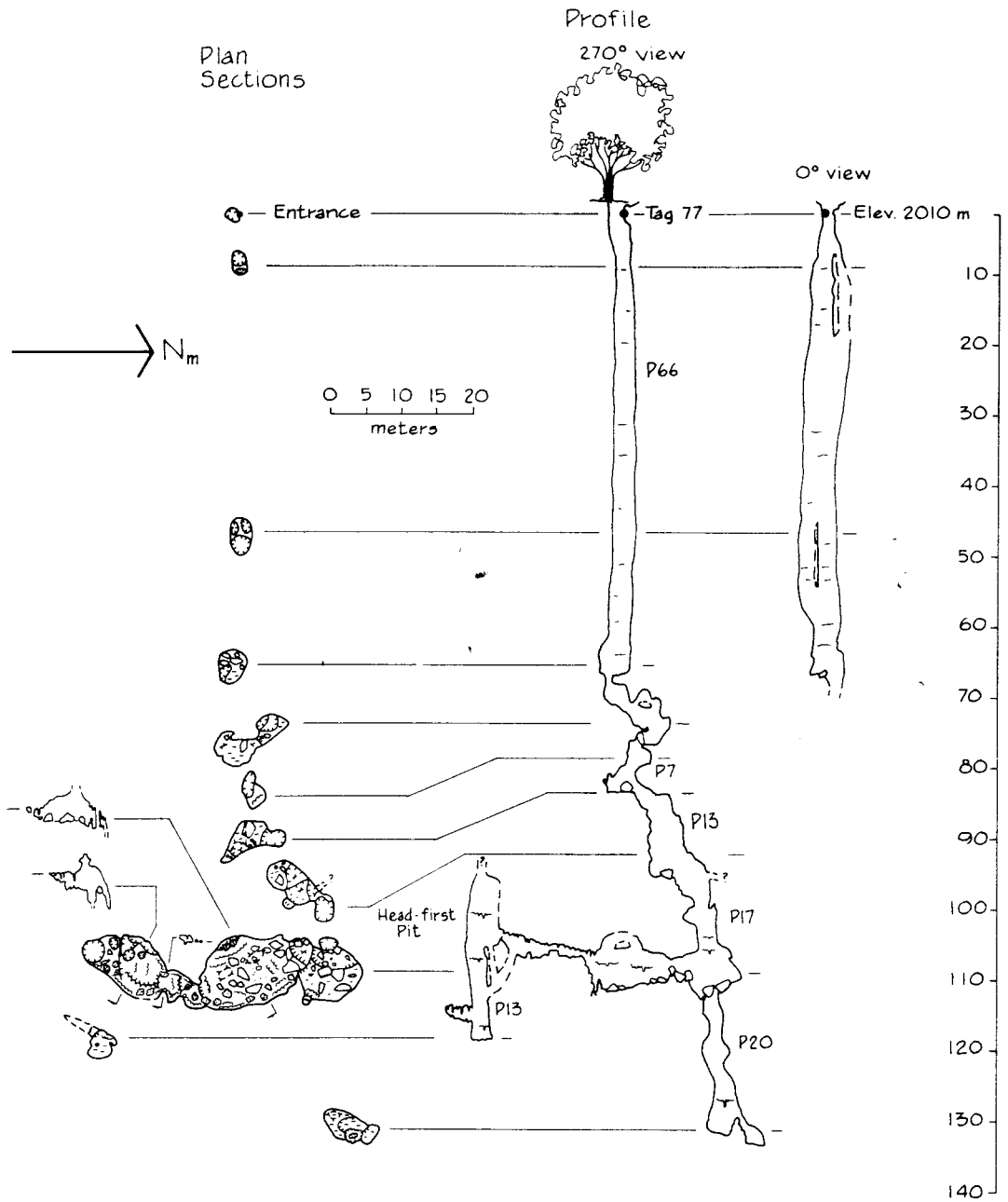
COMPASS & TAPE

VOLUME 13, NUMBER 1, ISSUE 41

Sótano de los Novios

Dulces Nombres, Nuevo León, México



Length: 204 m · Depth: 134 m · UTM coordinates E440,280; N2,652,115

Suunto and tape survey 29 December 1995
by R.M. Barksdale, P. Hollings, S. Lasko, B. Luke, B. Shade, and P. Sprouse

Drafted by B. Luke

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, survey and cartography.

