The Raders Valley Project
by Mark Passerby

Raders Valley, located just west of Lewisburg, WV, has long been our diggers paradise. Most of its known caves have been discovered over the years by our group's digging efforts. Zicafoose Blowhole, Bobcat Blowhole, Freelanders Well, Middle Earth, and Deels Hole are a few of the substantial caves that now tally over 4.5 miles of previously unknown passageways. Exploration and mapping of these caves have begun to help unravel the mysteries of the many blowing holes that continue to serve as our "diggers motivation."

My personal involvement in the project began 13 years ago with the successful opening of Zicafoose Blowhole. The cave quickly became exceptionally tough and proved to be beyond my comfort level at the time. Fortunately, on the night of the initial breakthrough Jim Tompkins and Mike Dore had become involved. Jim, Mike and a few others --largely motivated by the energy of Jim Tompkins -- would go on to discover about a mile of passage that is now displayed on page 1 of our 35-page, PDF-formatted working map. (View Map Book online at www.caves.com/zicmap.pdf.) But the source of the wind could not be found and exploration in Zicafoose Blowhole soon ceased.

Some 13 years later Bob Kirk, Aaron Bird and I would return to Zicafoose Blowhole and enlarge the tight areas, step by step, using a clever invention of Bob's that we dubbed "muzzminers." These rock rippers paved the way for discovery! The new discoveries and subsequent mapping in Zicafoose, as well as Bobcat, Middle Earth, and Deels Hole, created a pile of survey data that would become the evolving focus of my interest.

Choosing Software for the Project

The project initially used Compass Survey Software for its data processing. Data was compiled and a line/wall plot generated. Then, using various other programs I would "morph" the scanned sketches to fit the line plot. This approach ultimately resulted in a working map of decent quality, albeit still not much closer to a final drafted map. Other programs, such as Carto and Winkarst, have continued or expanded on this raster/scanned sketchbook approach, with Carto even beginning to add some basic drawing functions. These raster approaches all share a common foundation of assembling sketches and working map pieces, then virtually tacking them to the line plot. If the survey changes due to corrections and loop closure, the composition of scanned and assembled sketches will adjust accordingly.

The scanned sketch approach, however, doesn't force the project cartographer to actually begin drawing or working towards a final high-quality map. The lack of a "draw as you go" workflow has often produced (as many of us can recall) huge piles of accumulated data and stacks of sketch books full of long since forgotten passages. This kind of project eventually requires volunteers to devote large amounts of time to attempt a final map draft. And this is often made more difficult due to missing sections of survey, inaccurate data, and poor sketch quality. Thus the term "remap" was born.

A "draw as you go" workflow spreads the drawing workload over the life of the project and additionally provides tangible "near finished" results to those involved in the project. Ultimately, this jump forward provides exponential benefits and brings into the mix a dizzying array of new ways to present and explore the visual data. But at the same time, the digital working map must correctly conform to an ever-changing survey database. Vitally important to this process is software that treats various objects of the working map differently when features need to be adjusted. Passage outlines, for instance, must be reshaped or "morphed" in a way that depends on the shifts of nearby survey vectors. Other features, such as text, symbols, and cross sections, must be translated and scaled so that they keep their survey-relative positions. If this is not done regularly, the working map can't be used directly to produce an accurate finished map or in some cases even a useful provisional map. The drawings simply won't align with the latest data compilation and resultant line plot.

Until now this has been the cave cartographer's main problem with the approach of "draw as you go," especially as it relates to large cave systems where many line plot shifts and data changes occur through error discovery and loop closure.

The SVG Solution

The solution, which I will discuss in brief here, is a quickly emerging image format named Scalable Vector Graphics (SVG). This complex 2D format was spurred forward in 1998 by proposals submitted to the World Wide Web Consortium (W3C) by software developers, including Adobe, IBM, Netscape, Sun, HP, Macromedia, Microsoft, and Visio. This led to the first draft of the SVG Specification in February of 1999. From this beginning point the SVG format, which is XML-based, quickly took hold among cartographers and GIS specialists. How the format benefits the cave cartographer is nothing short of astounding!

