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ABRASION RESISTANCE
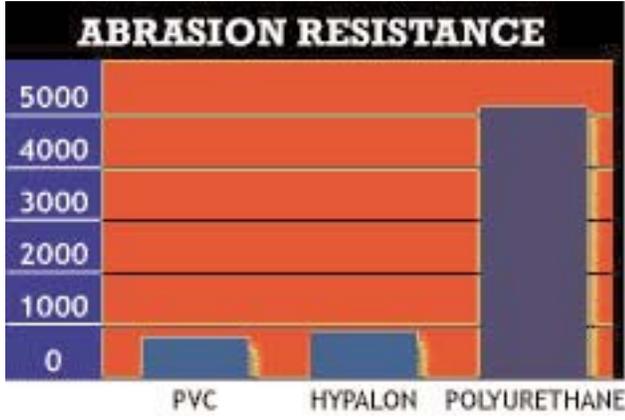
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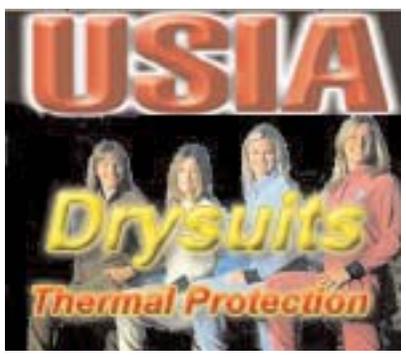
Manifold.....Photoshop... Picture Window.....DJVU and the Digital Survey

by Mark Passerby

The following article is an abbreviated attempt to convey the methods and processes involved in using software tools to converge rough survey data and sketches into useful digital maps. The software tools used include Picture Window, DJVU, Manifold, Compass, Photoshop, and vector graphics drawing software. I hope this can be of some using in moving the survey from the file cabinet to the digital landscape.

Beginning the Process:

In the Raders Valley Project we have organized a workflow that has proved efficient and effective for rapid display of relevent working maps of ongoing cave survey projects. The process begins in the cave with data being collected and a sketch being drawn. While some of the data collection tools are beginning to evolve the process remains largely the same. What has changed drastically are the map-making processes applied after the data and sketches leave the cave and are brought back home.

In our case, Bob Kirk is the Raders Valley Project's keeper of the raw "paper" data and thus is charged with typing the survey data into Compass. He then scans the notes at 180 dpi and uploads the Compass .dat files and scanned notes to a dated survey folder on the Projects internet server. From here all project members will have access to the critical data via the internet.

The Working Map:

After the survey trip, everyone in the group will be expecting the updated working map soon. In our case, I use FTP to transfer the scanned notes from the server to my laptop for use in assembling the working map. Once the updated working map is complete, the entire high-resolution image is encoded to DJVU format for display on the web for project participants to view.

What to Morph??

In my example I will present only one workflow model for the morphing process, but bear in mind that other models I have seen in use follow a much different flow and opt to only morph the line plots survey stations with relevant points on the working sketches. In my opinion this represents a somewhat flawed approach in that relevent wall points at each station are not accurately reflected. Further I would argue that even the examples here while representing a higher # of control points and accuracy still contain flaws that with minor changes in cave can be eradicated as well. All of these what I call "step ups" can be done with little or no time added to the entire process.

Adobe Photoshop 7:

With the scanned working sketches now in hand I begin assembly of the working map. In my flow no morphing is done until a large part of the survey is complete. Then using Picture Window 3.1 large chunks can quickly be morphed and then registered in Manifold. My example uses Adobe Photoshop 7, but earlier versions and even other photo editing software I am sure have similiar processes.

The process is designed to take a scanned sketch with all of its imperfections i.e. mud, graph lines etc. and separate out only the relevent penciled lines for use in assembling the working map. Once learned it is a very quick and an efficient process.

