



Compass & Tape

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Newsletter of the Survey and
Cartography Section of the
National Speleological Society

Survey and Cartography Section



The Survey and Cartography Section (SACS) is an internal organization of the NSS that is devoted to improving the state of cave documentation and survey, cave data archiving and management, and of all forms of cave cartography.

Membership: Membership in the Section is open to anyone who is interested in surveying and documenting caves, management and archiving of cave data and in all forms of cave cartography. Membership in the National Speleological Society is not required.

Dues: Dues are \$4.00 per year and includes four issues of *Compass & Tape*. Four issues of the section publication are scheduled to be published annually. However, if there are fewer, then all memberships will be extended to ensure that four issues are received. Dues can be paid in advance for up to 3 years (\$12.00). Checks should be made payable to "SACS" and sent to the Treasurer.

Compass & Tape: This is the Section's quarterly publication and is mailed to all members. It is scheduled to be published on a quarterly basis, but if insufficient material is available for an issue, the quarterly schedule may not be met. *Compass & Tape* includes articles covering a wide range of topics, including equipment reviews, techniques, computer processing, mapping standards, artistic techniques, all forms of cave cartography and publications of interest and appropriate material reprinted from national and international publications. It is the primary medium for conveying information and ideas within the U.S. cave mapping community. All members are strongly encouraged to contribute material and to comment on published material. Items for publication should be submitted to the Editor.

NSS Convention Session: SACS sponsors a Survey and Cartography session at each NSS Convention. Papers are presented on a variety of topics of interest to the cave mapper and cartographer. Everyone is welcome and encouraged to present a paper at the convention. Contact the Vice Chair for additional information about presenting a paper.

Annual Section Meeting: The Section holds its only formal meeting each year at the NSS Convention. Section business, including election of officers, is done at the meeting.

Back Issues: SACS started in 1983 and copies of back issues of *Compass & Tape* are available. The cost is \$1.00 each for 1-2 back issues, \$0.75 each for 3-6 back issues and \$.50 each for more than six back issues at a time. Back issues can be ordered from the Vice Chair.

Overseas Members: SACS welcomes members from foreign countries. The rate for all foreign members is US\$4.00 per year and SACS pays the cost of surface mailing of *Compass & Tape*. If you need air mail delivery, please inquire about rates. All checks MUST be payable in US\$ and drawn on a U.S. bank.

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SUBMISSIONS

All types of materials related to cave survey and survey data, cartography, and cave documentation in general, are welcome for publication in *Compass & Tape*. Manuscripts are accepted in ANY form but are most welcome on 3.5 inch diskettes either IBM compatible or Mac format or via email. Typed material is next best although we will accept handwritten material as long as it is legible. Artwork in any form, shape or size is also welcome

Send all submission for *Compass & Tape* to:

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Letters to the Editor

The last issue of *Compass & Tape* (Vol 14, Issue 14, Nu. 47), on the results of the 1999 Cartographic Salon was very well received. I would like to commend Scott Schmitz for doing an excellent editing job. Another special issue to cover the 2000 Cartographic Salon is being edited by Rod Horrocks. Following are two letters pertaining to the last issue.

I just picked up my copy of "*Compass and Tape*", Volume 14, Issue 4, Number 48.

I was rather shocked to read Hazel Barton's comments on the Hellsinky map. I sincerely hope that Hazel was just giving out an unsolicited personal opinion, on the topic, and that it really didn't have anything to do with the judging of the map.

The comments in question were:

"Some things that folks should be careful with Connie missed on this map. The first is to always remember to copyright your map; this needs the copyright symbol, followed by your name and a date (usually the year). With the copyright laws in the US, you can copyright your work without filing the paperwork. Then, if someone infringes the copyright and you wish to stop him or her, you can file the copyright then. You need to do this to protect your work and also the cave maps; without copyright control there is no way to limit distribution of the map, should it enter a public forum."

I take exception to a great deal of what she has to say. Some exceptions are minor, but the ones about filing after the infringement are grossly misleading.

It is unclear what she thinks "copyrighting your map" means. The comments confuse filing and the underlying copyright. Copyrights themselves exist in

a work from the moment of creation, whether or not they have a notice. When the US signed the Berne Convention in 1988, the copyright law (Title 17 of the US Code) section 401 (a) was amended to say a notice "may be placed on" instead of the old "shall be placed on". The notice of copyright doesn't make it "copyrighted", what it does do is inform the public of existence of copyright. So, yes you should have a notice. No, that's not the same as copyrighting the map.

The statements about the form of the notice are wrong. Hazel states that you have to have the copyright symbol. The copyright law itself [17 USC 401(b)] allows the word "Copyright" or the abbreviation "Copr." in place of the symbol. The second element of the notice is the date (and the law goes on to say when the date is not required).

The third element is the owner of the copyright. The comments about filing after the infringement are somewhat dangerous. By filing AFTER the infringement, you lose valuable rights. Section 412 of the copyright law (17 USC) "Registration as a prerequisite to certain remedies for infringement", states that you lose the ability to recover attorney's fees or statutory damages. Not being able to recover attorney's fees makes trying to stop an infringer an expensive proposition. Not being able to recover statutory damages means that you can only recover the amount that you can prove the infringement directly cost you.

Whether or not people want to register is still a matter that they will have to decide, but they should be aware of all the facts before following Hazel's advice.

Note also that filing the copyright doesn't automatically stop others from copying and distributing the map. (Which is the impression I got from Hazel's comments) You still have to sue to stop them, which can be expensive if you follow Hazel's advice and therefore can't recover attorney's fees.

John Halleck

Editor,

The “Compass & Tape” special issue presenting the maps entered in the 1999 Idaho NSS Convention was an excellent idea and I hope becomes an annual issue of our periodical. However, I do have some specific rebuttal points.

First, I was asked to provide comments about my maps prior to publication. It seems the judges were also given this opportunity, as their comments were significantly different and expanded upon their 1999 comments. It is as if there was a second judging of the works. It was my impression that my solicited comments were to be in rebuttal to the judge’s comments at the time of the event. Is this a stage for the judges or the contestants?

Second, although not pertaining to the *Compass and Tape* issue, I felt the selection of judges that year was needlessly compromised. Two of the judges were from the same grotto, which was in the same region as the convention. It is not a question of suspect objectivity of the judges, but the problem that any convention will have a strong showing of maps drawn of caves in the same region. Judges should be selected from outside the convention’s region as to reduce the odds they personally know the contestants or have visited the caves drawn.

Third, about some specific comments made about my maps. There was a comment that, “the north arrow could be improved by labeling the true and magnetic arrows, and adding the word ‘degrees’ after the 18.3.” The fact is, in reviewing the north labels in all of the maps, there is an amazing lack of consistency. In my version, true north was indicated by the “*” symbol and while it does not say “mn” on the other

leg, I felt the 18.3 was sufficient to indicate it was magnetic north. The only other units typically displayed for map bearings are “mils” and it is obvious from the width of the symbol the units were not mils.

The discussion of my map then devolves in to the issue of whether it is preferable to print a CAD map on a pen or raster plotter. Unfortunately, the judge mistakenly misidentified my method of reproduction for my map, raster. Originally, I had planned to produce a color map and it was difficult to impress upon my free publisher this fact. As a result, in the final version it was impossible to determine the geologic boundaries in the insert in the map. At the last minute I was forced to trace over some lines to widen them and make them distinguishable. I think it was these hand edits that caught the judge’s eye. The lesson learned here, is that to be competitive in the salon, you had better be prepared to spend up to \$100 for production costs.

Finally, there was some criticism of the placement of passage height symbols inside the passages themselves. The judges showed their clear favor for the alternate approach by awarding Bob Richard’s “Cueva de Villa Luz” and Carlene Allred’s “Arabica Cave” ribbons or medals. In fact, in these two maps these numbers were left out entirely, in favor of the profile views of the caves. I find it amazing these maps were favored despite the draftsman’s leaving off these traditional cave mapping symbols. It seems the judges favored the “artistic” over the “content” approach. While mapping methods evolve over the years, the judges need to understand when they are departing from traditional methods and setting new standards.

Garry Petrie

The 2001 Cartographic Salon

Steve Reames
2001 Cartography Salon Chair

It's that time of year again; time to finish those maps and enter them into the annual Cartographic Salon. Most readers of C&T are familiar with this map competition, but there are a few changes this year.

The core principles of the salon remain the same. The three categories—Apprentice, Experienced, and Master—have served well and will be used again this year. The Apprentice category is open to all cartographers who have not received an award (Honorable Mention, Merit Award, or Gold Medal) in a previous NSS cartographic competition. This is designed to provide a forum for new cartographers to compete against their peers. The Master category is for professional cartographers and those who have won two or more gold medals in previous salons. The Experienced category is for all those between.