Walls Survey Software and the Raders Project

During the 2003 NSS Convention in California I had the good fortune to attend a talk by George Veni who demonstrated a program called Walls. Quite ironically, at the same event I was giving talks on morphing working sketch scans or what are more commonly known as raster images. In contrast to this approach, Walls deals directly with vector-based images and more importantly with the problem of "merging" them with output from a commercial drawing program. Veni's demonstration, as well as the demo in the Walls program download, shows a cave with hundreds of loops and drawn wall outlines being morphed to fit a very complex adjusted line plot -- in seconds! Absolutely amazing, is what I thought as I walked out of the room, dizzy with thoughts of new possibilities for the Raders Project. Now I would actually have to draw, and not only draw but also become proficient enough to keep the drawing updated with the continuing influx of survey data and sketches.

Zicafoose Blowhole would become the first cave in the Raders Project to have a "draw as you go" map that automatically tracks an ever-changing set of survey lines. Adobe Illustrator (v10 or CS) was chosen as the drawing tool because of its ability to import and export SVGs that become part of a process known as roundtripping. Roundtripping, however, has no utility in small caves, or for that matter caves whose surveys contain no loops. It is strictly a function for bigger cave projects where error discovery and loop closures require readjustment of the line plot. For such projects roundtripping becomes an essential part of the "draw as you go" method of mapping.

SVG Roundtripping

The process begins with raw survey data entry in Walls. The data is then compiled and exported as a line plot in the SVG file format. The file's content is actually more complex than a simple line plot as it contains predefined layers and special tags that make subsequent versions of the map updateable. Next, the file is opened or placed in the master Illustrator document, the "draw as you go" cave project, where complex detail (such as boulders, formations, and wall outlines) is added and placed in the pre-defined layers as described in the Walls manual. Once the detail is added, the document is saved from Illustrator as an SVG image. Usually "_mrg" is appended to the file name to signify to the cartographer that the file is usable as a "merge" file, or source SVG for Walls.

After the next survey trip more data is entered into Walls and another SVG image generated. This time though, in the Walls SVG Export dialog, the latest SVG file saved from Illustrator is selected to be an SVG source file. Whenever such a file is specified, the export operation will adjust and merge its contents with the latest set of survey data objects. After a mouse click and a few seconds' wait, an updated SVG map is produced.

Once again this new SVG file from Walls is opened in Illustrator so that more detail can be added to the growing cave's line plot. The roundtripped SVG is therefore sharing additions from both Walls and Illustrator, with Walls adjusting Illustrator artwork to fit an evolving cave survey. From here, the sky is the limit.

Off and Running

After several trips the processes necessary to maintain a correct “draw as you go” project became clear, but something else became evident to me. Buried within the Walls/Illustrator roundtripping process is the ability, while in the cave, to rapidly add incredible amounts of detail “on the fly” to a running survey line plot. This would require the use of a ruggedized laptop or tablet PC. Getac (www.getac.com) provided us with our first opportunity to put my ideas to the test on the Raders Project. They sent us their Model W130, running Windows XP, with a touch screen and full keyboard to use in-cave for a couple of months. For transportation we used (and still use) modified Pelican 1490 cases (see picture below). These stout cases can easily carry the rugged PC and an external battery pack for extended run times, with room for some personal gear as well. If need be, the remainder of personal gear normally carried by the sketcher on a traditional cave survey can be divided over the remaining team members.

Author using Fujitsu Stylistic 2300 in Zicafoose to enter data and add detail to running lineplot.

The process does indeed work. As my knowledge of what it takes to draw electronically in-cave has increased, several critical factors necessary to realize real gains in efficiency have become evident. First, the in-cave electronic sketcher needs a high level of out-of-cave experience with the Illustrator program. This familiarity combined with a master Illustrator file that’s fully stocked with an organized library of drag-and-drop cave symbols and brush patterns can make the process very rewarding and efficient. Though labor heavy on the font end, such preparation can result in rapid gains in efficiency once you’re fully set up! A pile of breakdown becomes as simple as tap, stroke, and then move on to the next item of detail. A soda straw: just tap, tap, and move on. After the trip, the detailed drawings done electronically in-cave are added to the master “draw as you go” project file. Then the fun really starts!(A sample section of passage drawn in-cave on the Stylistic 2300 can be viewed at http://tinyurl.com/6usqx)