Open the first scan.....
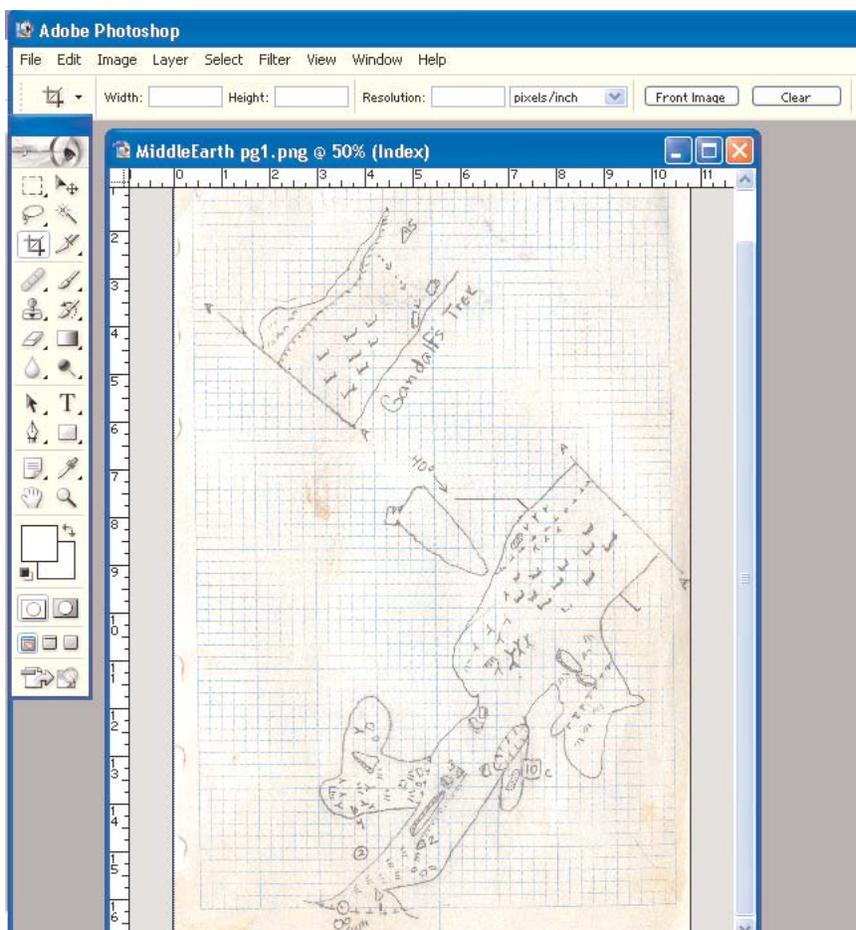
Then.........
Make sure your working map image is already opened in Photoshop or that you have a new blank image/canvas ready to begin the process of building your working map.

