SVG ROUNDTRIPPING WITH WALLS & ADOBE ILLUSTRATOR

By Jeff Bartlett

Recently, you may have heard the term "SVG round-tripping." Perhaps you saw it in a past issue of this newsletter, or a blurb in the *NSS News*, or in a post on cavechat. The option to "roundtrip" digital maps created in Illustrator with the Walls cave survey program first appeared in 2004, but five years later the concept seems a bit misunderstood. I am often asked exactly what it is, how it works, and what it's useful for.

The Walls help file, while thorough, can be a bit imposing, so I thought I would write an article in hope that I can help de-mystify the process.[1] If your weapons of choice are Walls and Adobe Illustrator, you won't need to change much about your approach in order to take advantage of the potential relationship between these two programs.

WHAT THE HECK IS IT?

"SVG Roundtripping" is the process by which the artwork in your cave map is essentially "linked" to the line plot upon which it is drawn. This workflow is only an option if, in addition to using Walls for handling your survey data, you are drafting your map in Adobe Illustrator (version 10 or newer, the first version after W3C made SVG 1.0 "official"). In a regular cave map, when the line plot is updated by new survey or resurvey or blunder correction, the cartographer exports a new copy of the line plot into his or her drawing program.

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1   Note: *This article is going to presume a bit of familiarity with Walls and how it works, as we'll be dealing with a specific workflow that's not currently used by too many users. If you're new to the program, or want to get started, the help file and examples included with the program are rather extensive, or I'm happy to answer questions for Arkansas Underground readers. Either way, Walls can be found at* http://www.utexas.edu/tmm/sponsored_sites/tss/Walls/tsswalls.htm