Bob Kirk carrying the modified Pelican 1490 into Zicafoose Blowhole for an in-cave draw as we go survey trip

A Note about Ruggedized PCs

Obviously a $4,000-plus Getac is out of reach for most of us, so I began to experiment with other units as I became familiar with the processing needs of the “draw as you go” project. For Zicafoose Blowhole we currently have a Fujitsu Stylistic 2300 tablet PC running Win98 with 160 MB of RAM and a 266 MHz processor. This processor/RAM configuration is fine; however, the Stylistic tablet models lack keyboards for quick data entry and are not ruggedized. Therefore, both Bob and I have purchased Panasonic Toughbooks (Model CF-27) with 266 MHz processors and 160 MB of RAM running Windows 98. These two units, which we found at less than $200 each, have a keyboard and are exceptionally rugged. Additionally, the Toughbooks are compatible with our choice of external batteries needed for the extended run times of a cave survey. NOTE: The current version of Illustrator (CS or v11) won’t install on Windows 98 but Illustrator 10 is compatible and still available online on sites such as Ebay.

The PDF Map Book

Perhaps the most rewarding part of the entire Raders Project has become what I have dubbed the PDF Map Book. The electronic format of this book (PDF format) allows the project participants to completely explore the cave project in incredible detail, page by page, via simple mouse clicks. Online it will display in the project participant's web browser in a lower resolution called "Fast Web View." Alternatively, it can be saved to a PC/MAC desktop and opened in Adobe's Acrobat Reader with a much higher display resolution. Each page or the entire book can be printed for hard copy reference as well. The Raders Project participants will receive, generally within a week of a survey trip, an updated link to the newest version of the PDF Map Book where they can view and explore the fruits of their labor. (You may view the PDF Map Book for Zicafoose Blowhole by going to www.caves.com/zicmap.pdf. The aerial and topographic overlay pages are disabled to protect the cave's entrance location from general online display). From the cartographer's point of view the map book is once again labor heavy on the front end. After formatting is complete, however, the addition of new working map pages becomes quite simple. Three products are used regularly in the PDF Map Book portion of the project: Adobe Illustrator, Adobe Photoshop, and finally Adobe Acrobat to generate the PDF Map Book file.

Complexities Made Simple

The PDF and SVG file formats both give the digital cave cartographer, through carefully selected choices, the ability to display incredibly complex sets of overlapping passages. Within SVG this is accomplished by subgrouping levels of passages nested inside the pre-defined groups of the original SVG generated by Walls. The SVG can then very easily be embedded in an HTML Web page. Placing simple scripts inside the HTML portion allows certain functions (such as turning selected layers on and off) to be performed by the online user. For example, if three levels of passages were stacked upon each other, it would be easy to script a few check boxes to allow the user to view the different levels independently. An early map of Zicafoose Blowhole that has this feature is accessible at www.cavediggers.com/fullmap2.html. (Viewing it on a PC requires Internet Explorer with Adobe's SVG plug-in installed.)