Now in your color range tool make sure that the "Invert" option is checked and the fuzziness slider is adjusted to the far right. The fuzziness slider can be adjusted to different levels as you become experienced with the tool. I also select the middle "eyedropper" position located just above and to the right of the Invert check. This will allow you to select multiple spots on the working sketch that will help to quickly isolate only the penciled in portions. Begin now to use your mouse to click on the scanned working sketch on points other than the penciled in drawing portions.
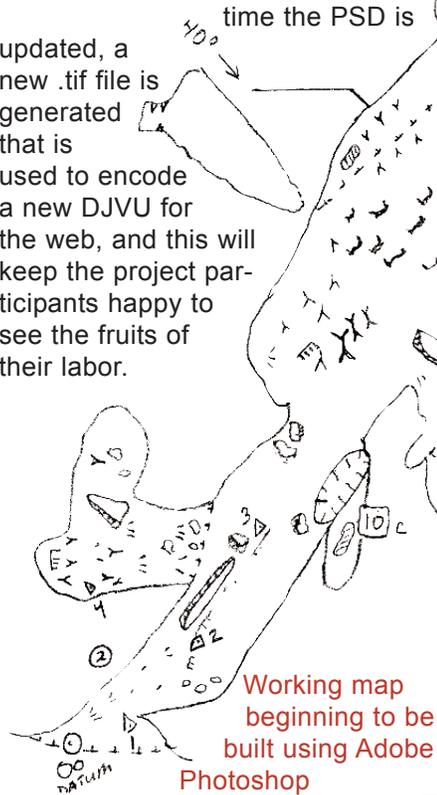
You will begin to notice in the Color Range box that the penciled-in portions are staying white whereas the unwanted parts are now illustrated as solid black. What you should see are that the penciled-in portions are highlighted on the image of the scanned sketch. Once this is successful, and while the penciled-in portions are still highlighted, use the keyboard combination of "ctrl" + "c" to copy. Now highlight your working map image and use "ctrl" + "v" to paste the penciled-in lines of the sketch into a new layer of the working map. You now have only the penciled in lines of your sketch in a new layer in your working map and can quickly move it into place using the move tool in Photoshop. Once this is complete with all the scans from the recent survey trip I save the entire working map layers as an Adobe .PSD file then additionally "flatten" the image and save it as a .tif at 180 dpi which can then be named for
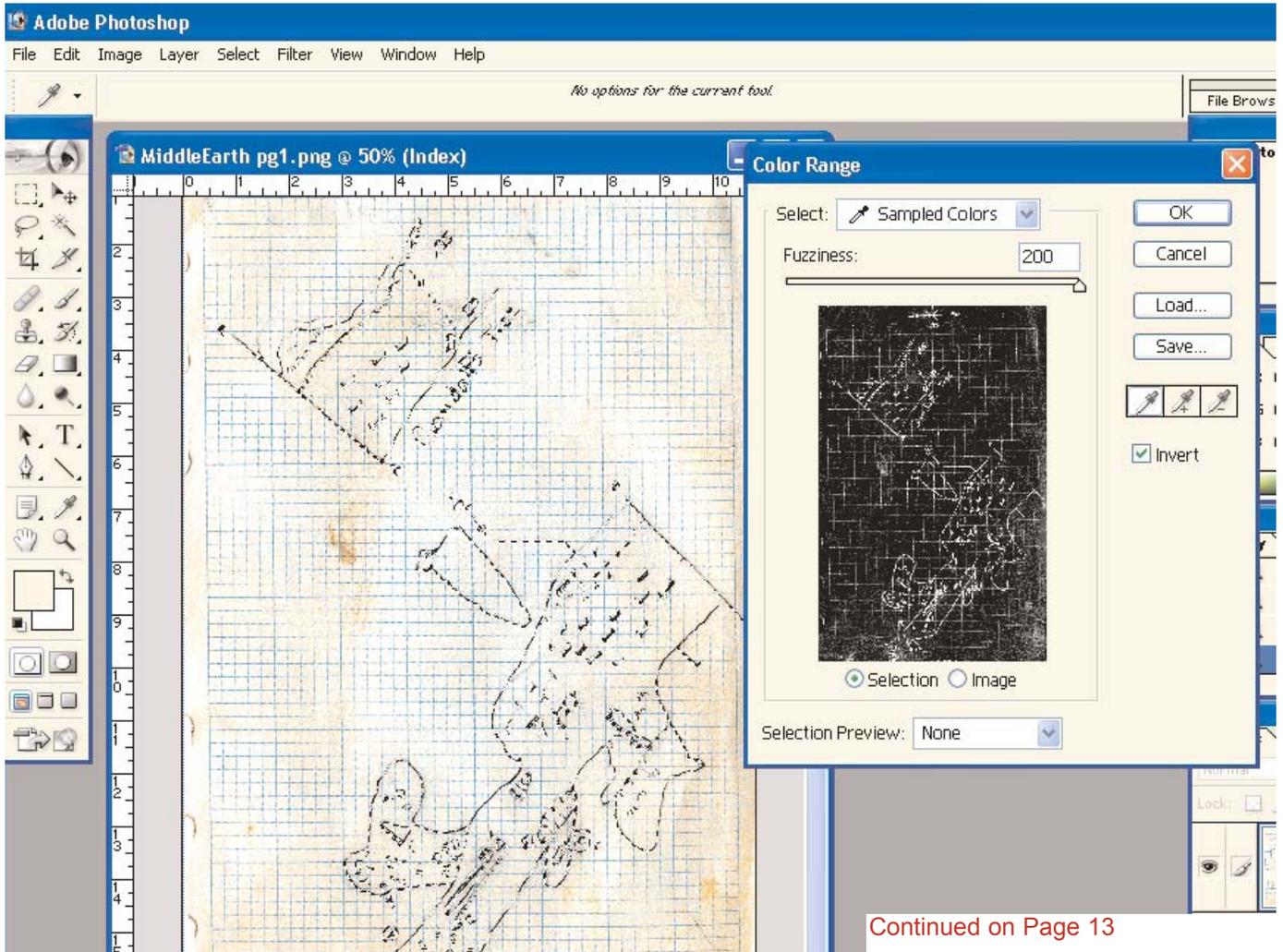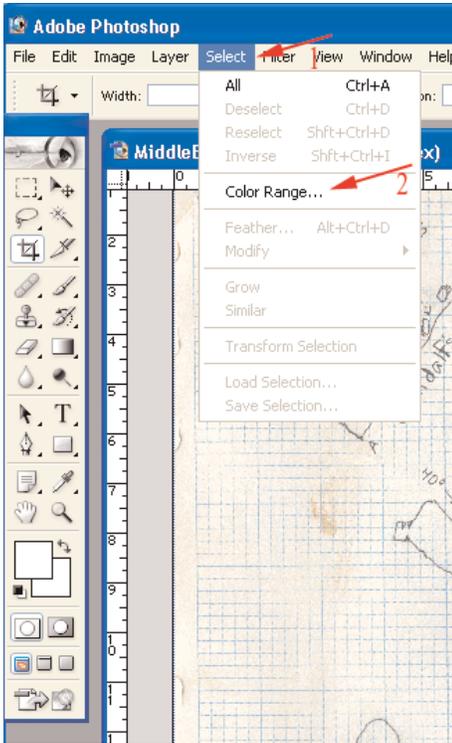
example 712003WorkingMap.tif. The .PSD file named WorkingMap.PSD will be used after the next survey trip to add additional survey onto the working map and the 7122003WorkingMap.tif is used in DJVU to generate a DJVU encoded working map for display on the web immediately. Each time the PSD is updated, a new .tif file is generated that is used to encode a new DJVU for the web, and this will keep the project participants happy to see the fruits of their labor.