MEMBERSHIP: Membership in the Section is open to anyone who is interested in surveying and documenting caves and in 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*. There are normally four issues of *Compass and Tape* each year, but if there are fewer, than all memberships will be extended to insure that four issues are received. Dues can be paid for up to three 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 normally published on a quarterly basis, but if insufficient material is available for an issue, the quarterly publication schedule may not be met. *Compass and Tape* includes articles covering a wide variety of topics, including equipment reviews, hints and techniques, computer processing, mapping standards, artistic techniques, publications of interest, and appropriate material reprinted from local and international publications. It is the primary medium for conveying information and ideas within the 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, at which 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 session. 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. All Section business, including election of officers is done at that meeting.

BACK ISSUES. SACS started in 1983 and copies of all 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 $0.50 each for more than six back issues at a time. Order back issues from the Treasurer.

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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Inside

From the Editor

As you can see from the table of contents, George Dasher spends entirely too much time writing about the Cartography Salon. Somebody please give the guy a break and volunteer to help him out at the 1997 Cartography Salon in Sullivan, Missouri. Or better yet, volunteer to be the Carto Salon Chairman for a convention in the near future. If that's a bit much, how about signing up to be a judge (though George would like everyone who lives east of the Appalachian Trail to take a break from judging this year.).

In addition to George's revealing look at everything anyone could possibly want to know about the SACS feature event, Larry Fish pokes some holes in a long-favored loop closure algorithm (is nothing sacred?) Also, David Parr helps get you get started down the road toward throwing away those messy drafting pens. Bert Ashbrook cuts loose with the hottest scoop on where to score some easy declination. And, the Cartographers Corner (aka lets-publish-more-maps section) offers suggestions on non-medicinal relief to some forms of cartographic migrane.

My favorite section is the Letters to the Editor. Aside from the fact that I love to get mail, it makes your editor really ecstatic to see that cartograpers and cavers - who just like to look at maps, both read *Compass and Tape.*

And finally, our treasurer, Bob Hoke, tells me that starting with this issue, *Compass & Tape* will be mailed out in envelopes. This frees up the back cover for - you guessed it - more maps! So, this page will be devoted to cave maps with formats that take a departure from the standard stuff we are used to seeing, to interesting and/or historical area maps and to unusual cartographic representations. George Dasher is correct when he says that the "Cartography Salon's Medal pick is not the cartography-style-to-end-all styles."

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Edited by Pat Kambesis

SUBMISSIONS

All types of materials related to cave survey and survey data, cartography, and cave documentation 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 submissions for *Compass & Tape* to:

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404-676-8918 (fax).
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Letters to the Editor

MORE ON PEN WIDTHS

I really enjoyed the Cartographers Corner article. It had some excellent ideas. My only comment on your line widths is that I vary the line widths depending upon the amount of reduction expected for final publishing. The line widths I use are:

0% Reduction:

Pen Size	Suggested uses	Letter Guide
1	Cave name	120CL
0	Passage Walls	
00	Location Information	100 CL
000	Passage detail/majority of lettering	80CL

50% Reduction:

Pen Size	Suggested uses	Letter Guide
2	Cave name	200CL
1	Passage Walls	175CL
0	Location Information	140CL
00	Small lettering	120 CL
000	Passage detail/majority of lettering	

I never had any luck keeping a 0x4 pen operable, so I stopped using them. As for my other pens, I found an ultrasonic denture cleaner at a drug store for less than $20.00. This and some rubbing alcohol can restore any dried up pens.