This new line plot may or may not wholly agree with the previously-drafted portions of the map, as loops close and coordinates change. How roundtripping differs from this process is that, with a roundtripped map, the artwork is actually included in the Walls project tree; when an updated line plot is exported, updated artwork is exported with it.

Let's think about that in terms of "traditional" cave cartography. Usually, in order for the cartographer to draw the map, there is a pre-drafting "loop rectification" phase. After all, closing large loops and solving loop errors causes the passages to move around; whether drafting by hand or digitally, certainly one needed to be certain that, when complete, the cave's passages and galleries will appear in the right place. This made it difficult to draft maps while exploration was ongoing. This also meant that, if a blunder was discovered after the fact, or a new connection exposed a loop previously thought to be "good" as "less than good," the project cartographer was forced to choose between redrafting

Below - the SVG export dialog in Walls. The scale and frame size are set on the "scale and position" dialog. Here, you name the output file and determine which layers will be merged and exported. The merged file is the SVG file you've created in Illustrator, and the output file is the new file to be created.
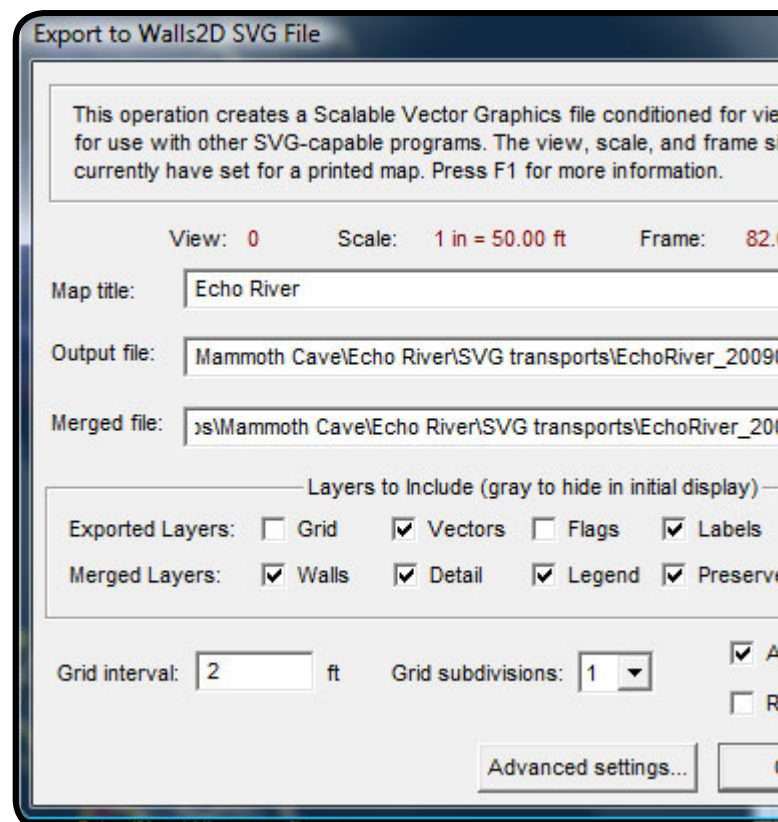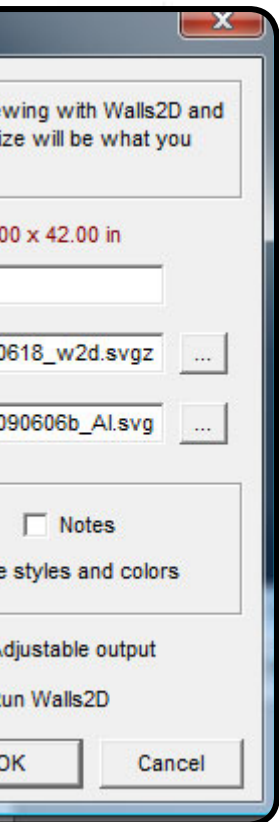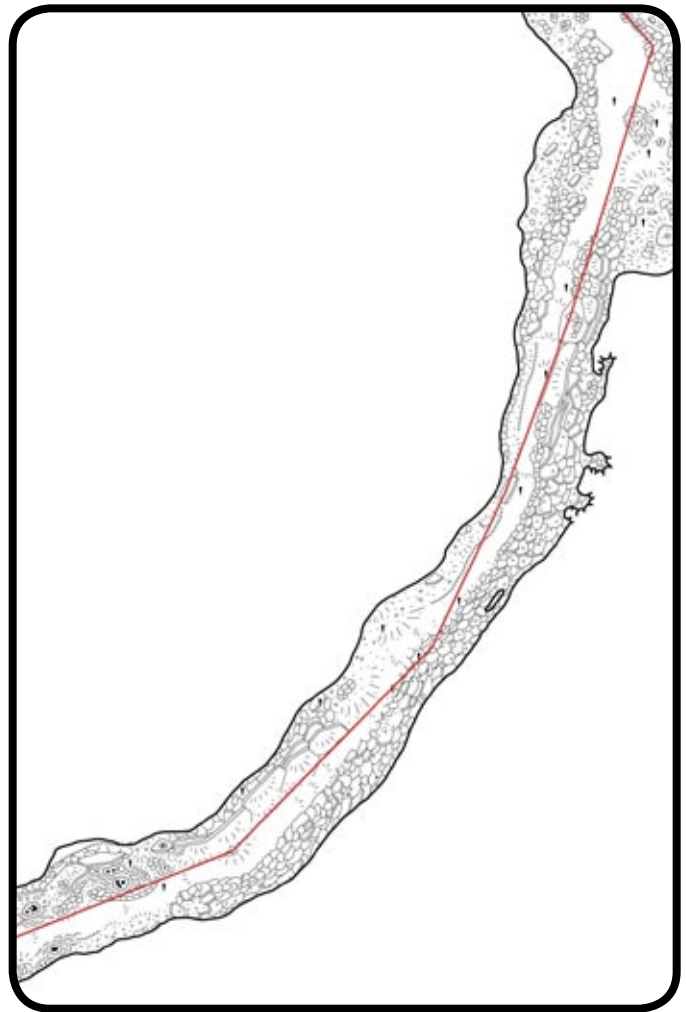
the affected areas or simply ignoring the inaccuracies.