Working map beginning to be built using Adobe Photoshop

DJVU Encoding:

Many years ago Lizardtech http://www.lizardtech.com developed a tool for compressing very large document scans and photos to a format they termed DJVU. They introduced it largely through the use of a "free" non-commercial version of their converter and DJVU editor. While the free version is no longer available the regular version is for larger projects a worthwhile investment.(approx. $250) A 250 image trial can be downloaded at:
ww.lizardtech.com/solutions/document/trial/
Another option is to convert to a compressed .pdf file, but comparisons by me of the two show that not only are .pdf's far bigger in file size they also lack the

sharpness and result in far more "loss" in quality.
In my opinion DJVU encoding and Lizardtech's DJVU editor represent the ideal solution for display on the web of high resolution working and finished cave maps.

The DJVU Editor:

Below is a screenshot from the DJVU Editor 4.0. Once the .tif image has been converted into a .djvu image the .djvu image can then be further edited with drawing tools and hyperlink boxes etc. In the example below I have added a book and a camera to the working map in Photoshop. Then once converted to .djvu I can use the Editor to add for example a hyperlink to the book so that when a project member clicked on the hotspot they would open a new
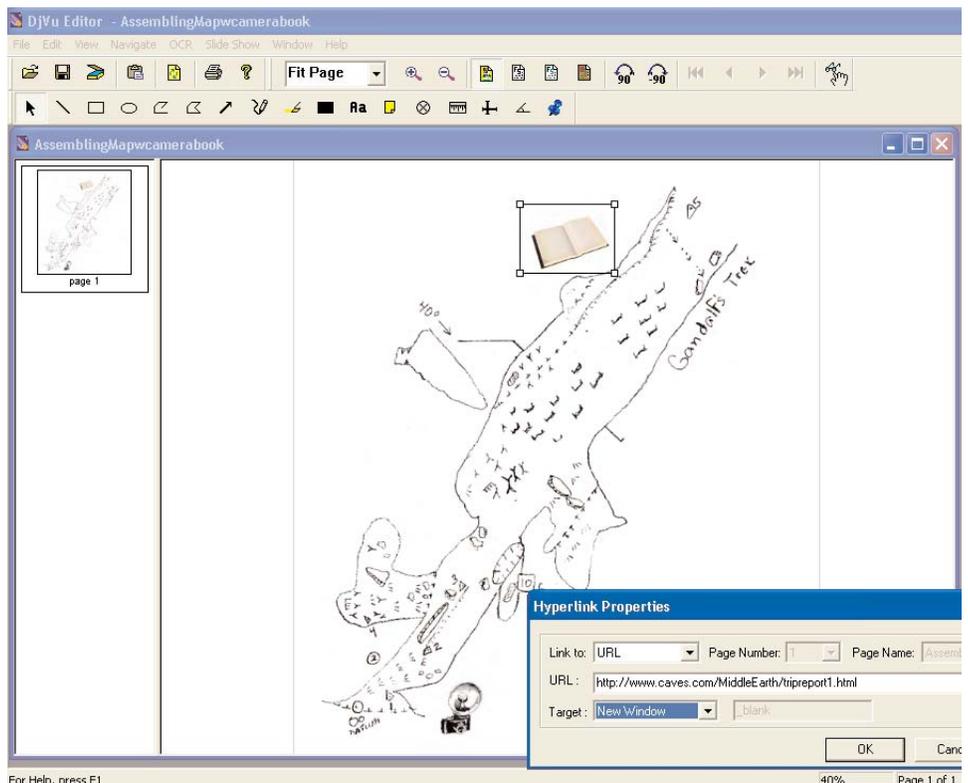
window with a relevent trip report from that particular survey trip. The camera as well would be used to provide a hyperlink to a relevent photo of that area of the cave and so on. The possibilities are endless, but remember to read the "help" sections as there are many functions that can be used to tweak the djvu-file even further.
One important thing to learn is the process of embedding the .djvu image into an .html page which enables you to add some text and a "regular" link for users to download the browser plugin that is needed to view the image online. This is important to remember because if the .djvu is left as a standalone image the user without the DJVU Browser Plugin would be left with a blank window. Embedding the .djvu in the .html of the page is recommended to insure that they can be given the option to download the browser plugin. The process of embedding is fully explained in the Help Menu.
Also included in the Full Version is a somewhat watered down version of Macromedia Freehand which can be used to add drawing functions to the editing process on a

.djvu image.

