solar power.

Today, most small electronic devices can run from or be charged by 12-volt current, usually via a male plug that is designed to be inserted into a car's cigarette lighter or, as in our case, into a female cigarette lighter plug that is attached by cables directly to a car battery. This led to a problem for us, because we forgot to purchase the cabled cigarette lighter plug in advance, and it turned out to be impossible to find one locally. Usually, making such a device is not a problem, and we did remember to bring a 12-volt soldering iron for just such emergencies. However, finding a cigarette lighter plug in rural Egypt was difficult, and then, of course, we were faced with the problem of getting power to the soldering iron. The solution to this problem was, naturally, duct tape and wire, which are standard items in any archaeological project. We also purchased a 12-volt "power strip"—a device that has one male plug and three female ones, which allows for three items to be charged simultaneously from one car battery.

This system of using 12-volt batteries to charge other internal batteries worked very well. We also could have used it to charge the internal batteries on the total station and laptop computers, but opted instead to power these devices directly from the 12-volt current, augmenting this with solar power, as described below.

Initially, we had hoped to power the total station directly from solar panels. To accomplish this, we purchased two solar power units that supplied 12-volt power to a female cigarette lighter plug. We found that on their own, even two of these units did not supply enough power to run the total station. Instead, we connected the solar panels and the car battery in parallel to power the total station (Figure 2). While it depended on the rate at which we recorded points, under normal use, the solar panels charged the car battery at just under the rate we were draining it, thus significantly extending the life of the car battery. Although we need to experiment more, it might be possible to significantly extend the life of the total station's own internal battery by supplementing it with solar power in this same way.

Figure 3: Deborah Olszewski and Harold Dibble working in the field lab. The large car battery in the foreground powered the two laptops seen in the photo for about 7–8 hours. The silver box to the right of the battery is a power inverter that converts 12 volts to 110 volts. It was used to charge a digital camera that did not have a 12-volt adapter.

The most challenging problem was to supply power for the laptop computers. Laptops, with their fast processors and backlit color screens, consume large quantities of power, and solar panels sufficient to power them are both large and expensive. Thus, we decided to power the laptops with car batteries and 12-volt adapters (Figure 3). This solution worked reasonably well, although even a large, fully charged car battery was only able to power two or three laptops for approximately seven hours.

The better solution, especially for even more remote settings, is found in the use of hand-held computers such as iPAQs. While we used our laptops throughout the day, their full capabilities were probably only used for approximately 30 minutes each day when digital images, total station data, GIS data, and lithics data were transferred to these machines and then integrated with existing databases, plotted, and checked for errors. For the rest of the day, they were used simply for data entry, a task we anticipate doing most often on hand-held computers like the iPAQ using external keyboards. The iPAQs also already run GIS software, and they are able to run the total station. Under these circumstances, we could imagine reducing the use of full-size laptop computers so that they could last a week or more on a single car battery. Moreover, given the fact that hand-held computers and digital cameras can take large amounts of relatively inexpensive memory, we envision designing a system wherein data is offloaded to the central database on a laptop only rarely.

For those devices that did not have 12-volt adapters, we purchased a 110-volt inverter. This device (shown in Figure 3) converts 12 volts to 110 volts, and thus allows any 110-volt adapter with American-style plugs to be attached to the current. The inverter was essential for charging our camera (although cameras with 12-volt adapters are easy to find) and provided us with an extra layer of flexibility should one of our other 12-volt solutions have failed.

While solar power merely helped to augment battery life for the total station, it worked very well with many of our other electronics. The problem with solar power, of course, is that it only works during the day, which is also the time when you would like to be using the device rather than leaving it in the sun to charge. The solution is to have at least two of every device, so that one can charge while the other is in use. This is not as frivolous as it might sound since having a backup is extremely important. In fact, we think it is always important to buy several of exactly the same model of any piece of equipment so that all the supporting parts (power supplies, lens adapters, memory cards, cables, software, etc.) are completely interchangeable and can therefore serve as backups.

We found that a single solar panel can easily power the iPAQs, as well as their expansion pack and GPS unit, even when their own battery was completely dead. In other words, rather than leaving the unit to charge, it could be used on solar power. This makes them excellent candidates for total station data collectors in the future. And although we did not try it, the Garmin GPS unit also comes with a cigarette-lighter adapter and likely could run on a solar panel.

Aside from the items just discussed, we found that solar did quite well with low-power items such as flashlights, lanterns, and cell phones. Flashlights and lanterns are the perfect solar applications since they are not needed during the day while they are charging.

Closing Comments

Archaeologists are becoming accustomed to using technology to aid in their fieldwork (Table 1). Technology makes it easier to collect data faster and less expensively than before, and in many cases, the data are much more precise. We cannot imagine doing archaeology without computers and total stations, which is why we were motivated to try them in Egypt. The experience was not without its challenging moments, and at times we were forced to modify the way we typically work. It was clear to us, however, that for relatively low costs, and with proper planning, technology can be integrated into any field setting.

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Table 1: Equipment List

Total Station

GTS-229 total station with internal battery
Stadia rod
Prism
Tripod
Backpack carrying case for total station
220-volt charger for total station battery
12-volt adapter for charging total station battery
12-volt adapter for powering total station
HP-200 LX palmtop computers (3) (AA batteries)
HP to total station and HP to laptop cables
EDM software (written by authors)

GPS (3 units total)

Garmin (AA batteries)
12-volt adapter for Garmin
Compaq iPAQ 3650 (2)
12-volt adapter for powering/charging iPAQ (2)
Compaq expansion pack (2)
256-mb compact memory card (2)
Compact memory card to pc-card adapter (4)
GPS unit (with compact memory card connector)
ESRI's ArcPad software

Laptops (3 total)

Micron Transport ZX (2)
12-volt power supplies for Microns
Mitutoyo 6" calipers (lithium batteries)
Keyboard wedge for calipers
Ohaus scale (9-volt batteries)
Microsoft Access 2000
ESRI's Arcview 8.0
Golden Software's Surfer
E4 data entry software (written by authors)

Kodak DC4200

Kodak lens adapter for DC4200
Kodak wide angle lens for DC4200
Kodak 110-volt power adapter for DC4200
Kodak DC220 (with NiMH AA batteries)

Solar

Brunton SolarPort 2.2 (2) (produces 12 volts)
Brunton Solar AA battery charger (2)
NiMH AA batteries (24)
PowerLine Sun Catcher Sport (produces 12 volts and charges its own internal AA batteries)

Other

RadioShack 12-volt to 110-volt power inverter
RadioShack 3 plug cigarette lighter adapter
RadioShack miscellaneous cigarette light adapter parts
American to European plug converters
110-volt to 220-volt power converters