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Capturing "Where and When" on Video

(GeoWorld online September, 2000)

The past several columns described procedures for translating GIS data into virtual renderings of a landscape (see *Landscape Rendering*). While traditional maps generalize landscape features as abstract symbols and patterns, a virtual forest portrays mapped data more like a painting. Instead of pastel colors and crosshatching, realistic objects, such as trees, rocks and water, are appropriately placed on a shaded relief surface. The effect is a map that rivals a photographic snapshot of the conditions recorded in the GIS database.

An alternative is to populate a GIS database with actual snapshots and streaming video that are linked to their map location. Multimedia GIS provides a connection between a map and field-collected images, audio and tabular summaries. This emerging field is poised to recast our perspective of what maps are and how they can be used.

Video mapping is an exciting part of the revolution in visualization of mapped data. It records GPS signals directly on videotape shot in the field. When the tape is played to a computer it links these data to a digital map for easy access and review. The result is an extension of *field data collection* to *field experience collection* through geo-registered visual and audio records.

With video mapping, the construction of a multimedia GIS no longer involves tedious and time-consuming procedures for encoding spatial coordinates of the imagery. The entire process, from field video collection to map indexing and Web page publishing consists of three simple steps— *Recording*, *Indexing* and *Review.*

During the **Recording Step***,* video mapping encodes GPS coordinates directly onto the videotape (*see figure 1*). The video mapping unit contains a standard GPS board that monitors the satellite signals, converts this information into a data stream consisting of *longitude (X)*, *latitude (Y)*, actual *time/date*, and a variety of supporting data. These data are output as standard NMEA formatted data. A second circuit board in the unit converts this digital information into an audio signal in a manner similar to a modem for phone line access to the Internet.
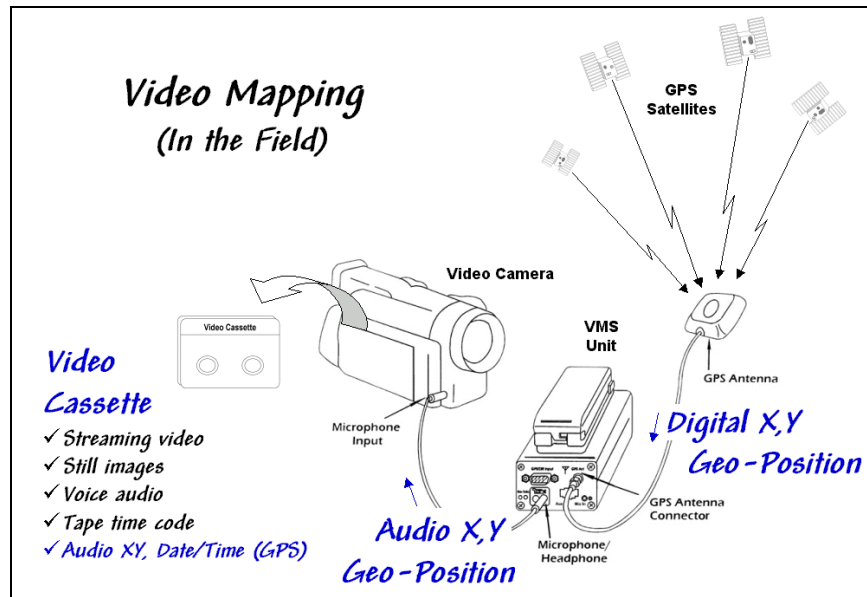
*Figure 1. Video Mapping in the Field. As video is recorded, the precise location, time, and
date are recorded every second to one of the videotape's audio tracks.
The other track records pertinent information as you speak.*

In turn, the acoustic signals are sent to one of the audio channels through the microphone
input connector on the video camera. The result is recording the GPS position on the
videotape every second that the camera is on.

The direct recording of "where and when" on the tape greatly facilitates field data
collection—as long as there is GPS reception, the information is automatically recorded
on the same medium (videotape) as the imagery. In addition, any audio notes you might
make are captured on the same tape. Voice recognition software can convert the notes
into text, or if a specific voice commands are used, the information can be converted into
a database record.

Most contemporary video cameras have a switch between photo and movie mode. In
movie mode, streaming video is recorded at 30 frames per second. In photo mode, the
camera acts like a still camera and "freezes" the frame for several seconds as it records
the image to videotape. In this mode, a one-hour videotape can record over 500 digital
pictures. In both photo and movie modes the one-second GPS "data stamp" provides
ample positioning information for most applications… every 88 feet at 60 mph in a car or
every 3 feet while strolling at 2 mph.