Morphing:

In my opinion, morphing represents the critical step in the process from working map to final digital map. In days past a final map would be hand drawn or traced using the working sketch and a line/wall plot as reference points. The relevance of the wall points is something I will discuss later in this article but suffice it to say these points have and will continue to be critical control points in the drafting of a final map. Software in use currently, such as Winkarst and Cartos, morph the line plot by using survey stations as control points; however, they leave out the left and right points at each station.In small passages without high angles, this process will suffice. However, where it begins to break down is in high-angle, wide, or improperly sketched passages. Acknowledging this then requires that the data collection process be changed a bit to insure that the data later can be used to generate relevent control points for the final morphing sequence.

Conversations with Miles Drake, Aaron Bird, and Bob Kirk have solidified my opinion that such data collection can be done on every survey without slowing down the process and ultimately achieving a far more definitively accurate represention of the cave.

The image to the right is a section of Middle Earth that has

been mor-phed using Picture Window 3.1 using control points on both the survey stations

and the relevent left/right at each station. It looks to be a perfect image and a great background layer to begin the final map trace in your favorite drawing program, but actually it has flaws.

The cause of these flaws is in the standards most of us now use for data collection. This can and should be changed.......

Morphed Section
of Middle Earth

20'

First:

First though let me discuss the process of morphing the working map into a final traceable map. In my workflow I have chosen to do large chunks of morphing at a time and include control points at each survey station as well as left and right wall points. The benefit to doing the morphing at the end of the survey is that programs like Picture Window are capable of morphing large segments of cave in a single pass thus bypassing the tedious process of doing this with small chunks as the survey goes.

For this I initially used Manifold but opted to later use Picture Window 3.1. For those choosing to only morph the survey stations of the line plot, any of the existing programs, i.e. Manifold, Cartos, or Winkarst 10 will suffice. For my example, however, Picture Window 3.1 seems to be the only program capable of the high-speed morphing required for inclusion of a large number of control points along the main survey and at the walls.
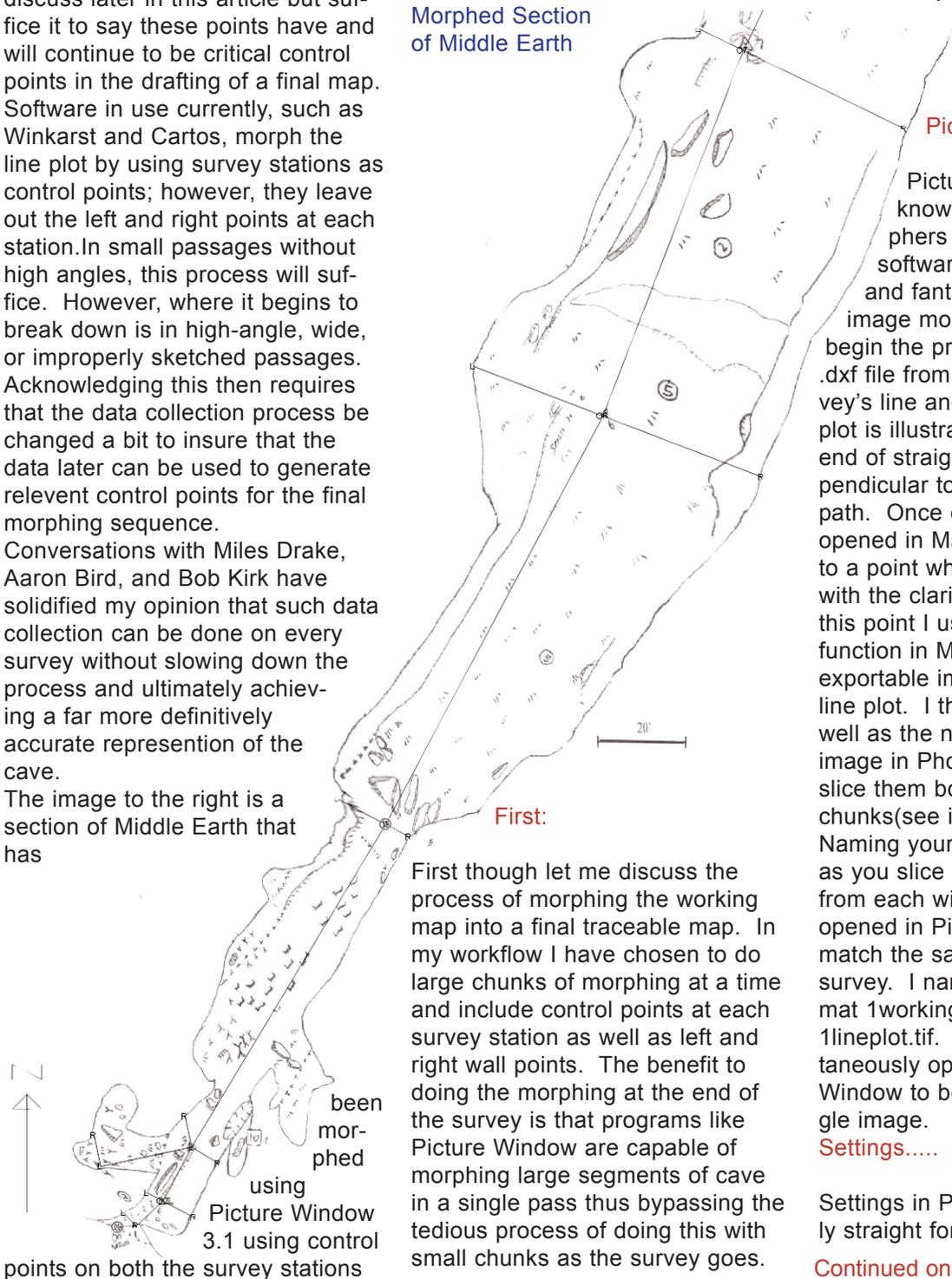
Picture Window 3.1