With roundtripping, your artwork will adjust along with the line plot. This can be difficult to explain without examples, so I have applied cruel blunders to my own projects (and those of friends; thanks for sending me your stuff and letting me break it, Stan!) for sake of providing just that.

Let's say you realize, after drawing a particular passage, that a shot you've entered with an azimuth of 104 degrees was actually recorded as having an azimuth of 140 degrees. Uh-oh. What happens when you apply the correction to your Walls data and then subject your existing artwork to a roundtrip? See example this page.

Or, even worse, let's say you close a loop and… what happened? Were they using a tape that had broken at the 1' mark and didn't' note it in the book? Was that compass a degree-and-a-half off? Either way, you've already drawn it, but it needs fixing. The result? See example page 24.

What if you're drawing a maze cave, and every survey adds 8 or 10 loops to the mess? Can you confidently draft the map as you survey the cave, or are you forced to wait? See example page 25.

We often think of cave survey programs as software
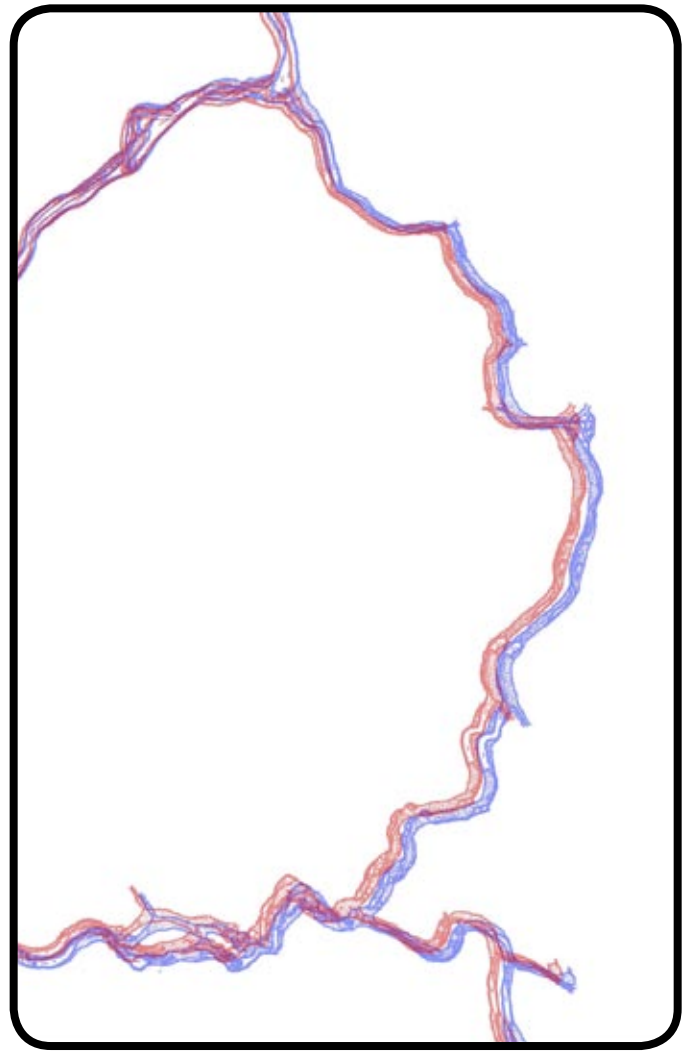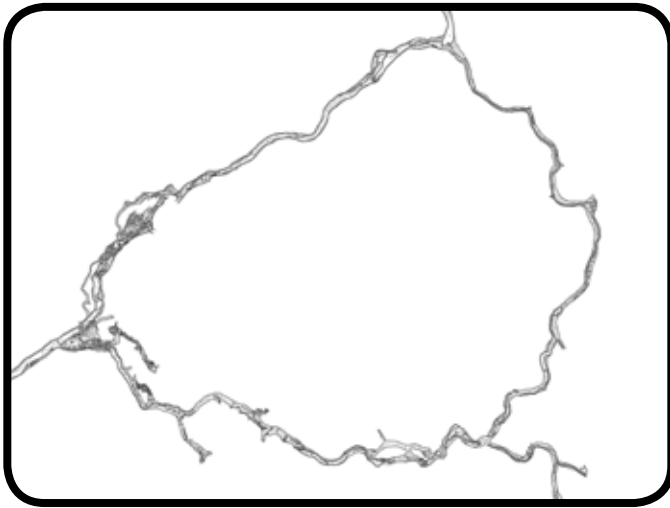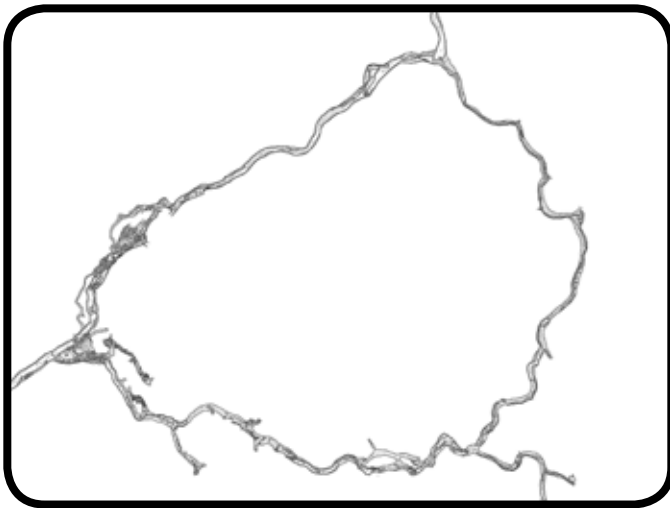
Maybe more significant than being able to make blunder corrections on the local level, roundtripping allows the cave map to remain in place when large, global corrections cause slight shifts. Here, I've applied a correction as if this 3600' cutaround survey was performed with a survey tape missing one foot! While the zoomed-out "before" (top left) and "after" (lower left" shots look identical, a color-coded overlay (above) reveals how the map has accurately shifted. Similar results are obtained when, for example, a survey has had a declination correction applied. This prevents situations where, over time, the ongoing survey line wanders beyond the drafted walls!

that reduces data for us and helps manage that data, but now it becomes a part of the cartographic process.

Some cave surveyors are using SVG roundtripping to actually draft the final map on a tablet PC in-cave, and this technique has been relatively well-publicized. Seems like it works fine… I have no idea, as I've never tried it and have no immediate plans to do so. It's important, then, to note that the roundtripping workflow

is *just* as valid for standard cave projects, with paper sketches, and for use outside the cave. This is a common misconception. In fact, I believe this was the original intended use. From the Walls help file:

"When I started Walls development in 1994, I wanted to create a set of tools for constructing complete cave maps that grow dynamically over the years as the surveys themselves grow. If a station moves due to the addition of new or revised survey data, the map features surrounding it should also move…. (SVG roundtripping) does address a problem affecting both the pen-and-ink and computer approaches. This is that updating an already drawn map of a complex cave is often difficult if not impossible. As a result, some of the largest cave systems have remained in the computer line plot stage for years. What will soon make this hard to justify, I believe, is the ability to create complete cave maps that are truly dynamic in nature."

Therein, then, lies the heart of the concept. SVG roundtripping allows your cave map to be grow *dynamically* along with the survey line. If you're involved in a large cave project where the cartography is split up into quadrangles, you may not even be responsible for the surveys being performed and replaced outside of your quad, but delivering a map in this format allows for future adjustment as necessary. This ensures that the passages on your side of the boundary continue to line up with those on the other side of the fence.

WHAT HOOPS DO I NEED TO JUMP THROUGH?

If you're already using Walls & Illustrator for your cave maps, the answer is "surprisingly few."