The big change this year is the Judging Form and Judging Guidelines. The Judging Form is a new layout based on input from previous judges and salon chairs. The criteria have not changed, just the way the form is presented. Many judges in the past have commented that it would be nice to have a set of guidelines so when two different judges score a map on an element such as “layout and balance,” they are both evaluating the same thing. The new Judging Guidelines are an answer to this request, and are based on the collective input of dozens of judges and entrants. These guidelines are not binding; judges can

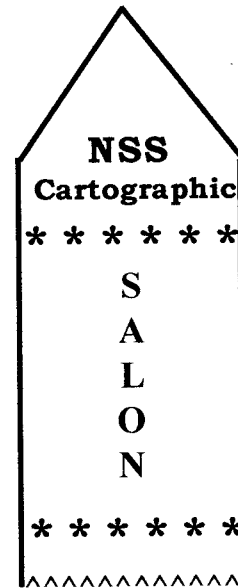
still use individual experience and opinion to weight their scores.

Why do you, as an entrant, care about new judging forms? The reason is that both the Judging Form and the Judging Guidelines are available now on the Internet. We hope to foster higher quality maps by having these available to entrants ahead of time. Feel free to download these documents and have a fellow cartographer pre-judge your map with them. This will help aspiring award winners to fine-tune their maps and eliminate the minor oversights that always seem to occur.

The new forms are located at www.Deep-Secrets.com (don't forget the dash) under Cavers Corner | Cartography. Or you can go there directly with the URL:

<http://www.Deep-Secrets.com/html/cartography.html>

If you have questions or comments on this year's salon, please feel free to contact me, Steve Reames, at reames@diskdrive.com, or 719-495-0141. I look forward to seeing your entry.



Survey and Cartography Section - Call for Papers

Survey and Cartography Session Call for Papers 2001 NSS Convention - Mount Vernon, Kentucky

This is a call for papers for the Survey and Cartography Session at the 2001 NSS Convention in Mount Vernon, Kentucky.

The session is informal and provides a good way to tell other cave mappers what you are doing, and to discuss problems related to mapping and cave surveying. Most cave surveyors have either developed useful techniques that may benefit others, or are encountering problems that someone else may have solved. In either case an informal session presentation is appropriate.

The session is informal and the audience is friendly. There are no requirements to provide fancy visual aids or to provide a written paper (other than an abstract to include in the Convention Program). Of course, the *Compass & Tape* editor would be glad to receive any written papers for publication.

Presentations can be on any topic related to any aspect of cave mapping, and the material can be for folks with any level of mapping experience. A partial list of potential presentation topics include:

- Cave mapping applications of high-accuracy GPS and digital mapping technology
- How to keep cave mud off your survey instruments
- How to minimize fogging of Suunto instruments in cold, wet caves
- How to resolve blunders without another trip to the cave
- How to set and maintain mapping standards in a project
- Keeping track of survey data in a large project
- Mapping standards (accuracy, symbols, etc.)
- New and improved computer programs for mapping (compare, describe, critique)
- New tools and toys to aid in mapping or cartography
- Representing complex vertical caves on a 2-dimensional map
- Use of computers to draw cave maps (techniques, pros, cons)
- Use of computers to interactively view cave maps (views, colors, rotation, perspective)

The above list is obviously incomplete. If you are doing something that you think would be of interest to other cave surveyors and cartographers, please consider doing a presentation on it.

If you plan to do a presentation, you should send an abstract of not over 250 words to Roger Bartholemew: (email:RVictor43@aol.com) who is coordinating the session, so he can insure that the abstract gets into the Convention Program and to help set up the session schedule. Please be sure that your abstract includes a summary of your conclusions and results, not simple a statement of what you are going to talk about. The abstract deadline is passed, but you can still present at the session by contacting Roger.

When you submit your abstract, please let Roger know what equipment you will need for your presentation. You can assume that the usual 35mm slide projector and viewgraph machine will be available, but don't make any other assumptions. There is a possibility that we may also have an overhead projector that can be connected to a laptop computer. Check with Roger if you are interested in using it.

Linear symbols for cave maps in FreeHand

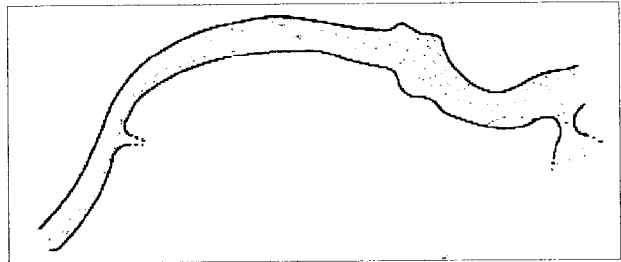
by John Ganter,

ganter@etrademail.com,

Reprinted from the Caving Technology Website - <http://nerve-net.zocalo.com/jg/c/>

Cave map symbols require complex lines. If these lines are not automated, drawing them digitally can take much longer than drawing them with ink. This article describes the approaches I have used with FreeHand (www.macromedia.com). Similar techniques can be used for other drawing packages such as CorelDraw, Illustrator, etc. For AutoCAD, Bert Ashbrook has written an article in *Compass & Tape* 13:3, July 1998 (www.caves.org/section/sacs) that may be helpful.

When I started using FreeHand 2.0 back in 1989, the first patterned lines I used were for unsurveyed passage (- - -) and underlying passages (. . .). Later I used swarms of dashed lines, offset slightly, to draw long water-carved mudbanks in Kentucky caves. But I was still drawing hachures along lines (_ _ _ _) one at a time. There had to be a better way.

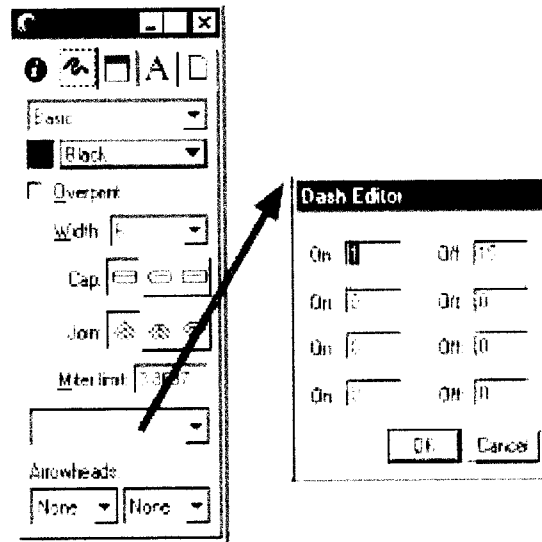


Part of Penick Spring Cave, Kentucky, showing mudbanks drawn with parallel dashed lines.

First approach to hachures: Overlaid patterned lines

I posted a question to news://forums.macromedia.com/macromedia.freehand and asked the experts for advice. They suggested a couple of things to try.

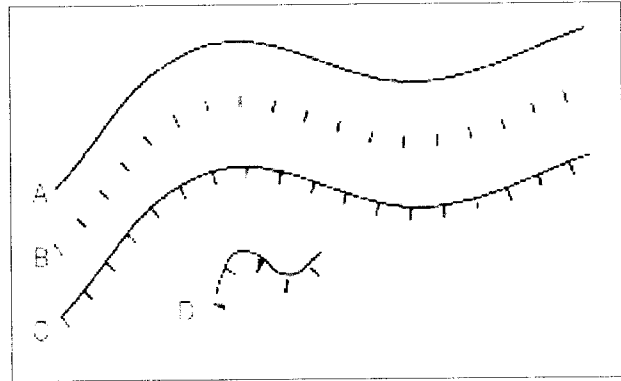
The first approach I tried was combining two patterned lines. In FreeHand, you change line patterns by <ALT> clicking on a dashed line in the Stroke inspector, which brings up the Dash Editor. A good introduction is "Dashed Line Editing Techniques" at www.freehandsource.com.



A is a curvy line, B is a very wide 6 pt line that has a On 1, Off 15 pattern, and C is the result when the two are overlaid.

To make such an overlay, just select a line like A, then press <SHIFT><CTRL>c to clone the line exactly in place. Then select the cloned line and set it to 6 pt with the On 1, Off 15 pattern. You can save this as a Style that can be applied to other lines.

This approach works for gently curving lines, but not for tightly curving lines as visible in D.