Picture Window 3.1 is known mainly by photographers as a photo editing software but its lesser known and fantastic feature is its image morphing abilities. I begin the process by exporting a .dxf file from Compass with the survey's line and wall plots. The wall plot is illustrated as L and R at the end of straight lines that are perpendicular to the relevent survey path. Once exported the .dxf file is opened in Manifold and zoomed in to a point where I feel comfortable with the clarity of the image. At this point I use the "make image" function in Manifold to create an exportable image of the entire .dxf line plot. I then open this image as well as the now large working map image in Photoshop and cut or slice them both into corresponding chunks(see image on next page). Naming your slices systematically as you slice corresponding chunks from each will insure that when opened in Picture Window they match the same locations of the survey. I name each set in the format 1workingmap.tif and 1lineplot.tif. These are then simultaneously opened in Picture Window to be morphed into a single image.

Settings.....

Settings in Picture Window are fairly straight forward. Once corre-

sponding images are opened go to the "transformation" option on the toolbar and choose "Composite". This will bring up the composite toolbar(see image to right) at which point you choose the "thin plate method". For the "Input Image" choose the lineplot image and for the "Overlay" choose the working map image. Then for "Operation" choose "Register" and for "Alignment" choose "Multi-Point". This final step will lay down three control points in each image which should be positioned at the first station and then at corresponding control points on each image starting from bottom to top. To add more points simply hold the "Shift" and left click your mouse nearby on your "Input Image" or in this case the lineplot image. Because you are zoomed out so far you will only be able to approximately position the points
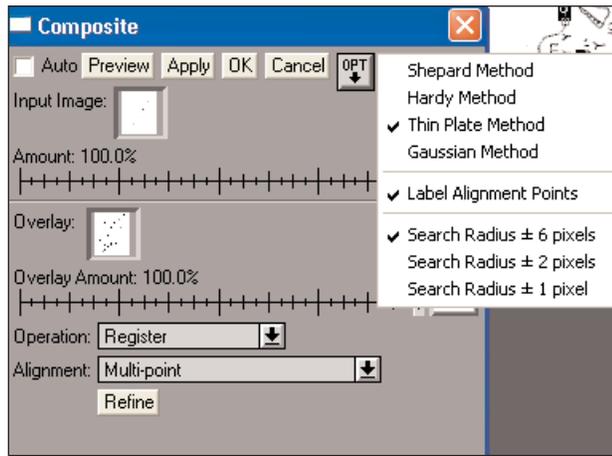
on each image but this can be taken care of quickly later. Up to 60 control points can be placed prior to registering. Once all points are closely positioned simply zoom way in on the images and use the keyboard to type for example "1" which will bring you instantly to control point #1 in the image at which point you can precisely position the point...then 2, 3, 4, etc. in