Your data, on the Walls side, won't change at all. No need to do anything different whatsoever. In fact, even the export process doesn't change, except that you'll be exporting an SVG file instead of a Windows Metafile (WMF). Once you have reached the point where you're bringing a map back from Illustrator to be updated, the changes are still incremental: at this point, you simply include the SVG in the project tree. The bottom line? You won't have to alter your data management practices, so don't be put off by fears that roundtripping
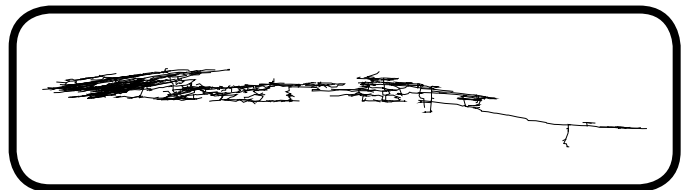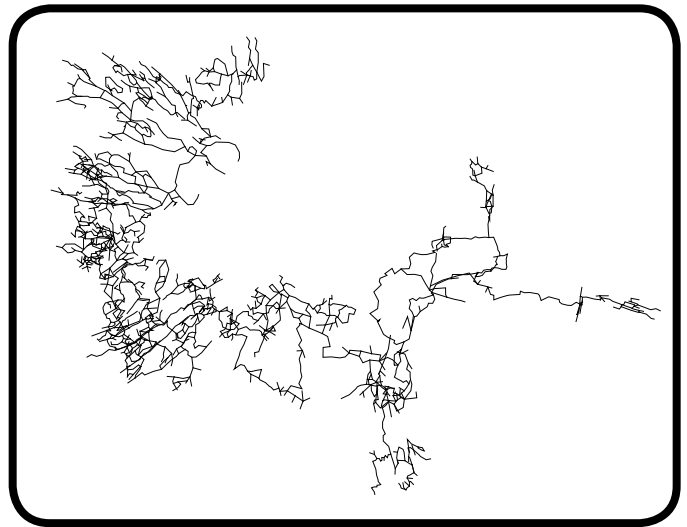
What if your cave project is exceptionally complex, as shown in the plan and profile views above? SVG roundtripping allows the cartographer to confidently draft as the survey progresses, knowing that another 50 or 100 loops aren't going to make the plot migrate away from the drawing. Cave draft below and line plots above are Dry Cave, NM by Stan Allison.

Lots o' Stalactites

Wind Vent

will make the organization and reduction any more complex than it already is.

Once you've exported your SVG, you can open it in Illustrator. On the Illustrator side, there will be a small difference, as Walls exports things in a specific order and you need to retain this layer architecture so that Walls knows what to adjust and how to adjust it. Convert your groups to layers (see instructions, and explanation, page 28) and let's take a look.

See screenshot this page for a list of the layers as Walls chooses to organize them.

Holy complicated! 13 layers! Luckily, this isn't nearly as bad as it looks. In fact, it's not bad at all. Let's start by whittling these down to what you actually need to worry about.
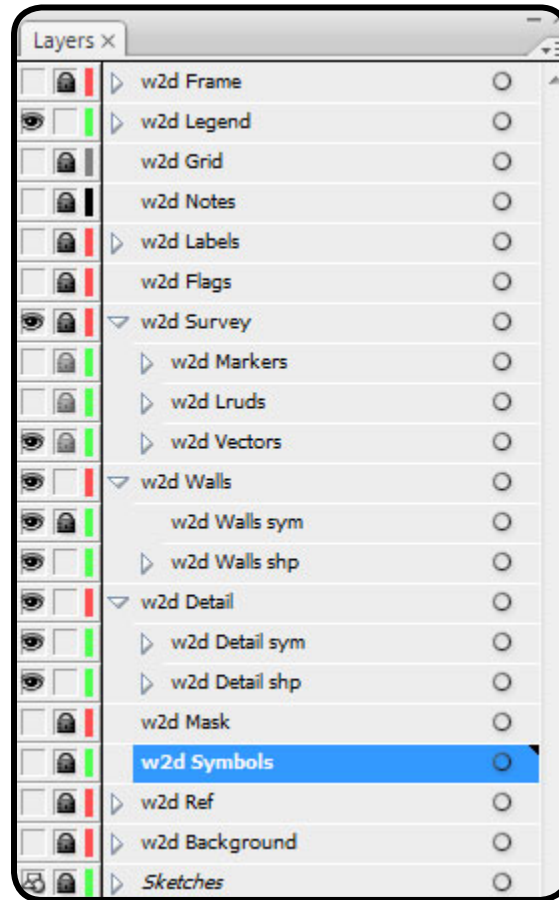
W2d Frame, w2d Ref, w2d Symbols and w2d Background are junk from walls. I keep 'em turned off and hidden, and never touch them (I make my own frame and put it on the Legend layer). W2d Grid, w2d Notes, w2d Flags and w2d Mask will be empty (unless you export Grid/Notes/ Flags, which I don't, and the Mask layer does have a specific function for advanced users). That kills 8 of the 13 What's left?

W2d Labels and w2d Survey are the station names and survey plot, respectively. It's nice to be able to toggle the visibility of the Markers, LRUDs, names and actual survey vectors. You won't do any editing on these layers, but you'll certainly use them.

That leaves THREE layers, and those are the three where you're going to put all your artwork.

W2d Legend is exactly what it sounds like. This is for

Above - This is how Walls organizes the layers when exporting an SVG. See article for details on why you can basically ignore many of these. The "Sketches" layer at bottom is a template layer added afterward; it is used for placement of survey sketches and its contents are excluded from SVG exports.

artwork that is to receive no adjustment whatsoever, neither location correction nor feature-based morphing. Walls basically just keeps this artwork with the project, in the same place, unadjusted, no matter what happens to the project. This is where you'd put your scalebar, title block, north arrow, rose diagram, stratigraphic column, or whatever else you're including that is part of the final map but not part of the actual cave.

W2d Walls Sym and w2d Detail Sym are essentially the same thing, but two layers have been provided so you can divide primary and secondary features if you'd like. To quote the help file, the Sym layers are for artwork: "…*whose survey-relative position must be maintained through translation and scaling alone.*" In other words, when an adjustment occurs, these elements will be moved if necessary, but will retain their aspect ratios and won't be stretched, rotated, twisted or morphed. Examples of artwork that should be treated this way: Feature names, Ceiling heights, Cross-sections, and various symbols. These items retain their position relative to the page, not the survey line, so some symbols (like those representing formations or small breakdown) are better off on the Shp layer.