Note: You can get the actual FreeHand file (116Kb) used to make these illustrations at: nerve-net.socalo.net/jg/ftp/Test_FreehandSymbols.Fh8

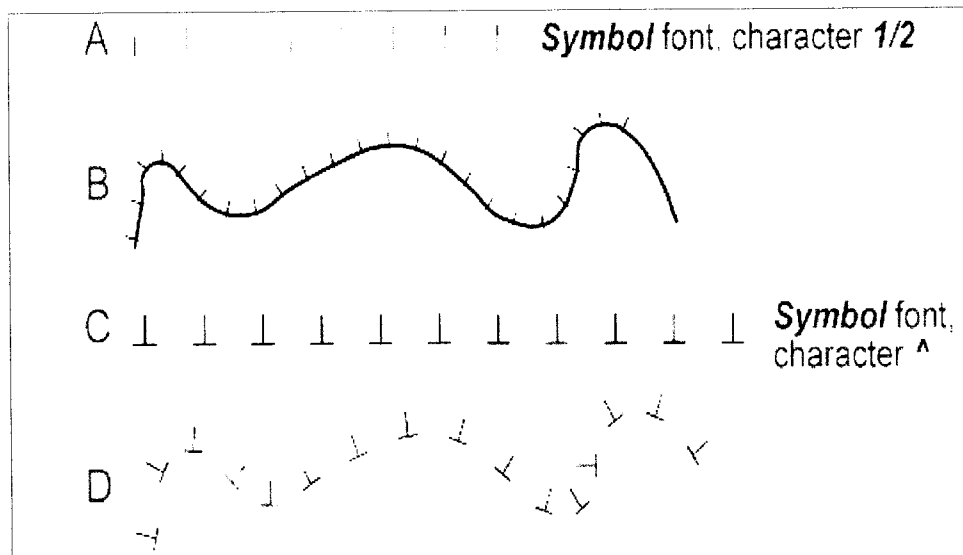
Second approach: Font attached to line

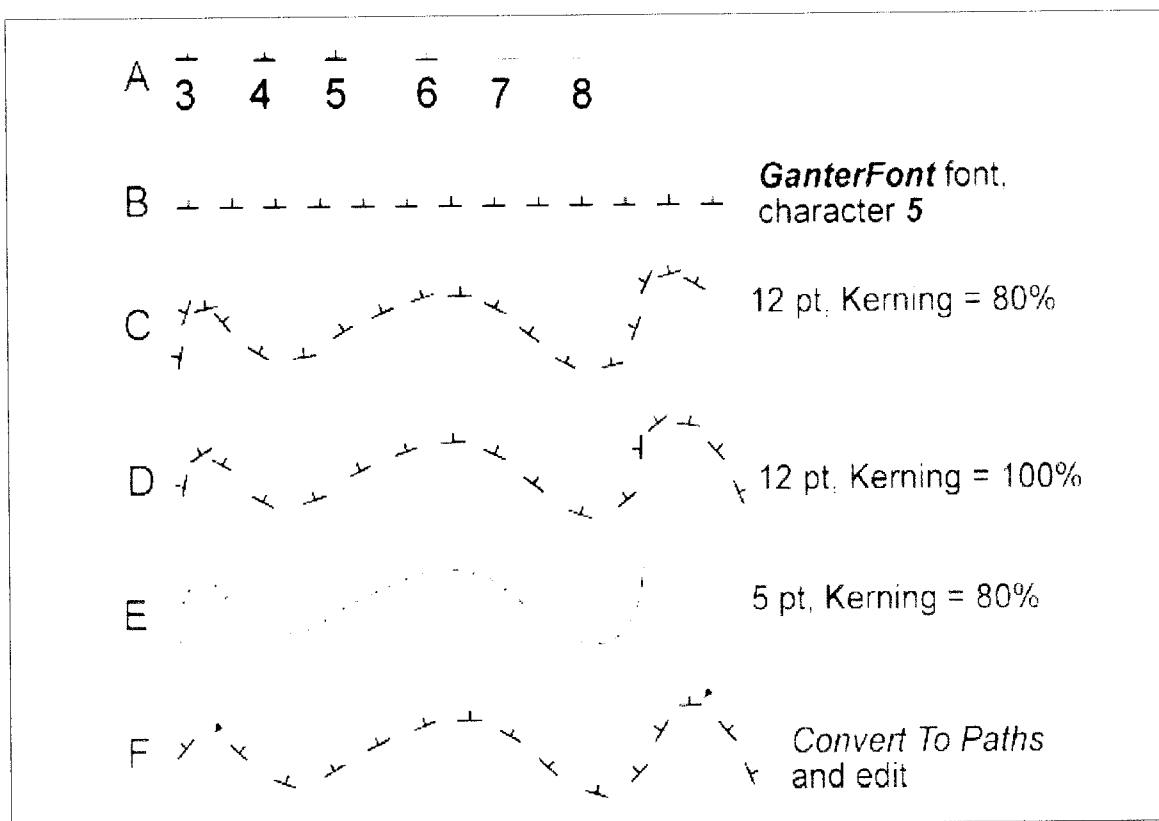
The next thing I tried was a string of text characters attached to a line. First, I used the Windows "Character Map" utility (usually found under **Start, Programs, Accessories**) to explore the various fonts on my machine. I discovered that there was a character in the Symbol font that looked like a hachure. I copied this character out of Character Map and into a text box in FreeHand. When I set the font to Arial, this printed as a "1/2" symbol. But when I set the font to Symbol, and made a bunch of characters, I got a piece of text that looks like A (below). I set the Range kerning to 175% in the Object Inspector so that there is space between the characters.

I then attached this text to a curvy line, with a result of B. To make such an attachment, you select the line and the text (hold down <SHIFT> to select more than one object at the same time) and then choose **Text, Attach To Path**.

Sometimes the the hachures overlap the line; this can be fixed by adding a small baseline shift using the Object Inspector.

This looked encouraging, so I tried a ceiling contour. Again, in the Symbol font, I found a useful character shown in C (above). This works fairly well in both straight and curvy cases (D). However the character is a bit "tall." I was unable to find any characters with the right shape, but shorter, so I decided to try to make a custom font.





Third approach: Custom font attached to line

I did not want to purchase a font editing package for an experiment with a single character, so I looked around and found the shareware Font Creator Program 2.0.1 from www.high-logic.com. FCP turned out to be easy-to-use, if a bit unstable at the present version. I was able to quickly draw six custom characters which correspond to the 3 through 8 keys (A above). Not likely to become another Helvetica, but it took a half hour and I did not have to scribe metal or pour lead.

You can get GanterFont at nerve-net.zocalo.net/jg/ftp/GanterFont.ttf. Use **Control Panel, Fonts, File, Add new font** to install this font on your machine. It will then be available in the FreeHand font list.

I should mention that GanterFont is not perfectly-behaved in FreeHand. Its "outline" appears offset from where a character actually appears, and it does not always display at every zoom level. I would guess

this is a problem with FCP, but overall the font has worked acceptably for me.

B shows a FreeHand text using the "GanterFont" character 5. C and D show the character at 12 pt size, with kerning set at 80 and 100%, respectively. You can see the difference in spacing that results.

Also, note that you can select the text block and move the little arrow that appears at the left end (>) to slide the text along the line.

There is a bit of collision between the characters in the tight curves. One way to reduce this is with smaller characters, as shown in E (above). Another thing you can do is select the text and choose Text, Convert To Paths. At this point the text becomes simply lines and you can edit them. The arrows in F show where a hachure has been deleted and moved, respectively.

Another option: Postscript

Still another option is Postscript. Postscript is a "page description language" that is sent to printers to

tell them what to do. It can be read and written by humans, but it is a very terse, low-level language. You can enter Postscript code in FreeHand, but FreeHand will display only a simple line or fill: you won't see your custom line or pattern until the Postscript is interpreted or "RIP'd" by a Postscript printer or software interpreter such as Ghostscript. The Postscript approach is a nuisance in several ways, so I did not try it. The FreeHand experts recommend the book *Real World FreeHand* for anyone creating Postscript lines.

A flowstone symbol

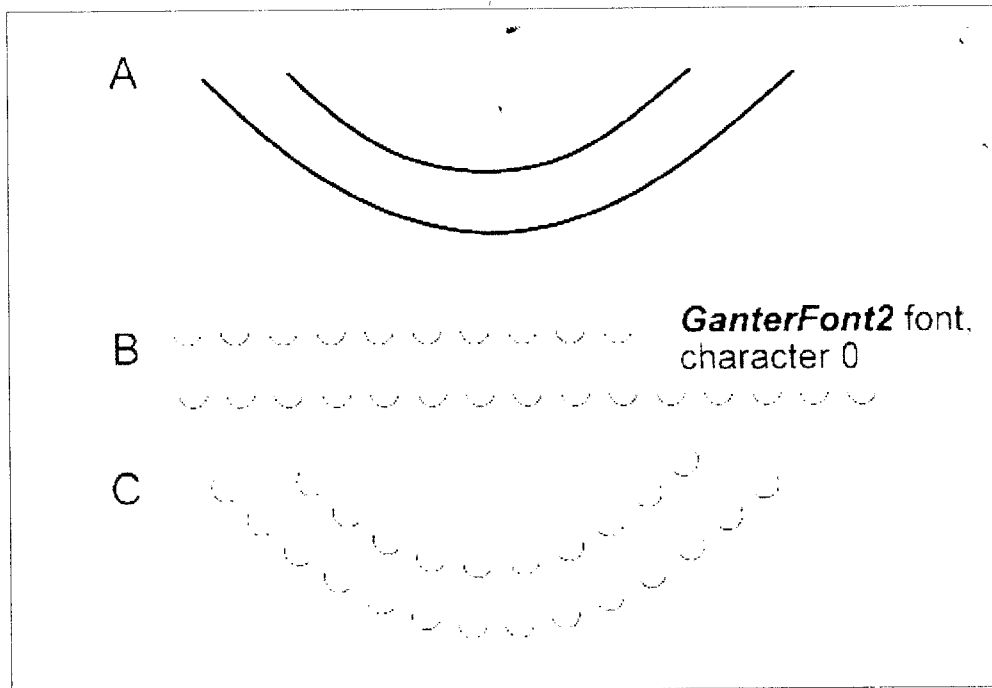
I also made a flowstone symbol, as shown below: Remember, you draw the "form line" (A) showing the shape of your slope, make a string of flowstone "text" (B), then use **Text, Attach To Path** to connect the two objects. At this point the line disappears and only the text is visible (C). (This example shows two of everything; you have to attach them separately.)