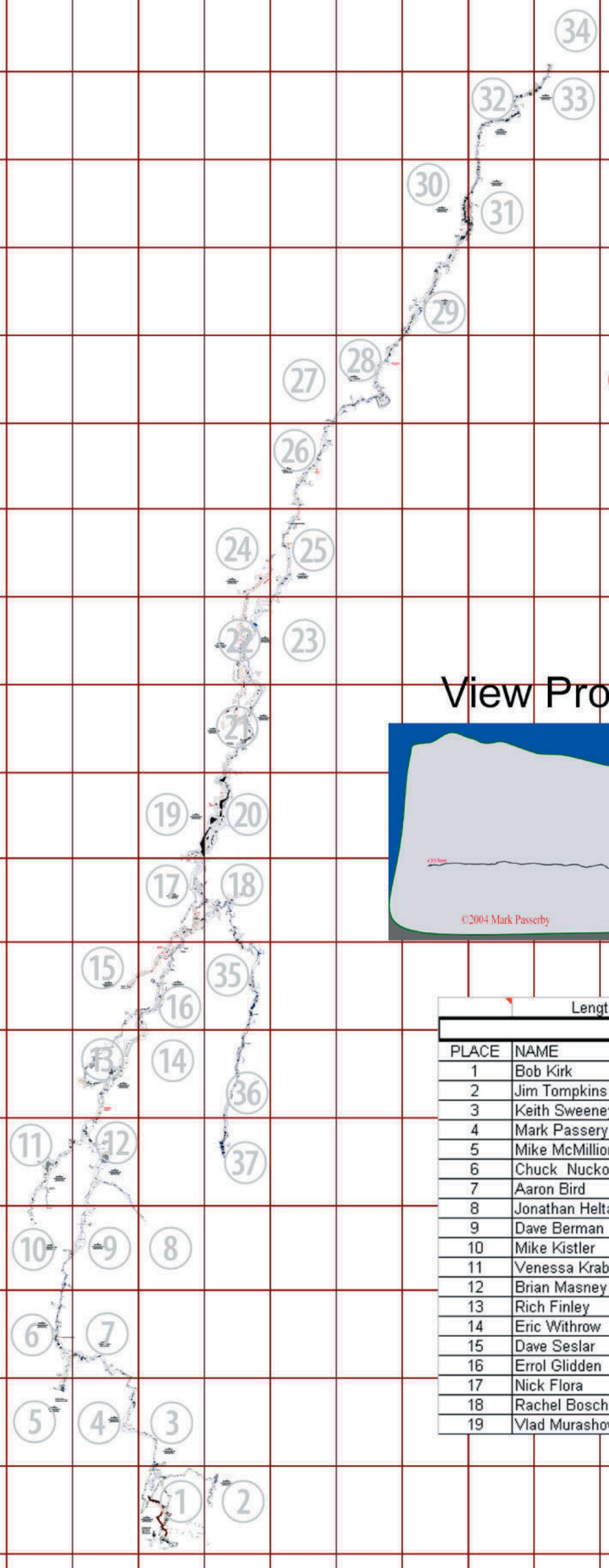
I suspect that with the growing popularity of SVG, images in that format will become natively viewable in most browsers without the need to download the plug-in from Adobe's Web site. The PDF version allows for complex overlapping passages to be displayed, with the cartographer choosing colors for passage floors or outlines to signify different levels. The levels can be made "clickable" within the PDF book so that a user wishing to view only a particular level can, with a mouse click, jump to a corresponding set of map book pages. Obviously, when the cave system is very complex the decisions of the project cartographer will bear heavily on the overall functionality and ease of use of the PDF Map Book.

Details and Purchasing Information for Items Mentioned:

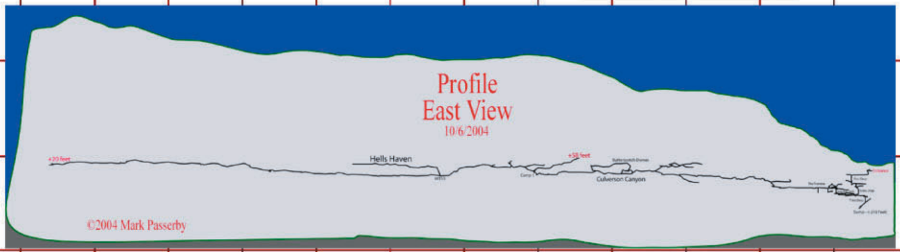
1) Starting set of Illustrator Cave Symbols at www.cavediggers.com/Symbols.zip.
2) Walls Online Printable PDF Format Manual at www.cavediggers.com/walls32.pdf.
3) Walls Survey Software at www.utexas.edu/depts/tnhc/.www/tss/Walls/tsswalls.htm.
4) External batteries (15v) to run the Toughbook line of rugged PCs are approximately $180 each with shipping. (See model PM-148 at www.bixnet.com/unpowbat.html .)
5) Pelican 1490's can be found on Ebay for $125-140 and modified with hardware found locally.
6) For Toughbooks (CF-27) and other new or refurbished other models, contact Greg Doyon at Telrepco, Inc. (203) 284-5239, (800) 537-0509 x239, gdoyon@telrepco.com , www.telrepcoPCstore.com.