W2d Walls Shp and w2d Detail Shp are likewise similar, and are for the artwork that you *do* want smooshed and squooshed and contorted as necessary. To again quote the help file (which is much more extensive than the excerpts I am including here): "*It is here that you draw prominent reshapable features like passage walls, large breakdown, and major water boundaries.*" This is also where you'll place your slope symbols, ceiling or floor ledges, and floor details. Features on the Shp layers will be adjusted as-necessary to accommodate a shifting survey plot, including morphing rotating. In other

words, when your 20.5 foot survey shot is revealed to be a 25.0 foot survey shot, and that 20 foot long piece of breakdown is thus revealed to be a 25 foot long pice of breakdown, the software not only adjusts the passage Walls to fit the new plot but it also adjusts the features on the Shp layer to preserve their relationship with the passage, whereas on the Sym layer it would only move them without further adjustment.

Whew! It's a very simple concept, despite all this explanation and the fact that the layer architecture looks a bit like a train wreck compared to the layer order utilized by most cave cartographers. Typically, I put my walls and w2d Walls Shp and all of my plan view details on w2d Detail Shp, with cross sections and ceiling heights on w2d Detail Sym. I put all of my "legend" stuff on, well, the w2d Legend layer.

Essentially, what you are doing is putting artwork in the proper cubbyhole according to how you'd like Walls to handle it. Walls makes its decisions based upon these placements. Of high importance is the fact that, within this arrangement, you are welcome to organize things however you normally would. Do you usually separate out your plan view details into separate layers for breakdown, floor details, etc? You can do this just as easily within the layer order describe above as you

Below - When a file has been successfully roundtripped, Walls confirms whether or not an adjustment was required. One drawback of this display window is that it does not specify which station has moved to the degree noted, a fact which may not be immediately apparent in complex maps or when multiple corrections have been applied simultaneously.
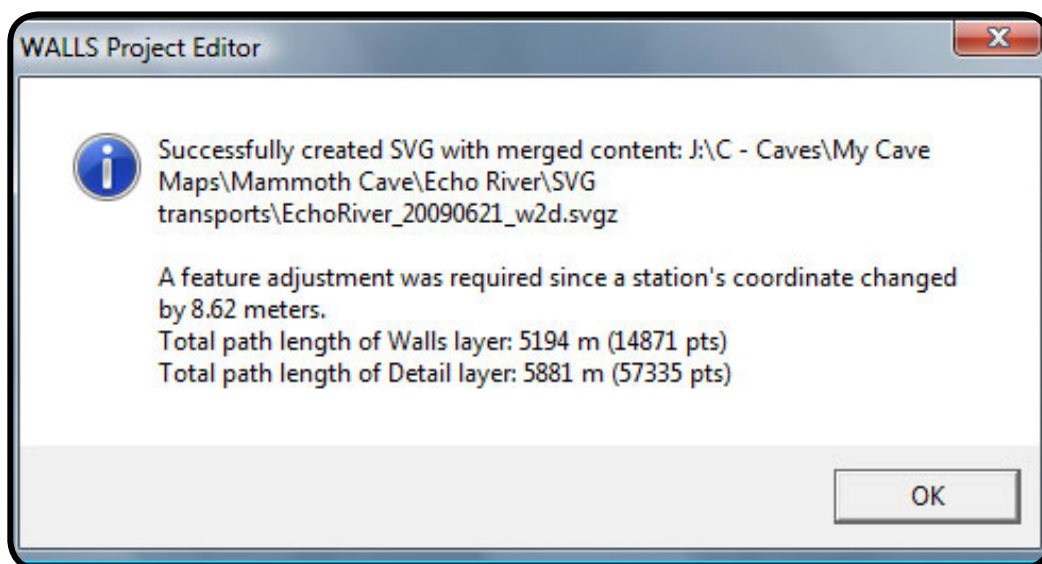
would in any other map. Does your project require a specific layer architecture? If so, I'm sure you can spare the 10 minutes to export a copy of your working file and reorder things however you'd like before turning in to the project coordinator.

If you're already using Walls for your data and Illustrator for your artwork, then, this isn't a huge leap forward. You need to export SVGs instead of WMFs, and you need to tuck your preferred layer setup within the appropriate "master" layers. If that sounds like more work than redrafting sections of cave every time an error correction or loop closure causes a shift, well, I can't help you further.

THE WORKFLOW

The reality, then – if you're using Walls and Illustrator – is that you don't need any additional software or special equipment. You can roundtrip any cave project, whether your cartography is simple or detailed, whether your survey notes are drawn on paper or recorded digitally or etched into stone tablets.

Let's take a look at the actual workflow you'll be using. First, as described above, you'll export an SVG file (as opposed to a WMF) to the proper scale, then open it in Illustrator and convert the groups to layers (see page 28 for instructions). When you generate the SVG, it is integral to make sure that "adjustable output" is selected, or you will end up with a map that can't be roundtripped! I did this once by accident, had to seek guidance from David, and the result was no fun. Anyway, at this point, save a copy of your SVG as a new AI file. Then… draw! Draw, I tell you!

When your survey plot needs to be updated, it's time to let Walls have a crack at it. Make a copy of your AI file this time, saving it as an SVG. Then, in Walls, go to the top of your project tree and add a new item (of the "other" type), selecting your SVG file and making sure it's attached to the project

WALLS Project Editor

Successfully created SVG with merged content: J:\C - Caves\My Cave Maps\Mammoth Cave\Echo River\SVG transports\EchoRiver_20090621_w2d.svgz

A feature adjustment was required since a station's coordinate changed by 8.62 meters.
Total path length of Walls layer: 5194 m (14871 pts)
Total path length of Detail layer: 5881 m (57335 pts)

OK

tree. That's it! Export a new SVG, just like before, and Walls will recognize the one you've attached, listing it as the "merged" file being used as the basis for the output (as shown on the dialog pages 22-23).