The **<CTRL>d** shortcut is very useful for quickly duplicating any object. Also, you can still adjust the font characteristics from the object inspector, and if you want to edit the text string just use **Text, Detach From Path**. That will separate the text and the line objects once again.

The flowstone symbol has been added to the hachures and saved in *GanterFont2*. You can get *GanterFont2* at nerve-net.zocalo.net/jg/ftp/GanterFont2.ttf.

Conclusion

The "custom font attached to line" approach seems to work well for a variety of linear symbols. I will keep some long text blocks of the characters handy. These can then be duplicated (**<CTRL>d**) and quickly attached to lines. This is a bit more work than simply setting a line style, but a lot less work than drawing repetitive symbols one by one.



<? Cave Survey Data in XML ?>

by Devin Koots

Worldwide, cave surveys collect and store masses of data in a variety of electronic formats each year. Frequently the particular software product used to render the data drives the format. This limits interoperability between software products because data, the common denominator of all applications, is not immediately readable from one program to another. As a result the only solutions to moving data from one program to another include: re-keying of survey data, writing new software to adapt to a legacy format, or the development of data translation utilities.

In order to stimulate discussion and cooperation within the community of people interested in the collection and electronic storage of cave data this article gives a brief introduction to XML fundamentals. Building upon those fundamentals these writings further introduce a simple XML document intended to support discussion and provoke thought toward the creation of an XML standard for the cave surveying community.

The goal of data entry should be the complete and accurate electronic representation of raw data for the purpose of communication, processing and archival. Placing controls upon the practice of data representation, as it concerns a logical class or group of data, is a fundamental tenet of data management. A cooperative effort to establish the norms of data representation is necessary if the quality of data as a whole is to improve.

The rapid spread of XML creates a new opportunity to store, share and represent cave survey data across existing and future software products. XML stands for eXtensible Markup Language and is a hu-

man readable tagging language much like HTML (of internet fame). Unlike HTML however, which focuses on the display of data and how it looks, XML was designed to structure, store and send data. XML focuses on what the data is, not how it appears. XML is about describing information and is not a replacement for HTML.

Storing data in XML creates information that can be read by many different types of applications. XML stores data in plain text files and this simplicity makes it easy to exchange data between incompatible systems. XML supports Unicode, therefore making the data internationally transportable. Since XML is independent of hardware, and software, your data is made available to a wider audience of existing (and yet to exist) applications. Other clients and applications can access your XML files as data sources, as if they were accessing databases.

The goal of data entry should be the complete and accurate electronic representation of raw data for the purpose of communication, processing and archival.

XML can also be used to store data in databases. Applications can be written to send and retrieve information from the store, and generic applications can be used to display the data. Finally, XML can be used to create new languages. For instance the Wireless Markup Language, WML, is used to markup Internet applications for handheld devices like mobile phones. WML is written in XML. A whole host of possible acronyms come to mind for a caving markup language, the most obvious, CaML.

But XML does have its downside. It can be verbose, in some cases XML doubles or triples the size of the data file. But careful planning can minimize this aspect of XML, and the benefits of a common markup framework far outweigh this small draw back.

The issues of hard disk space, memory constraints or bandwidth are laughable at best with today's rapid pace of technology. But for all the benefit XML delivers, it still doesn't solve the human issue of "coop-

eration". In order for an XML based markup language to serve a community of users well, the members of that community must develop their standard cooperatively.

An example of XML

The following XML document is a simple note to Jane from Jack, stored as XML:

```
<note>
  <to>Jane</to>
  <from>Jack</from>
  <heading>Spot</heading>
  <body>Don't forget to see Spot run!</body>
</note>
```

The note has a header, and a message body, indicated by the <heading> and <body> tags. It also has sender and receiver information, following the <to> and <from> tags. The XML file is just pure information wrapped in XML tags and incapable of doing anything on its own. Someone must write a piece of software to do anything with it, but because the data is stored in a common form, several software developers can write complementary applications based upon a common starting point.

An example of how cave survey data could be represented in XML follows a similar form to the note above. Consider exhibit 2, an example of real cave survey data stored in XML, but reduced in scope for brevity. Notice that XML documents use a self-describing and simple syntax.

Exhibit 2: Cave Data Stored in XML

```
<?xml version="1.0"?>
<caveSurvey>
  <caveName>Twisted Fissure</caveName>
  <surveyName>D</surveyName>
  <surveyDate>10 15 1994</surveyDate>
  <surveyTeam>Miles Drake, Jo Smith, Paul Gillis</surveyTeam>
  <surveyComment>Entrance Passage, West and East Stream Trunks</surveyComment>
  <surveyData>
    <shot>
      <fromStation>r1</fromStation>
      <toStation>r2</toStation>
      <distance>9.8</distance>
      <foreAzimuth>276</foreAzimuth>
      <foreInclination>-12</foreInclination>
    </shot>
    <shot>
      <fromStation>r2</fromStation>
      <toStation>r3</toStation>
      <distance>2.9</distance>
      <foreAzimuth>275</foreAzimuth>
      <foreInclination>4</foreInclination>
    </shot>
  </surveyData>
</caveSurvey>
```

The first line in exhibit 2, the XML declaration, defines the XML version of the document. In this case the document conforms to the 1.0 specification of XML. The next line describes the root element of the document, <caveSurvey>. This is the equivalent of declaring this document to be a “cave survey”.

The next six lines contain six child elements of the root (caveName, surveyName, surveyDate, surveyTeam, surveyComment and surveyData). They identify elements of data commonly collected during a cave survey.

Exhibit 3. XML elements describing typical cave survey data

```
<caveName>Twisted Fissure</caveName>
<surveyName>r</surveyName>
<surveyDate>10 15 1994</surveyDate>
<SurveyTeam>Miles Drake, Jo Smith, Paul Gillis</surveyTeam>
<surveyComment>Entrance Passage, West and East Stream Trunks</surveyComment>
<surveyData>
```

The <surveyData> element, a child of the root element <caveSurvey>, also has children of its own. In this case those elements are shots, and each <shot> element in turn has its own children. The five lines after each <shot> tag describes elements of a typical compass and tape survey shot

Exhibit 4. Data common to a compass and tape survey captured in XML

```
<shot>
  <fromStation>r1</fromStation>
  <toStation>r2</toStation>
  <distance>9.8</distance>
  <foreAzimuth>276</foreAzimuth>
  <foreInclination>-12</foreInclination>
</shot>
```

In each of the previous exhibits the end of each element is indicated by a tag with the same name as the lead element, but prefixed with a slash inside the brackets. For instance the <shot> element is ended by the closing tag </shot>. A second <shot> element immediately after this marks the beginning of a new series of data describing the next shot in the survey. In a real survey file this would continue until all shots associated with this particular “<surveyName>” had been recorded.

Finally, the last line of exhibit 2 defines the end of the root element, </caveSurvey>, and the end of the XML data file. Even with an application no more sophisticated than a simple text editor it is a pretty simple thing to interpret the contents of an XML data file. XML elements are extensible.

One of the strongest benefits of XML is the ability to extend documents to carry more information. Look at the following expanded cave survey example:

Exhibit 5. XML documents can be extended to carry additional data

```
<?xml version="1.0"?>
<caveSurvey>
  <caveName>Twisted Fissure</caveName>
  <surveyName>r</surveyName>
  <surveyDate>10 15 1994</surveyDate>
  <surveyTeam>Miles Drake, Jo Smith, Paul Gillis</surveyTeam>
  <surveyDeclination></surveyDeclination>
  <surveyComment>Entrance Passage, West and East Stream Trunks</surveyComment>
  <surveyData>
    <shot>
      <fromStation>r1</fromStation>
      <toStation>r2</toStation>
      <distance>9.8</distance>
      <azimuth>
        <foreAzimuth>276</foreAzimuth>
        <backAzimuth>97</backAzimuth>
      </azimuth>
      <inclination>
        <foreInclination>-12</foreInclination>
        <backInclination>11</backInclination>
      </inclination>
      <shotComment></shotComment>
    </shot>
    <shot>
      <fromStation>r2</fromStation>
      <toStation>r3</toStation>
      <distance>2.9</distance>
      <azimuth>
        <foreAzimuth>275</foreAzimuth>
        <backAzimuth>95</backAzimuth>
      </azimuth>
      <inclination>
        <foreInclination>5</foreInclination>
        <backInclination>-6</backInclination>
      </inclination>
      <shotComment></shotComment>
    </shot>
  </surveyData>
</caveSurvey>
```

Imagine that an application has been designed to work with the earlier simple XML example and it extracts the <fromStation>, <toStation>, <distance>, <foreAzimuth>, and <foreInclination>. With that data the application performs the typical functions of a cave data reduction program. Now imagine new standards of cave survey have created the need to include additional data in the XML file. This results in the second, expanded cave survey data file. The author of the new XML file rearranges the schema somewhat

and includes <azimuth>, <inclination>, <backAzimuth>, <backInclination>, and <shotComment> tags and data.