both images. Once this has been done satisfactorily, click the "Preview" button to view what will be the results of the final morph. If satisfied click "OK" to morph. You will now have a single image of the working map section fully morphed to the control points you placed on the relevent sections of the line/wall plot. How many accurate control points you ultimately have depends on your methods of data collection. Save this image for example as FinalSection1.tif. This image can then be registered in seconds in Manifold where the final map pieces will be assembled over the lineplot. Once in manifold it can be zoomed in and out with images produced for use in a drawing program as a back "tracing" layer.
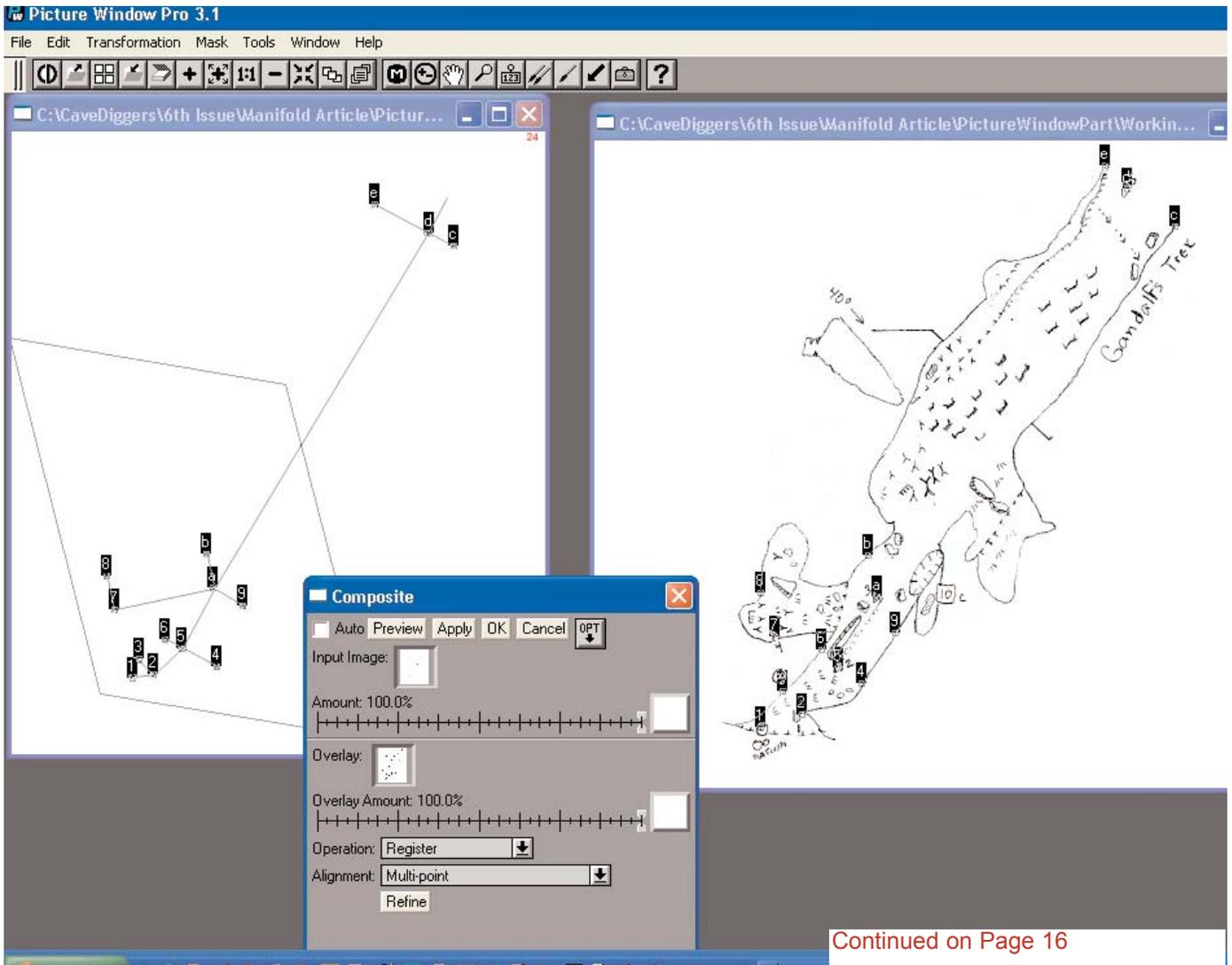
Data Collection:

On page 14 the illustration of a final morphed image looked perfectly adjusted and matched to both the survey line and the wall plot. The flaw of course as mentioned is in the data collection method of estimating left/right points at each station. Whereas this process may be "accurate enough" in narrower level passages it is inaccurate in its final representation in this example. In my example the passage actually slopes at about 40 degrees therefore an estimation of a right wall of say 30' without taking into account the declination results in not only an inaccurate penciled sketch but also inaccurate sets of control points generated for the walls in the .dxf export from Compass. How this can be simply corrected was the topic of a discussion between Bob K, Aaron B, Miles D, and myself at Digcon03 this year As a result of those conversations our next survey trip into Middle Earth will be the first adjustment of our data collection methods.

New Collection Process:

At the entrance of each new cave survey actual splay shots will be taken from the first station to the left and right sides of the opening to the outside. This will establish relevent control points to be used in the morphing process to accurately and digitally redraw the penciled in-cave sketch to actual data collected. Subsequent stations will no longer have left/right estimates recorded, but instead will be Disto'd as splay shots on a 90 from the survey path. Only when passage dimensions are narrow enough will it be estimated. On a high angle an inclinometer will be used to measure the angle to the furthest point left and right. In some cases a wall ceiling projection may block the view or other obstacle cause a problem. In these cases a "rough" reading will be used for the inclinometer reading and either a Disto or estimate

used for the distance. The azimuth would be a 90 to the survey path.