The *Indexing Step* involves connecting the video mapping unit to a computer and
playing the video (*see figure 2*). In this configuration, the audio cord is switched to the
Headphone Output connector and a second cable is connected to the Lan C connector on
the camera. The connector provides information on tape position (footage on older
cameras and time code on newer ones) used in indexing and playback control of the tape
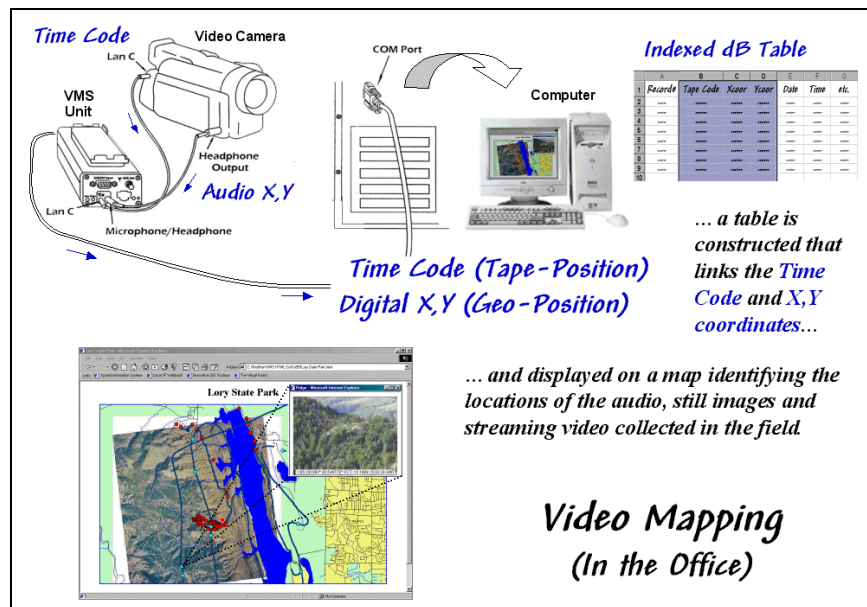similar to those on a standard VCR.

Figure 2. Indexing the Videotape. The video, audio notes and GPS information is used to construct a multimedia map of the precise position and date/time of the video footage providing direct retrieval of text, data, audio, image and video by simply clicking on the map.

As the videotape is played, the audio X,Y and time code information is sent to the video mapping unit where it is converted to digital data and sent to the serial port on the computer. If a headset was used in the field, the voice recording on the second audio channel is transferred as well.

For indexing there are five types of information available—streaming video (movie mode), still images (photo mode), voice audio (headset), tape time code (tape position), and GPS data (camera geo-position plus date/time and information on satellite lock)—all automatically registered on the videotape whenever the camera is recording.

Video mapping software records the GPS information from the videotape and constructs a database that connections GPS locations with videotape time codes. The computer generates an interactive map of everywhere that video was recorded. Special map features can be marked on the map and information entered about them or still images captured, while the map is being indexed. The map can be used for review, or exported in a MapInfo or ArcView compatible format.

The **Review Step** uses the indexed database to access audio and video information on the tape. The hardware configuration is the same as for indexing (audio, Lan C and serial cables). Clicking on any indexed location retrieves its GPS data and associated video. Player controls similar to a VCR are sent to the video camera to play back the video recordings by noting its time code and causing the tape to move to that location.

Map features can start applications, open files and display images. The software works with video capture cards to create still images and video clips you can link to map features, giving maximum flexibility in choosing a data review method. In many applications the completed multimedia map is exported as an HTML file for viewing with any browser or over the Internet. The map features can contain any or all five of the basic information types:

- *Text* — interpreted from audio as .DOC file
- *Data* — interpreted from audio as .DAT, .XLS or .DBF file
- *Audio* — captured as .WAV file (about 100KB per 5 seconds)
- *Image* — captured as .JPG file (about 50KB per image)
- *Video* — captured as .AVI file (about 1MB per 5 seconds)

Next month's column explores the procedures for constructing finished maps and describes several applications of video mapping. In the interim, you might checkout the links to some online examples (see author's notes).

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Creating Interactive Video Maps

(GeoWorld online October, 2000)

As detailed in last month's column, video mapping enables anyone with a computer and video camera to easily create their own interactive video maps. The integration of computers, video camera, and GPS marks a technological milestone that finally makes GIS multimedia a practical reality.   A user can inexpensively add real time, geographically indexed images, audio and video clips to ongoing data collection activities. Applications abound in natural resources, precision farming, business, government, science, recreation, and any other endeavor that needs a visual GIS capability.