Should the changes in the new data format cause the original application to crash? No, the original application can still find the elements it needs: <fromStation>, <toStation>, <foreAzimuth>, and <foreInclination>. It cannot however take advantage of the new data added to the XML file. That is a function of the new software program that reads the XML file.

DTD's and their role.

Because XML is free and extensible, XML tags are not predefined. Instead, you must define your own tags. This is in contrast to HTML, where the tags are defined by standards (e.g. HTML 4.0), and the author of an HTML document can only use tags defined in the standard. The tags in the cave survey example above (e.g. <caveSurvey> and <foreInclination>) are not defined in any XML standard. Instead these were created for the purpose of this article. In order for these tags to become widely useful however the tags and their relationships need to be recorded.

When an author (or community of authors) defines the elements and structure they intend to use within a document those decisions must be preserved for later reference. This record is kept in a DTD (Document Type Definition). XML uses DTD's to describe elements of data and their relationships. An XML document that complies with a particular DTD is self-describing and "valid".

Exhibit 6. A DTD can be used to validate the form of an XML data.

```
<!DOCTYPE caveSurvey [  
  
  <!ELEMENT caveSurvey (caveName, surveyName, surveyDate, surveyTeam, surveyComment,  
  surveyData*)>  
  <!ELEMENT surveyData (shot*)>  
  <!ELEMENT shot (fromStation, toStation, distance, foreAzimuth, foreInclination)>  
  <!ELEMENT caveName (#PCDATA)>  
  <!ELEMENT surveyName (#PCDATA)>  
  <!ELEMENT surveyDate (#PCDATA)>  
  <!ELEMENT surveyTeam (#PCDATA)>  
  <!ELEMENT surveyComment (#PCDATA)>  
  <!ELEMENT fromStation (#PCDATA)>  
  <!ELEMENT toStation (#PCDATA)>  
  <!ELEMENT distance (#PCDATA)>  
  <!ELEMENT foreAzimuth (#PCDATA)>  
  <!ELEMENT foreInclination (#PCDATA)>  
  ]>
```

The first line in exhibit 6 uses the statement - "<!DOCTYPE caveSurvey [", to declare the document to be a type of caveSurvey. The line after this defines the element caveSurvey and enumerates its children:

Exhibit 7. The valid elements of caveSurvey are enumerated in the DTD.

```
<!ELEMENT caveSurvey (caveName, surveyName, surveyDate, surveyTeam, surveyComment, surveyData*)>
```

Note that the last element in this group, surveyData, is post-fixed with an asterisk. This indicates that surveyData itself has child elements. In this case the child is the element “shot”, which has children of its own as indicated by another post-fixed asterisk.

Exhibit 8. The DTD lists children of shot, and illustrates shot’s relationship to surveyData

```
<!ELEMENT surveyData (shot*)>
```

```
<!ELEMENT shot (fromStation, toStation, distance, foreAzimuth, foreInclination)>
```

These first three statements (caveSurvey, surveyData and shot) define the hierarchical structure that an XML document must possess before it can be validated by this DTD. After these structural statements are made, the DTD goes on to define the specific elements and the type of information they will carry.

Exhibit 9. The DTD also identifies the type of data carried by each element.

```
<!ELEMENT caveName (#PCDATA)>
```

By now Element and caveName should be self-explanatory. PCDATA means “Parsed Character Data” and indicates to the XML reader how the information in the caveName element should be handled. Another possible format is CDATA, or Character Data, which is handled differently by the XML reader.

DTD statements such as those in exhibit 6 can be associated with an XML file via one of two methods. For small, relatively simple XML documents it’s easiest to include the DTD within the XML document itself as header information, similar to the following example.

Exhibit 10. DTD statements can be included within the XML data file.

```

<?xml version="1.0"?>
  <!DOCTYPE caveSurvey [
    <!ELEMENT caveSurvey (caveName, surveyName, surveyDate, surveyTeam,
      surveyComment, surveyData*)>
    <!ELEMENT surveyData (shot*)>
    <!ELEMENT shot (fromStation, toStation, distance, foreAzimuth, foreInclination)>
    <!ELEMENT caveName (#PCDATA)>
    <!ELEMENT surveyName (#PCDATA)>
    <!ELEMENT surveyDate (#PCDATA)>
    <!ELEMENT surveyTeam (#PCDATA)>
    <!ELEMENT surveyComment (#PCDATA)>
    <!ELEMENT fromStation (#PCDATA)>
    <!ELEMENT toStation (#PCDATA)>
    <!ELEMENT distance (#PCDATA)>
    <!ELEMENT foreAzimuth (#PCDATA)>
    <!ELEMENT foreInclination (#PCDATA)>
  ]>

<caveSurvey>
  <caveName>Twisted Fissure</caveName>
  <surveyName>D</surveyName>
  <surveyDate>10 15 1994</surveyDate>
  <surveyTeam>Miles Drake, Jo Smith, Paul Gillis</surveyTeam>
  <surveyComment>Entrance Passage, West and East Stream Trunks</surveyComment>
  <surveyData>
    <shot>
      <fromStation>r1</fromStation>
      <toStation>r2</toStation>
      <distance>9.8</distance>
      <foreAzimuth>276</foreAzimuth>
      <foreInclination>-12</foreInclination>
    </shot>
    <shot>
      <fromStation>r2</fromStation>
      <toStation>r3</toStation>
      <distance>2.9</distance>
      <azimuth>275</azimuth>
      <inclination>4</inclination>
    </shot>
  </surveyData>
</caveSurvey>

```

For more extensive DTD's it may be desirable to place a reference inside the XML file to a DTD located in another file, as in the following example.

Exhibit 11. XML files can reference DTD statements in external files.

```
<?xml version="1.0"?>
<!DOCTYPE caveSurvey SYSTEM "caveSurvey.dtd">
<caveSurvey>
(...cave survey data...)
</caveSurvey>
```

The DOCTYPE attribute-SYSTEM "caveSurvey.dtd" - informs the XML reader that it can find the DTD to validate this XML file on the local system. This avoids the need to repeat the same DTD information in every XML file thereby reducing file size. It can also be used to refer to a DTD file located on another computer entirely, as in the DOCTYPE declaration in exhibit 12.

Exhibit 12. DTD statements may be retrieved from remotely located machines.

```
<!DOCTYPE caveSurvey SYSTEM
"http://www.psc-cavers.org/dtd/caveSurvey.dtd">
```

This statement would allow the XML reader to retrieve the appropriate DTD for application to this XML file from a web server on the network.

DTD's are much more flexible than this short description can convey and in the process of developing a cave survey DTD the caving community will likely need to use more advanced capabilities of the DTD in order to accomplish their objectives.

What remains to be done? So what next? How do we get there from here?

First, popular support is critical to the success of any form of community endeavor. Significant input from the community of persons interested in cave survey data is sought and will be shared on a range of topics as they arise. Further details to support these endeavors are available on the web site www.psc-cavers.org/xml, including examples, links to tutorials, tools and discussions.

Second, suggestions are needed from the community for the "things" they think a cave survey data file should include. This is a simple list that is not immediately concerned with how those "things" are ultimately arranged in XML format. The goal is to brainstorm those elements that are most critical to cave surveys and will result in a flexible standard to meet the community's needs.

Third, submissions for candidate arrangements of the data elements are needed. Those submissions could take the form of raw XML files, as used above, or DTD statements, which drive the design of the XML file. Within this phase it would be appropriate to discuss issues of style, formatting, abbreviations, use of attributes, etc.

Summary

XML is going to be everywhere (and indeed its use is already widely spread). The XML standard has developed swiftly, and a large number of software vendors have been quick to adopt it. XML holds the promise of becoming the most common technique for all data storage and data transmission needs.

Storing cave survey data in XML makes it more valuable to cave science because it becomes future-proof. Surveyors can position themselves to develop increased capabilities in the future by contributing to a joint effort to develop the XML representation of cave survey data today. For further discussion of the development of cave survey data standards in XML please visit the web site www.psc-cavers.org/xml and review the information it contains.