Example: Starting at a caves entrance shot....Station 0 to Station 1 has an azimuth of lets say 90 degrees or due East. Station 0 would also have actual splay shots measured and completely shot to the left and right points of the entrance opening thus creating highly relevent control points for morphing later. At Station 1 a splay in this case named Station 1WS(#1 West Splay) and Station 1ES(#1 East Splay) would be either estimated or in cases of wide or high angled passages measured using a Disto and or an inclinometer. What methods are used at each survey station and/or frequency will solely depend on the # of accurate control points that are desired in any given area. In wide or high angle areas our method will be at every station but in narrow and level passages perhaps this will be done only every 3rd station or so. What is important is that everyone in our survey team understand the nature of control points and where their accurate measurement is deemed more desirable for the final morphing processes. Splays will be appropriately named so that they can later be deducted from the survey total will however replace the estimated left/right measurements we now use. The entire focus will be directed to attempting to collect more relevent control points for use in the .dxf export and eventual morphing in Picture Window.

Picture Window Pro 3.1 **Free** 30 Day Trial Version can be downloaded at:
http://www.dl-c.com/

Because of its precise registration capabilities Picture Window has become a favorite amongst astrophotographers for combining multiple images.

Manifold GIS is a great and relatively inexpensive product for projects and long cave systems where alot of data is being collected in regard to the geology, biology, and hydrology. Using Manifold this data can be related visually back to the cave survey and stored, shared, and displayed either as a Manifold .map file or published on the web.
I will go over a few highlights of the program as it relates to the cave survey, working map and final map. More can be learned by visiting the Manifold site at
http://www.manifold.net

Morphing:

My first reason for beginning to use Manifold was an interest in its morphng capabilities. For morphing **only** the line plots survey points to relevent points on the working sketches the program works fantastic. For many this type of morph will be sufficient but in our case I decided to bring in the much larger # of relevant wall points at each station which proved to be at times a bit frustrating using Manifold. I opted to use Picture Window instead which seemed more optimized to perform this very specific more demanding type of redraw. For those choosing to only morph the line plot I will briefly go over the steps using Manifold to correctly register/morph the working sketches to the .dxf line drawing.

Manifold GIS:

Open the .dxf in Manifold which actually gets imported as a drawing initially and displayed in the project window as a MAP. So open the map of the .dxf and the first sketch section you want to morph. Then go to "view" "panes" and choose "control points". This will make available the control points tool which will allow you to begin to drop control points onto each piece. I start from the bottom and work my way to the top only putting control points on the actual survey sta-

tions on each object. NOTE: because the MAP(.dxf) is a drawing you can use the snap to line function on the top toolbar to quickly put exact control points down on the .dxf part of the control point position. Once you have satisfactorily placed matching points on each object click on or make active the working sketch image and in the control points tool select to register to the map(.dxf) file then choose the affine method and click OK. The morph will take place and then you can go to your map(.dxf) window and right click to quickly add the working sketch layer to the line plot. You can then move layers around to put the line plot on top or turn off the line plot, change opacities, register other relevent geology layers and so on.

Cave Script for Manifold:

Perhaps most exciting about Manifold is the development of a cave survey script that will work within the Manifold project environment. It is being devel-oped by David Brubacher in Canada and will allow for the raw data to be input directly into Manifold which will then process and display the line plot drawing. As the script becomes more and more robust the tight integration will allow for easier executions involv-ing morphing, painting surveys on to terrain views, and display on the inter-net. When properly done a project member will be able to not only view different aspects of the survey project online but also see live UTM coordi-nates by simply dragging the mouse over any part of the cave, turn off and on various layers built into the project as well as view and manipulate other relevent GIS data from the proj-ect......all online.

Drawing Programs:

I have over the past several months played with a few of the drawing pro-grams. I am particularly impressed with the newest version of Freehand i.e. Freehand MX and have made it my final choice for use in our projects. It's tight integration with Flash MX makes it ideal for developing cool flash movies using the drawings creat-ed in Freehand. Other tools such as Xara X have the ability to export to Flash(.swf) but lack the tight integra-tion that is possible between Freehand MX and Flash MX. Below are some of the most used options and their pricing.

Xara X-- www.xarax/products/xarax
Free 30 day trial.....$149 U.S.

Adobe Illustrator 10--www.adobe.com
Free Trial......$399 U.S.

Macromedia Freehand MX----
www.macromedia.com
Free 30 day trial......$399 U.S.