For example, corridor mapping of oil and gas pipelines, transmission towers, right of ways and the like provide images of actual conditions not normally part of traditional maps. In law enforcement, video mapping can be used from reconnaissance to traffic safety to forensics. Agriculture applications include crop scouting, weed/pest management, verification of yield maps, and "as-applied" mapping. Geo-business uses range from conveying neighborhood character, to insurance reporting to web page development.

By coupling audio/visual information to other GIS data, anyone can see first-hand conditions that add reality to tabular field data. In disaster assessment, the ability to click on several indexed locations and see and hear the extent of damage can convey much more information than simple statistics. In forestry, resource managers who were not involved in field data collection can review conditions not easily quantified, such as under-story characteristics and wildlife habitat

potential. In short, video mapping provides "the missing link" in GIS, enabling incorporation of visual layers into any geo-referenced data set.

Data is collected without a computer in the field or cumbersome additional equipment. Figure 1 shows the VMS^{TM} unit by Red Hen Systems (see author's note) that weighs less than a pound and is connected to the video camera via a small microphone cable. The GPS antenna is easily attached to a cap, hardhat or shoulder strap of a carrying case. Optional hardware includes an electronic compass to record camera direction and a laser rangefinder to electronically measure the distance to objects at the optical center of the camera's view. A multispectral unit for simultaneously recording up to four wavelength bands is under development.
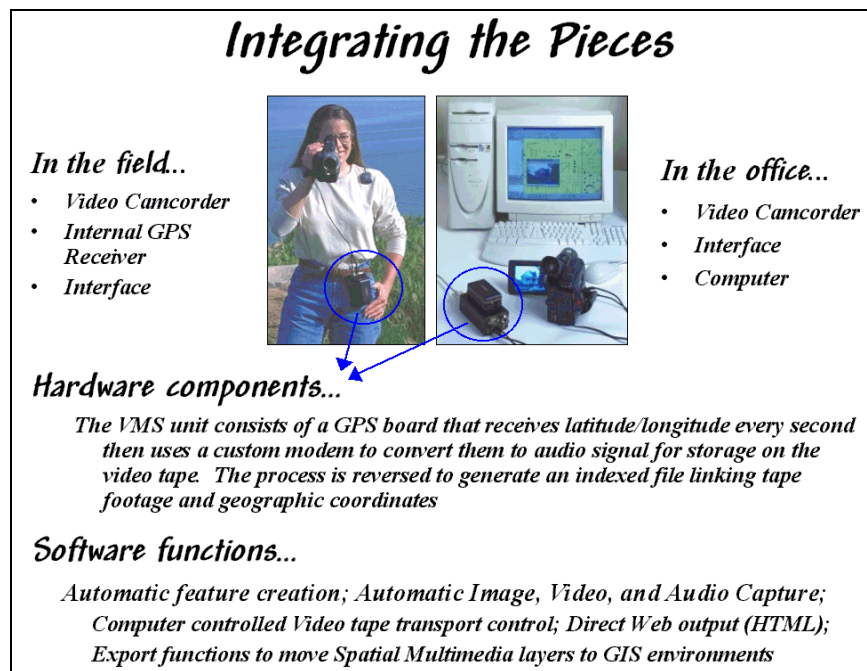

Integrating the Pieces

In the field...
- Video Camcorder
- Internal GPS Receiver
- Interface

In the office...
- Video Camcorder
- Interface
- Computer

Hardware components...
The VMS unit consists of a GPS board that receives latitude/longitude every second then uses a custom modem to convert them to audio signal for storage on the video tape. The process is reversed to generate an indexed file linking tape footage and geographic coordinates

Software functions...
Automatic feature creation; Automatic Image, Video, and Audio Capture; Computer controlled Video tape transport control; Direct Web output (HTML); Export functions to move Spatial Multimedia layers to GIS environments

Figure 1. Video Mapping Hardware. The VMS 200 unit enablesrecording and processing of GPS signals and video time codes.

The office configuration consists of a video camera, VMS unit, notebook or desktop computer, and mapping software. The software generates a map automatically from the data recorded on the videotape. Once a map is created, it can be personalized by placing special feature points that relate to specific locations. These points are automatically or manually linked to still images, video clips, sound files, documents, data sets, or other actions that are recalled at the touch of a button. A voice recognition package is under development that will create free-form text and data-form entry. The mapping software also is compatible with emerging GPS-based still cameras.