-Devin Kouts

Let me know if you have any questions,

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COMPUTER MODELING OF CAVE PASSAGES

By Larry Fish

Since the 1960's, computers have been used to generate *line plots* of caves. A *line plot* is the simplest form of cave map, showing only the lines that trace the survey shots through the cave. While A *line plot* is easy to generate and illustrates the general layout and structure of a cave, it shows nothing about size and shape of the passages. To truly understand the geology, hydrology, and origins of a cave, you need to be able to see the size, shape and orientation of the rooms and passages. This article explores some ideas and new techniques for creating good passage models on computers.

In the early days of cave surveying, surveyors took measurements of the passage dimension primarily to help cartographers draw maps. With the advent of the personal computer, these measurements are increasingly used to create computer passage models. However, even with the power of today's computers, it is surprisingly difficult to create pleasing and accurate passage models.

Part of the problem is the way we collect survey data. Cave surveyors typically take four measurements of the passage outline at each shot. While this would be enough information if cave passages had a square cross section, it is not enough information to accurately portray the irregular shapes of real caves. To accurately model cave passages, we need more points. For example, instead of the four *left, right, up* and *down (LRUDs)* measurements, we probably need six or eight. Likewise, instead of only taking measurements at the ends of each shot, they should be taken at regular intervals, every few feet along the passage. Unfortunately, cave surveying is already a tedious task and it is not very likely that surveyors would be willing to gather more data. Collecting this kind of data is not likely to happen until we have com-

puterized surveying tools that will automatically record this information.

Given that we don't have a lot of information, we still should be able to create pleasing cave-like passage shapes. However, even this simple task is more difficult than it might seem. Let's look at some of the issues.

TWO-DIMENSIONAL MODELS.

We will start with two-dimensional models. Our goal is to create a computer map that looks reasonably like a hand-draw map.

Starting with the plan view, if you take a survey shot and the *left* and *right* dimensions at each station, you can draw a line on each side of the shot that approximates the position of the passage walls. You also may want to draw a line showing where the left-right measurements were taken. This will close the ends of shots, generally creating long, rectangular shapes.

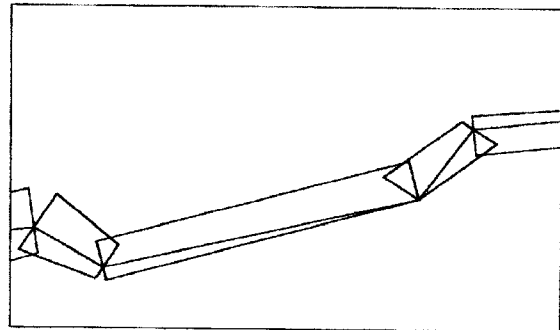


Figure 1 - *Polygon Mode* passages models, taken from the COMPASS Viewer.

As you can see, while this does approximate the passage shape, it is not very visually pleasing. The gaps and overlaps give it a confused, disjointed look.

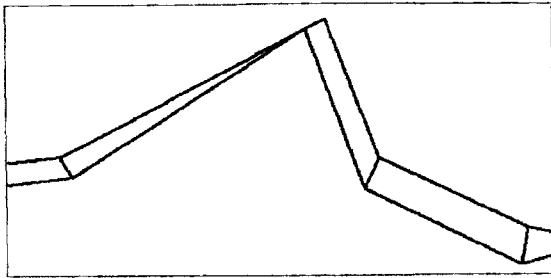


Figure 2. *Joined Polygon Mode*, taken from the CaveX Viewer.

You can eliminate some of the disjointed appearance by joining the ends each shot together. This works well up to a point, but as you can see in Figure 2, when the angle between the two shots approaches 90°, the passages walls get closer together and the passage appears to kink like a garden hose. You can mitigate this problem slightly by adjusting the angle of the joint, but that just spreads the distortion to both shots. Even when the angle is not too acute, the corners have sharp edges that don't look much like the smoothly curved walls of hand drawn maps or real caves.

SMOOTHING FUNCTIONS.

One way to deal the disjointedness at the corners is to use a mathematical function to draw smoothly curving passage walls. Although there are many functions that will draw curved lines, the most useful are called *Parametric Cubic Curves*. These functions are particularly useful because they make it easy to control the shape of the curve. There are several different types of *Cubic Curves* and each one has a different method of controlling the shape. In *COMPASS*, I chose to use a variation of the *Hermite Curve* to draw passage walls¹.

¹ The Hermite curve was chosen because of its obvious applicability to the task at hand. Other cubic curves might work as well or better, but some of experimenting and coding would be necessary to find out.

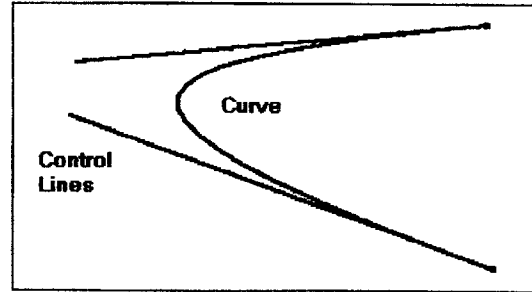


Figure 3 - *Hermite Splines and Control Lines*.

The *Hermite Curve* uses line segments to control how a line is curved. Normally, these *control lines* are hidden and only the curve is drawn, but the length and angle of the *control lines* govern how sharp and long the curve will be. In Figure 3, you can see how typical *control lines* might effect the shape of the curve.

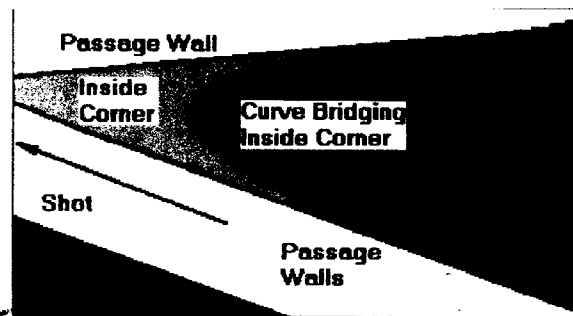


Figure 4 - Using passage walls as *control lines*.

It is easy to see how you could use parts of the passage walls as *control lines* to draw smooth curves around corners. Figure 4 illustrates the process of constructing *control lines* from passage wall lines. Here there are two connected shots that make a sharp right-hand turn. The right-hand passage walls are used as control lines and the curve bridges the inside corner forming a smooth transition between the two shots.

In actual practice, the process is more complicated. The biggest problem is that you have to deal with the inside of a corner differently than the outside.

1. Inside Corners. As the angle between two shots gets more acute, the lines forming the passage walls will overlap. If you use crossed lines as *control lines*, the function will draw a very unattractive loop at the

corner. For this reason, you must truncate the lines some distance back from the corner to get a pleasing curve. Determining just where and how to truncate the lines can get pretty complicated.

2. Outside Corners. Outside corners suffer from a different problem. As the angle between two shots gets more acute, the outside curve tends to flatten until it cuts off part the corner. The solution to this is to extend the *control lines* beyond the end of the passages. The tricky part is to get the distance to extend the lines just right. Several parameters come into play including the width of the passage and the angle between the two shots.

All these adjustments to the *control lines* require quite a few calculations, but it is worth the trouble. The result is a pleasing passage model that looks similar to a hand-drawn map.

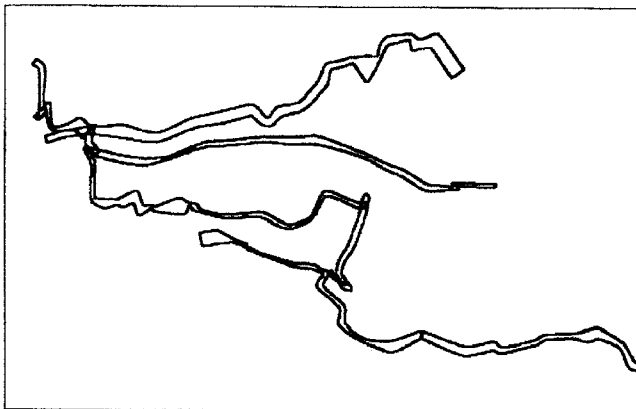


Figure 5 - Actual passages image from the COMPASS Viewer. ¹

FILLED PASSAGES. Another useful feature is to fill the passage outlines with color. Usually this is done with some kind of *flood filling* routine. Even this can be tricky because if there are any gaps in the passage outline, the flood-fill will leak out and color the whole page. Filled maps are very useful because they give a simple, clear image of the cave and, since they can be printed in black and white, they work well for publication.

¹ This plot is taken from Fixin' To Die Cave, in Western Colorado.