When you actually generate a new SVG file in Walls with "merged" content from Illustrator (your existing map) attached, a pop-up window will warn you if any adjustments have been applied, based on the largest change; in other words, if a station moves 18 feet, Walls will tell you exactly that (see illustation page 27). It doesn't say what has changed or where, presuming you know what to look for, but this may not always be the case, so it's worth doing a quick look-over of the new file to make sure that any adjustments applied are seamless. In cases where major blunders have been rectified or, for example, an incorrect tie-in has been corrected, it's possible a bit of cleanup work (or redrafting a particular junction) may be in order.

I usually name my SVG files with the date and program that generated them; that is, EchoRiver_20090609_ w2d.svgz would be an Echo River map from June 16th generated by Walls. Likewise, the same file going back to Walls might be named, say, EchoRiver_20090617_ AI.svg depending on the date. This helps me keep track of the project history and when changes have been applied, and is generally in keeping with what's suggested by Walls.

How often to roundtrip? It depends on the project, really. If you're surveying every day over the course of a week and don't intend to start drafting until the week is over, you might apply all the new work as a single roundtrip. If you're surveying once a month, and updating the map in between trips, you might roundtrip after each trip's data has been entered. If you're on an expedition and need to update a preliminary map on a daily basis, you can roundtrip every day. Typically, for Chinn Springs Cave and Mammoth Cave I roundtrip and apply changes within a few days after each survey trip or survey weekend, once I've entered and proofed all the survey data. This adds the new survey to the line plot as well as applying any adjustments,

HIDDEN POST-ROUNDTRIP PITFALLS

Hey, how come this SVG doesn't quite look like it did before we roundtripped?

After you roundtrip your working map through walls and bring the newly-generated SVG back into Illustrator, you're going to have to do a bit of housekeeping. With the exception of version CS1, Illustrator manages to turn your layers and sublayers into groups and subgroups, and you're going to have to turn them back again before you can do anything. By the way, this is why the in-cave-digital-survey guys use CS1; it allows the cartographer to ping-pong the working map back and forth without any additional maintenance. If this sounds like a problem for you, CS1 will work fine. I'm partial to CS3, but grooming the incoming file isn't more than a nuisance.

Since I began writing this article, David has incorporated instructions into the Walls 2b8 help file in regard to the most efficient way to fix this. Rather than re-invent the wheel, I'll swipe directly from the help file, rather than directly from the email thread the help file is based upon anyway. This is the process:

Double-click a high level w2d group in the Layers palette, for example, w2d Walls. (The parent must already be a layer.) This opens a small "Options" dialog showing the group name. Use Right-click | Copy to save the name to the clipboard, then Cancel the dialog.

While the group is still highlighted in the Layers palette, open the Layers context menu by clicking on the tiny right-arrow near the top of the palette. From the list of commands, select "Collect in New Layer". This will create a new layer with a unique name, say Layer_5, containing the group you want to convert, w2d Walls. Layer_5 also takes up the slot originally held by w2d Walls.

Select Layer_5 (all contained objects) by clicking the select circle to the right of the name, then select Object | Ungroup. The objects and other groups originally in w2d Walls will now be Layer_5, but the group w2d Walls will no longer exist.

Finally, double-click Layer_5 and replace its name with the clipboard contents, in this case "w2d Walls". This makes w2d Walls a true sublayer (grayed on the Layers palette). We would then repeat these steps for both w2d Walls sym and w2d Walls shp.

As David recaps in the help file, this is only a few clicks per layer, and is only necessary when first opening the Walls-updated SVG files in Illustrator.
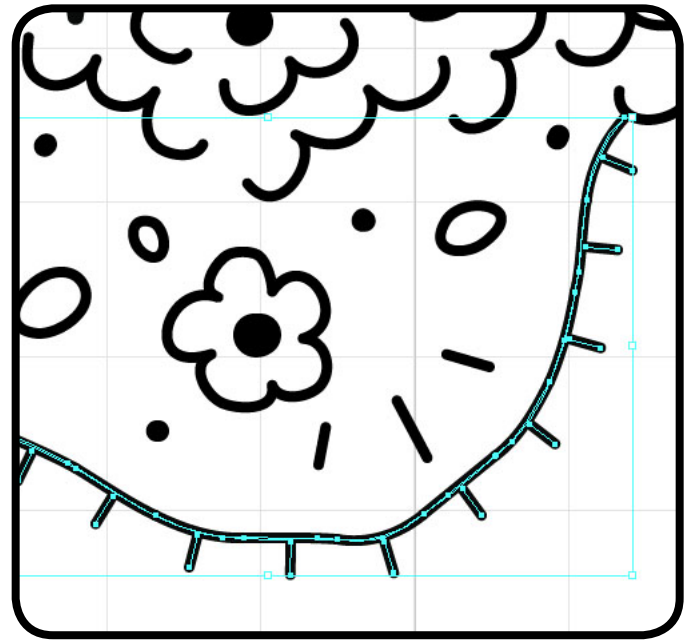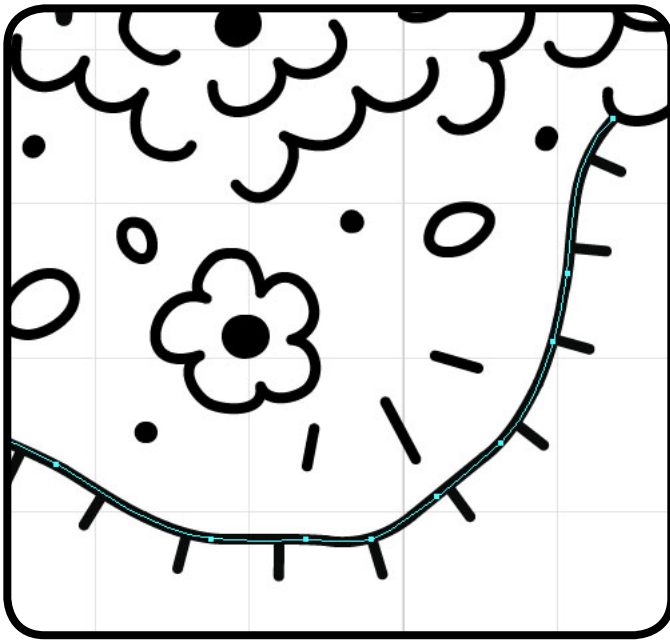
In addition, post-roundtrip, there are some changes to the structure of certain elements that you need to be aware of, as in some instances these minor changes may be significant. Basically, as a part of the SVG export process, Illustrator "expands" certain complex items, such as live paint groups and brushed paths. This can lead to an increase in the size of your working files.[2]