PDF Map Book Index "Clickable" Grid Sample Page

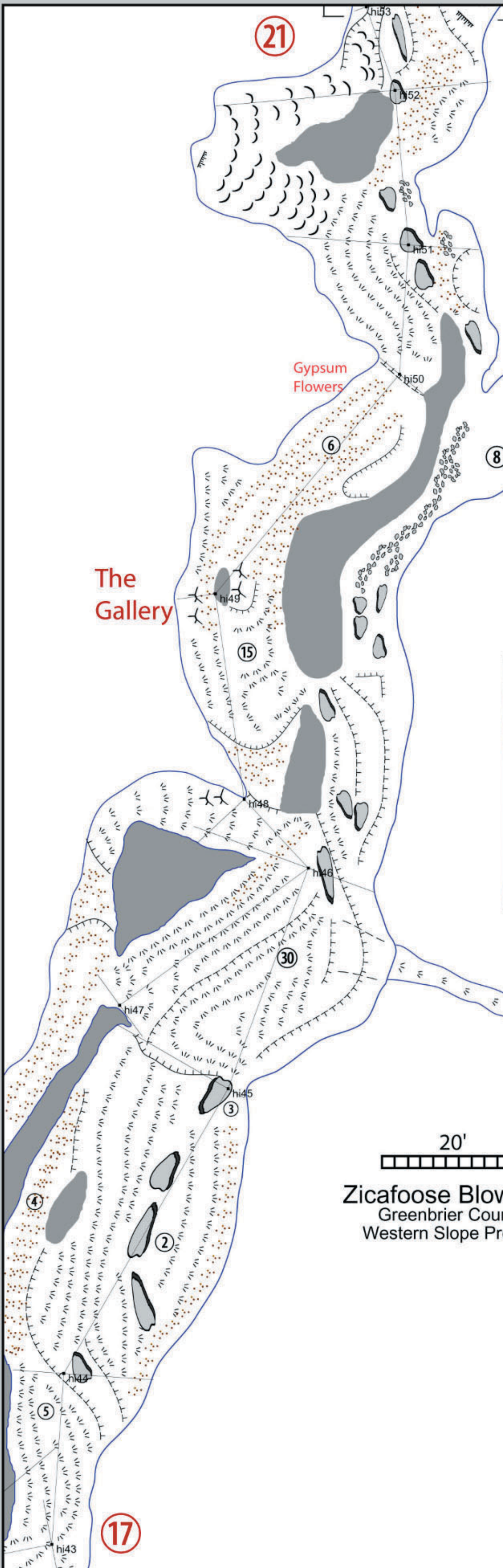
Click on Page #'s to View that section of map



View Profile--East View-Click Here



	Length: 11,459' Depth: 275'			Last updated 10/16/04
	Zicafoose Survey Totals			
PLACE	NAME	# trips	Total Surveyed Feet	avg. per trip
1	Bob Kirk	10	**5545**	554.50
2	Jim Tompkins	8	**5044**	630.50
3	Keith Sweeney	8	**4834**	604.25
4	Mark Passery	7	**3614**	516.29
5	Mike McMillion	5	**3145**	629.00
6	Chuck Nuckols	3	**2866**	955.33
7	Aaron Bird	6	**2849**	474.83
8	Jonathan Helta	4	**2205**	551.25
9	Dave Berman	2	**1661**	830.50
10	Mike Kistler	3	**1269**	423.00
11	Venessa Krabacher	2	**992**	496.00
12	Brian Masney	1	**958**	958.00
13	Rich Finley	1	**958**	958.00
14	Eric Withrow	1	**911**	911.00
15	Dave Seslar	1	**490**	490.00
16	Errol Glidden	1	**379**	379.00
17	Nick Flora	1	**317**	317.00
18	Rachel Bosch	1	**273**	273.00
19	Vlad Murashov	1	**273**	273.00


21
Gypsum Flowers
The Gallery
17
20'
Zicafoose Blowhole
Greenbrier County
Western Slope Project