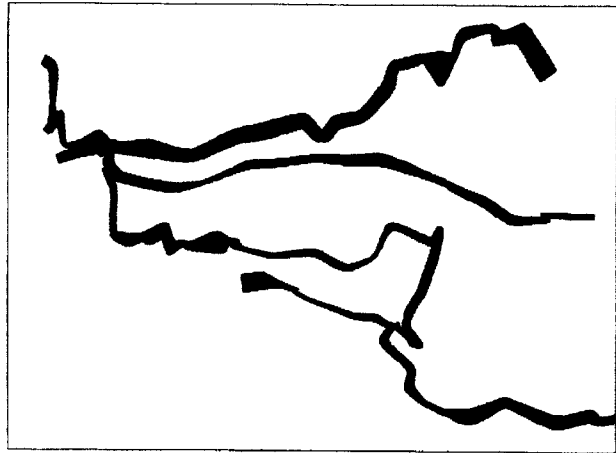


Figure 6 - Filled passage model. (Image from the COMPASS Viewer.)

THREE-D MODELS.

So far, I have only described two-dimensional passage models. While they are very useful for paper maps, to truly appreciate the structure of a cave, you need a 3D model.

Generally speaking, 3D computer models are created using a grid of points that represent locations on the surface of an object. By connecting these points together, you create a series of *faces* that can be used by the computer to draw an image of the object.

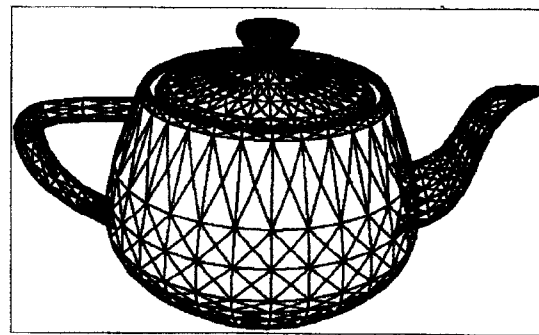


Figure 7 - Typical mesh of a three-dimensional object.

This collection of points and faces is called a *mesh* and, as you can see in Figure 7, it can be used to represent any three-dimensional object. The more faces, the smoother the object can be drawn.

CROSS SECTIONS.

In the two-dimensional model, we started by drawing lines next to the shot that approximated the position of the passage walls. In the 3D model we want to draw a tube around the shot based on *left, right, up* and *down* dimensions. Since there are four measurements in each *LRUD*, it is very easy to generate a four-sided tube with a diamond or square cross section. However, more sides are needed to create a smooth surface. Given the four measurements, it is relatively easy to create octagonal cross sections.

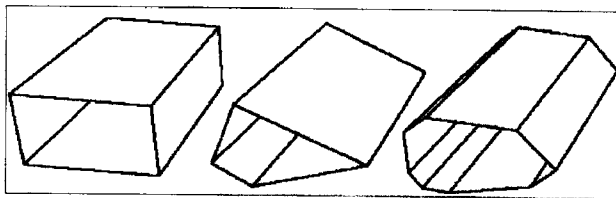


Figure 8 - Square, Diamond and Octagonal tubes. (Images from the CaveX Viewer.)

Figure 8 shows a square, diamond and octagonal cross sections using *LRUDs* of 3, 10, 5 and 2 respectively. As you can see the octagonal shape more closely approximates the typical oval shape of a cave passage.

CORNERS.

As in the 2D case, connecting two shots together by joining the tubes can be difficult. Using the cubic curves and dealing with inside and outside curves could be very complicated on a 3D object. As a result, I have developed a new technique that simulates the cubic curves; but is faster, simpler and gives very pleasing results.

NEW ALGORITHM.

The process involves subdividing each corner into two smaller corners that smoothes the transition between shots. The process can be carried out repeatedly, with each successive round of subdivision further rounding the corner. The process works well with any inter-shot angle and doesn't require any special

handling of the inside or outside part of the corner. Another big advantage of this technique is that most of the work of rounding the corner is done with the two shot lines rather than two 3D solids.

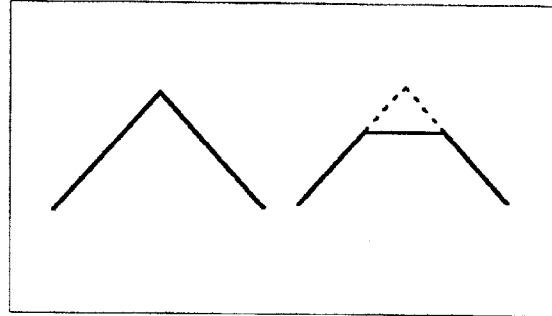


Figure 9: Subdividing the corner into 3 shots

Figure 9 illustrates the process. The drawing on the left shows two shots connected at a 90° angle. The process begins by selecting a point a short distance from the corner on both shots. The shots are then truncated at these points and a new artificial shot is added, connecting the new end-points. New *LRUDs* are then generated for these new end-points by linearly interpolating from the original values. You now have three shots where there were originally two and the *LRUDs* for the new shot smoothly transitions between the original two. All the math is carried on the shot lines and *LRUDs*, and you don't have to deal with 3D objects until the passages are drawn.

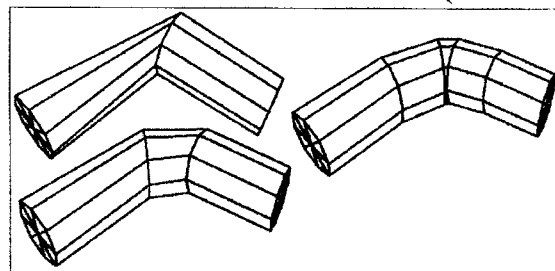


Figure 10 - Subdividing 3D passage. (From the CaveX Viewer.)

Figure 10 shows a simple, two shot sequence that has been rendered as an octagonal tube. In the first image, no corner rounding has been done. Here the tube has been flattened by the sharp angle at the corner. The second image shows how the passage looks

after it has been subdivided once, generating three shots. In this image, the angles between shots are much less acute. Finally, in the last image, the shots have been subdivided twice, generating a total five shots. Having five shots in place of two, opens the angle between shots and makes a smooth transition around the corner. (Note: these artificial shots are not actually inserted into the cave data, they just generated temporarily to create the mesh.)

Once the passage has been converted into a mesh, further smoothing can be accomplished by splitting the rectangles into triangles and creating more faces. The tradeoff is that more faces put greater the demand on memory resources and processor power.

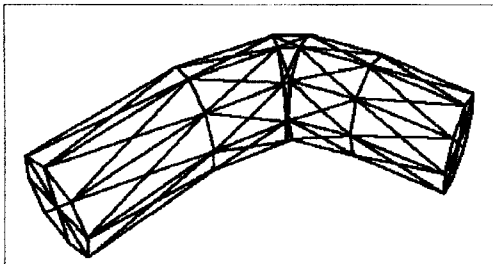


Figure 11 - Increasing the number of faces. (CaveX Viewer.)

To give you an example of the mesh sizes we are dealing with, rendering Lechuguilla Cave, which is about 100 miles long, requires about 500,000 polygons and 180 megabytes of memory. This is with one pass of corner rounding and no other smoothing. This may sound like a lot, but a 450 MHz Pentium III and an accelerated video card can display more than 2 millions polygons per second. This gives animation rates of five or six frames per second, more than adequate to manipulate and animate the image in real-time.

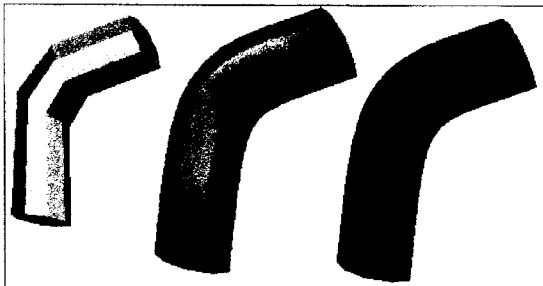


Figure 12 - Filled, Smoothed and Texture passage segment. (CaveX Viewer.)

Although the mesh now approximates the shape of a cave, the flat faces give it a unnatural faceted appearance. The final step uses *illumination, shading* and *texturing* to further smooth the object. The *illumination* and *shading* process mathematically simulates the way light reflects off of the surface of an object. The first image in Figure 12 illustrates the first step in this process. Here, each face in the mesh is filled with color whose brightness varies according the amount of light reflected off each face. Because each face has the same brightness across its whole surface, the faces appear flat and make the object look faceted. In the second image, we have used a technique to eliminate the faceted appearance. Here the brightness changes across the surface of each face, smoothly grading from edge to edge. This makes the faces disappear and gives the appearance of a smooth, tubular surface. The method used here is called *Gourad Shading*. By changing the parameters of the *shading* process, you can vary the appearance of the surfaces from a soft matte finish to a glassy finish like polished steel.

Another thing that can improve the appearance is to overlay the surface with a *texture*. *Texturing* takes a bitmap image and overlays it on the surface of the object. In the final image above I have taken a photograph of a limestone boulder and stretched it over the cave passage. This gives it a rock-like appearance more consistent with cave walls

So far, we have been viewing the cave from the outside but there is no reason they cannot be viewed from inside as well. With advanced illumination techniques, you can even simulate the effects of a caver's helmet light on the passage walls. Figure 13 shows the combination of two techniques on the interior walls. Here the walls are painted with a limestone texture and the tunnel is illuminated with a spotlight aimed down the passage.