If you're not sure what I mean, try selecting a brushed path and clicking "expand appearance" (see illustration above). Editing ceiling and floor ledges after this step can require redrawing them entirely, so if you need to make any changes you should plan to make them before the roundtrip process. Any edits that may be necessary at "ground zero" where an error correction has been applied are an exception.

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2 As a workaround to deal with increasing file sizes, David McKenzie and I had tried "excluding" the brushed paths from the SVG export by housing them in their own template layer, then copying this layer from the old file into the new one after the roundtrip had been applied. However, this created the potential for more problems than it resolved; in one case, a minor correction to the data caused all the brushed paths in one map to be about 10' away from their appropriate locations, because they had been excluded from the roundtrip! I'd rather have small, occasional corrections to make on a local level then major cartographic issues to address on a global level, so I have abandoned this practice.

Above, left - A brushed path in Illustrator. Above, right - A brushed path after expansion during the SVG export. While the visible appearance does not change, the selection lines betray the new behavior of the object: this is no longer a pattern brush applied to a single line, it's a series of separate lines. The former is much easier to adjust than the latter.

Some items that are demonstrably affected by expansion during SVG export:

Brushed Paths. As mentioned previously, this will likely affect all of your ceiling and floor ledges. Those who use brushes for things like flowstone and floor details may be further inconvenienced. It's important to note, however, that unless you need to make changes to a brushed path in an area you've already drawn, this shouldn't be an impediment except in the local area near a data correction where some cleanup may be necessary. In most cases, loop corrections are minor and no corrective redrafting is required.

Text Boxes. Most maps have some kind of text block, either the title or auxiliary information such as a list of surveyors. When text elements are expanded, however, multi-line text boxes are separated into individual, left-justified lines of type. In almost all cases, this is no issue. However, I found this out the hard way. After painstakingly typing the names and number of survey trips for each of the nearly 100 survey contributors on our project, and organizing this information into a text box, I was frustrated when I realized the post-roundtrip file could no longer be edited properly; keeping sur-

veyor names in the correct order meant moving items from one line to another and adding items in the middle of the list! Luckily, this speed bump is easily dealt with by keeping the surveyor list as a separate file and "placing" this file into the map.

Another issue not addressed in the help file, unfortunately, is what happens when you remove a survey from your project file. Let's say I have an E survey and the surveyors didn't take backsights or inclinometer readings. I have replaced this survey with an F survey to modern standards, and would now like to supersede the E survey in my data set. Depending on your personal preferences and/or the data-management standards of a given survey project, we might be inclined to remove the E survey completely from the project file, "detaching" it in the project tree or simply pruning that branch out. This would be all well and good… until the next time you roundtrip. At that point, you'd be bringing an SVG file into Walls with the old E survey still in it, but Walls wouldn't have these E stations in the data set.

There are two ways to solve this. First, you can just leave the E survey in your project and "float" the traverse or disconnect it at one end. Second, if you prefer to remove it entirely from the data set, you will have to manually edit the SVG file in a text editor. SVG is essentially just XML, so any text editor will do, and Walls will tell you which line of code is triggering the error. I use Notepad++, which numbers the rows and allows me to scroll right to the offending line of code. Manually remove the lines with the shots that no longer apply, resave the SVG, and you'll be ready to go.

Regardless, being aware of this potential issue makes it easier to plan around. You will likely still have an occasional line to delete from the XML source, as corrections involving renamed stations will have the same effect. This is really annoying, but not prohibitive.

LIMITATIONS OF THE TECHNOLOGY

Lest I unintentionally imply that the SVG roundtripping method is perfect or will work for everyone, let's examine some of the ways the process is still in need of refinement.

One significant issue is that, presently, profile views cannot be roundtripped. If you're saving your profile

for last (and you'll pretty much have to if you're round-tripping), no problem here. However, if the point is to be able to draft-as-you-go, this is an obvious problem. I don't think the lack of SVG support for profiles is enough to outweigh the benefits of the workflow, but I am hopeful that this functionality can be included in the near future, and David McKenzie does list this as a "feature being worked on."

The second primary shortcoming of SVG roundtripping is the way Walls handles overlapping passages on different horizontal planes. Fundamentally, the software is not able to differentiate between upper and lower passages that may cross over one another. In extreme cases, then, where a blunder correction has been applied on an underlying passage, the adjustments applied there may also be improperly applied to an overlying passage, necessitating more "cleanup" work than would otherwise be necessary (see page 31 for screenshot of a worst-case scenario).