While a map is being created, or at a later time, a user can mark special locations with a mouse-click to "capture" still images, streaming video or audio files. The

"fire wire" port on many of the newer computers makes capturing multimedia file a snap. Once captured, a simple click on the map feature accesses the images, associated files, or video playback beginning at that location.

Sharing or incorporating information is easy because the video maps are compatible with most popular GIS programs. An HTML export function provides an extremely useful data delivery device for service providers, project managers, or others who need to make their imagery generally available. By transforming the maps and associated data to a Web page, time-dependent information can be "served to the Internet" and available to thousands of people within a few minutes of collection.

Differential post-processing is another important software addition. The post-processing software (EZdiff^{TM}) takes base station correction data from the Internet and performs a calculation against the video mapped GPS data for the same time period, then outputs a data file containing the corrected, highly accurate points. It mathematically corrects the autonomous ("normal") GPS signals from an error of about 10 meters to positional accuracy of about 1 to 2 meters.
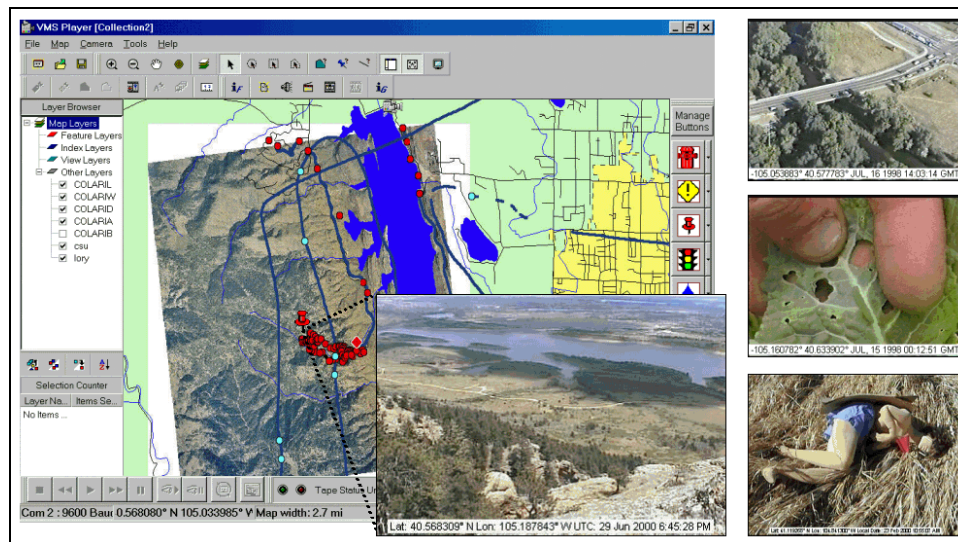

Figure 2. Video Mapping Software. Specialized software builds a linked database and provides
numerous features for accessing the data, customizing map layout and exporting to a variety of formats.

Figure 2 shows an example of the video mapping software. The dark blue line on map identifies the route of an ultralite (a hang-glider with an engine). Actually the line is composed of a series of dots— one for each second the video camera was recording. Clicking anywhere on the line will cause the camera, or VCR, to automatically fast forward/reverse to the location and begin playing the video.

The light blue and red dots in the figure are feature locations where still images, audio tracks and video clips were captured to the hard disk. The larger inset is a view of the lake and city from the summit of a hiking trail. The adjacent red dots are a series of similar images taken along the trail. When a video camera is set in photo mode, a one-hour videotape contains nearly 600 exposures— no film, processing or printing required. In addition, the automatic assignment of GPS time and position makes filing and retrieving a trivial task—no more file cabinets, manila folders and with photos taped to reports.

The top captured image on the right side of the figure shows a photo taken from an ultralite inventory of bridges along a major highway. The middle image is a field photo of cabbage loper damage in a farmer's field. The bottom image is of a dummy in a training course for police officers. The web pages for these and other applications are online for better understanding of video mapping capabilities (see author's notes).

For centuries, maps have been abstractions of reality that use inked lines, symbols and shadings to depict the location of physical features and landscape conditions. Multimedia GIS, and video mapping in particular, provide an easy means of linking additional audio/visual information to map features. Special equipment, field procedures and office processing is minimal and easy to learn. The ability to access stored images, video, audio, text, and data at the click of a mouse radically changes our paradigm of a map— from abstract drawings to sights, sounds and summaries of actual conditions. Video mapping truly "makes maps come alive."

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