The techniques used to do *illumination, shading* and *texturing* are covered in detail in any textbooks

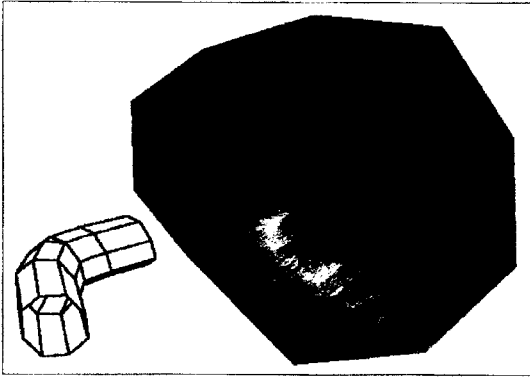


Figure 13 - Passage interior, using spot lighting and texturing. (CaveX Viewer)

on computer graphics¹. However, modern graphic cards are capable of carrying out all these operations in hardware, greatly accelerating the display. Since every graphics card has its own proprietary techniques of hardware acceleration, most programmers use a graphic language such as Microsoft's *DirectX* or Sun Microsystems's *OpenGL* to access these special features.



Figure 14 - View of fully rendered cave passages. (CaveX Viewer.)

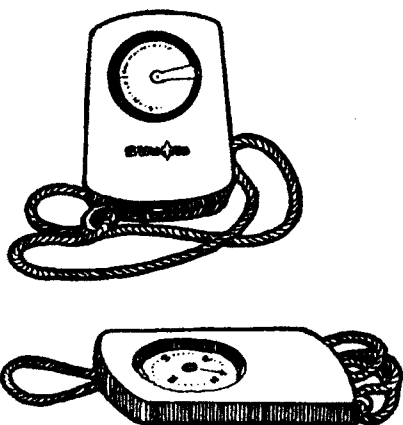
Figure 14 shows the finished product. Here, all the techniques described in this article are used to show passages in the *Chocolate High* section of Carlsbad Cavern. Using *DirectX* or other similar technology, even these very complex images can be manipulated at very high speed.

The Future. Many of the techniques described in this article would be unnecessary if we collected better data. In addition to collecting more data points, the most pressing need is to change the way we deal with vertical or steeply sloping shots. Currently, there is no standard way of making measurements in a vertical or near vertical passage. Obviously, the concept of making *up*, *down*, *right* and *left* measurements is meaningless on a steeply angled shot. Currently, only **Toporobot**, a Swiss cave survey program, has a clearly defined standard for dealing with vertical shots and steeply sloping passages. Unfortunately, this standard is so different from the way the rest of the world surveys, that it probably won't be widely adopted. It is certainly incompatible with the thousands of miles of survey data already in our computers.

SOFTWARE.

All the images in this article were generated in **COMPASS**, a cave survey software package. For more images of caves and passage wall models refer to the **COMPASS** web page at: <http://fountainware.com/compass>

1 One of the best texts covering the whole field of computer image rendering is *Computer Graphics, Principles and Practice* by *Foley, vanDam, Feiner and Hughes*. Addison Wesley



Compass Brands and their Manufacturers

Bob Thrun

Years ago I bought a Sisteco compass and clinometer set as a backup and alternative to my set of Suunto instruments. More than a year later I checked out the Sistecos and found that the clinometer pivot had too much friction. I did not write to the importer at the time and then the importer changed. I heard that the Sistecos became Silvas.

Even longer ago I helped map a cave with Richard Schreiber. He used a Silva Ranger compass. This year I bought a Silva Ranger to round out my collection of cave surveying instruments. The manual said the compass was “Guaranteed Accurate for Life” and the registration card gave a toll-free phone number to call for warranty service. I called and was informed that there were two Silvas and my Sisteco clinometer was made by the wrong one. I then tried to track down who makes what on the Internet.

Silva in Sweden has a catalog of Professional Instruments posted on its web site. It shows a line of instruments identical to the former Sisteco line. There is a history of Silva that says that Silva acquired the Finnish instrument maker Sisteco in 1990 and the US company Brunton in 1996.

The Brunton website shows a line of instruments that look like the Sistecos, but have a Brunton label. This is in addition to the traditional Brunton, called a pocket transit, and a line of other outdoor items. The Silva Sweden catalog and the British Compass Points, the counterpart of Compass & Tape, both re-

fer to the former Sisteco designs as Silva instruments. I found a website with a 1997 article from Outdoor Retailer that explains the confusion of brand names. When Silva bought Brunton, Silva terminated its arrangement with its importer, Johnson Worldwide Associates, and decided to import its instruments into the US through Brunton, dropping JWA. However, JWA claimed ownership of the Silva trademark in the US and Canada. The inevitable lawsuit ended with JWA owning the trademark, but unable to import compasses made by Silva Production AB in Sweden. Silva decided to market through Brunton under the new brand name of Nexus. JWA arranged for Suunto to manufacture compasses with the Silva brand name. The head of JWA was quoted as saying “No matter who makes compasses for us, they will still be Silva compasses.” This is true only under a strict reading of US trademark law.

The article makes it sound like the ownership of the Silva trademark by Johnson Worldwide Associates was an oversight on the part of Silva. I have encountered situations involving photographic equipment where the ownership of the trademark by the importer was deliberate. If a trademark is owned by someone other than the manufacturer, the trademark owner can have US Customs block the importation of “grey market” goods. The grey market arises when a manufacturer sets different prices in different countries. A dealer is able to buy merchandise in a country with lower prices than the US and sell it for lower prices than the officially imported merchandise.

The fine print on the packaging of the Silva Ranger model 515 I bought says "Made in Finland". I have a 1989 Forestry Suppliers catalog with full pages devoted to the Silva type 15 Ranger and the Suunto MC-1. The Silva Ranger that I have is almost identical to the Suunto MC-1. The most notable difference between the Swedish-made Silva Ranger and the Finnish-made compasses is in the hinge lugs on the cover of the compass. I also purchased a Brunton Nexus compass. The fine print says "Made in Sweden by Silva Production AB" with a small Swedish flag.

I was able to find the history of some of the compasses. I don't know when the the metal-bodied Suunto KB-14, the compass model we are all familiar with, was first made. It was described in the May 1969 NSS News with a reference to a 1967 Arkansas Caver article. According to an official of Brunton, Sisteco was founded in Finland in 1978. The first mention of the Sisteco instruments for cave surveying in the US that I could find was an article by John Ganter in *Compass & Tape*, Volume 5, Number 3. He said that Sistecos were available in June 1987. As I mentioned before, Sisteco was bought by Silva in 1990. Production of the Sisteco designs, renamed to Silva, was moved from Finland to Scotland.

The Brunton pocket transit has a long history. It was patented in 1894 by David W. Brunton, a mining engineer. He contracted with William Ainsworth, a watchmaker, to make it. Ainsworth founded the Ainsworth Gold Scale company in Denver. For many years, "D.W. Brunton's Pocket Transit" was made by Wm. Ainsworth & Sons, Denver, Colo. Starting in 1965, the company was owned by a series of corporate conglomerates, which were the fad on the stock market. A large corporation would own a bunch of unrelated businesses. The theory was that if one business went into a slump, the others might be unaffected. In practice it meant that top management did not know how to run most of the individual businesses. Ainsworth was successively owned by Xavier Sci-

ence, Taste Freeze, Beaver Mesa Exploration, and US Energy. I recall that quality went down during this period. In 1972 a group of Riverton, Wyoming businessmen bought the business and formed the Brunton company. They added lines of binoculars and hunting knives. In February 1996, Brunton was acquired by Silva Production AB of Sweden, makers of the famous orienteering compasses. The knives have been discontinued.

With all these mergers and name changes, it is no longer clear what someone means when he says a cave was mapped with a Brunton compass. Since Brunton offers a "limited lifetime warranty" for its current products, I asked about fixing my Sisteco. At first I was told that Brunton was not affiliated with Sisteco. After informing the service representative that Silva bought both companies, I got a return authorization. I sent the clinometer in with a letter emphasizing that it was in mint condition, but defective from the factory. I got a replacement clinometer with a Brunton label, but otherwise identical to the Sisteco.

New Compasses from Brunton

The two most recent Brunton compasses are the Eclipse 8099 and the Outback digital compass. I have seen both of these compasses. The Eclipse has too many pieces to be a cave surveying compass. It has a removable rubber boot that holds a plastic card. It is harder to read than the pocket transit. The Outback does not have good enough sights for accurate measurements. Precision Navigation, the company that makes the magnetic sensors, claims that the sensors are gimballed so that the Outback can be tilted up to 15 degrees and still be accurate. Perhaps it was just the unit I saw, but I could tilt the compass slightly side to side and the indicated direction would change plus or minus 15 degrees. This was a continuous change, not the gimballed sensor hitting its stops.