As a workaround, for his survey of Dry Cave (a five-level maze cave in the Guadalupe Mountains), Stan Allison roundtrips individual sets of artwork for each level, separately, having subdivided the layers in Walls with the #segment command. I won't go into this method in great detail here, except to note that, in the case of Dry Cave, this is even more of a necessity due to the cave's layout. Even without roundtripping, separate level maps would have already been the best available option for a multi-level maze cave.

CONCLUSIONS

Walls is one of a few available cave survey programs (along with Therion, Winkarst and Carto, to varying degrees) with the capacity to adjust features. As outlined in this discussion, it's not perfect, but it's also not particularly difficult, especially if you're already using Walls or Illustrator or both to produce cave maps. A roundtripped map, versus a traditional map created with the same software, can be fluidly adapted to a growing, changing survey line… regardless of whether those changes are blunders in ten-year-old survey you've just fixed or if ten years from now some young punk is fixing the blunders in your survey that you don't know about yet.

The practice of cave cartography has experienced a wholesale switch from hand-drafted maps to digital

maps over the last decade and a half, and digital tools for cartographers continue to march forward. Adjustable, dynamic cave maps are simply the next step in this progression. In the past five years this concept has advanced beyond the pie-in-the-sky stage to be a present-day reality. What might seem like a cutting-edge method is simply a modern way to use the computer programs you're already familiar with.

With SVG roundtripping, it now becomes possible to draft maps before the loops have all been fixed (or closed). This empowers the cartographer to draw a real, honest-to-goodness cave map as exploration continues, without fear of needing to replace large portions of the work. We can draw the cave maps while everyone is still excited about the cave mapping, instead of watching once-enthusiastic surveyors burn out one by one as the survey project marches forward without a map. Ultimately, this may be the primary benefit of the workflow: more caves with drafted maps instead of simply line plots, and more immediate results to share with the contributing cavers. Now… get to work!
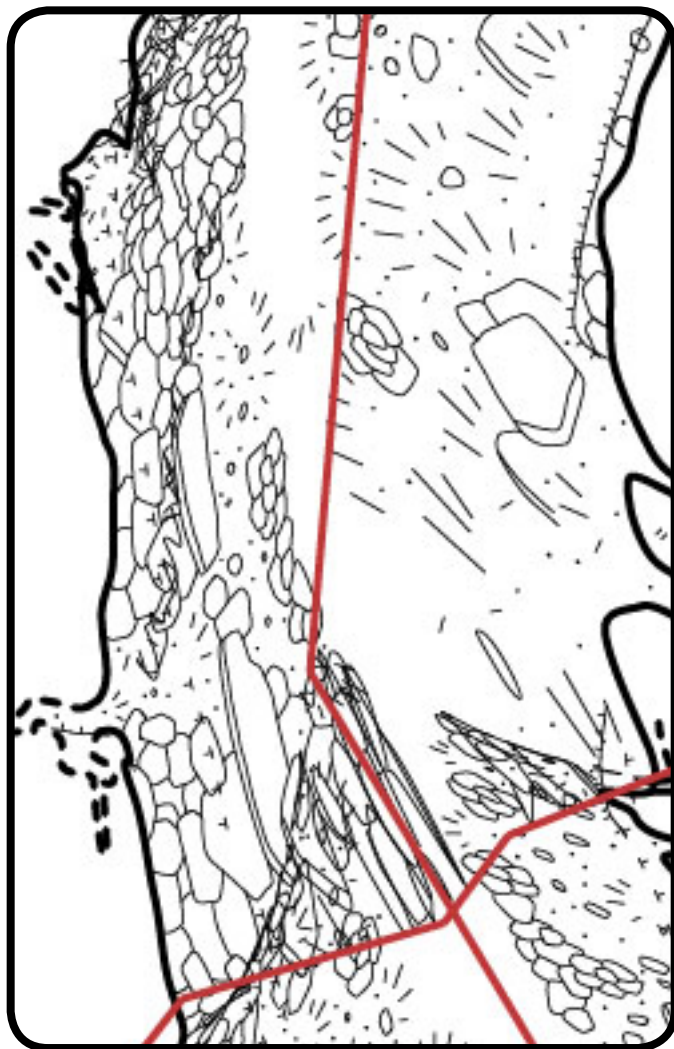
Above - FAIL! Since Walls only understands how to adjust artwork in two dimensions, some incredibly hideous things can happen when you apply a large, local adjustment to a passage with underlying or overlying passage nearby. If your cave map is multi-dimensional, you have two options: (a) the Stan Allison approach or (b) make sure your data is checked thoroughly before you begin drafting. The latter limits the benefit of roundtripping somewhat, although your map will still be adaptable to systemic or global changes.

Cartographers cited in, or contributing to, this article:

Jeff Bartlett (er, me) has used the SVG roundtripping workflow for the Big Rift quadrangle of Mammoth Cave, KY (~3 miles), and is currently utilizing the same workflow for Chinn Springs Cave, AR (~6 miles) and the Echo River quadrangle of Mammoth Cave, KY (~3 miles).

Stan Allison has used the SVG roundtripping workflow for the ongoing resurvey of Dry Cave, NM (~10 miles), an extremely complicated hypogenic maze cave with multiple vertical levels.

Spike Crews – whose contribution to this article was telling me "It works" via email, but was one of the catalysts for this article so I'm including him anyway – has used the SVG roundtripping workflow for Bruce Cave, MO (~2 miles) and is preparing to use it for the Turner / Mather quadrangle of Mammoth Cave, KY (10+ miles).