Good Caving,
Dave Black
Georgetown, Indiana

PROTECTING INSTRUMENTS

I tried Mike Yocum's method of protecting survey instruments which was described in the January 1995 issue of *Compass and Tape* (#37). I used Plasti-Dip, which is liquid rubbery stuff meant for dipping tool handles in for a slip-resistant finish. When it dries, it makes an almost indestructible coating. Since Mike's article was written, Plasti-Dip has become available in a clear color, so that light can get through the window. Unfortunately, the can is narrow so that dipping instruments is difficult. I opted to paint on the stuff after cutting it with a little toluene per the directions.

I got some bubbles because of the painting, but with about eight coats of the stuff on each of my compasses and clinometers, I'm not worried. I painted over everthing except the eye hole, where I put some clear silicone caulking between the glass lens and the aluminum housing. None of my instruments fogged the way Mike described. At eight coats each, I was able to do six instruments without quite finishing off the $9.00 can of Plasti-Dip.

The results are impressive: the instruemtns are (so far!) water-proof, mud-proof, and somewhat more idiot-proof. The last was achieved by drawing the frontsight and backsight scales on the aluminum compass housing and the degress and percent scales on the clinometer housing. Now covered with the clear glop, the drawings serve as permanent reminders of which scale is inside the eyepiece.

Bert Ashbrook
Allentown, Pennsylvania

ON THE COVER OF ISSUE #40

Congratulations on your new job as editor of *Compass & Tape* and thanks for giving of your precious time to do it! The results are really great - full, thick, and heavy with really interesting articles. I wish I had your talent for pulling those journalistic teeth!

The front cover of Issue #40 is just SUPER! I've seen lots of maps but never have I felt like I've been there, until now. What a wonderful format. I hope we are seeing a new trend.

Gotta go, hope you have some time left over for cavin'!

Earl Hancock
House Springs, Missouri

Earl, There's no pulling of journalistic teeth here. The cartographic tooth fairy just drops this stuff in my mailbox! That most excellent map to which you refer was done by David Parr using a graphics program called Interleaf (see article on page 19). As far as my time for caving, if I did a little less I could probably get ***Compass & Tape*** *out more regularly - (Hmm, Stay home on weekend and work on computer...or... go caving? -ed)*

THE 1996 NSS CARTOGRAPHY SALON

By George Dasher - August 18, 1996

The1996 Cartographic Salon was held at the Salida High School in Salida, Colorado. Thirty-five maps were entered, including four for-display-only maps. There were maps from fourteen U.S. states and from four countries: Switzerland, China, Mexico, and the United States. The judges this year were Bert Ashbrook, Bill Balfour, and George Dasher. This year nine Honorable Mentions (green ribbons), four Merit Awards (blue ribbons), and one overall Medal Award were given. Of particular note, the Medal was given to an individual who has participated in the Cartography Salon for approximately 15 years. His maps have on more than one occasion come very close to winning the Medal, and he is one person who may be described as coming the "closest the mostest." The judging criterial for the Cartographic Salon is explained in detail starting on page 6.

HONORABLE MENTION (GREEN RIBBONS)

1. **Green Canyon Cave**
   Brown Canyon Cave
   Prince of Wales Island
   Tongass National Forest, Alaska
   Kevin and Carlene Allred

2. **Nizina Cutoff Borehole**
   Wrangell-St. Elias National Park
   Tongass National Forest, Alaska
   Kevin Allred

3. **Conway Cave**
   Carter County
   Tennessee
   J.D. Shelton

4. **Marmot's Nest Cave**
   Gros Ventre Wilderness, Wyoming
   Garry Petrie

5. **The Hurricane Cave System**
   El Paso County
   Colorado
   Michael Frazier

6. **Adams Cave**
   Wildwood Park
   City of Radford
   Montgomery County, Virginia
   Ernst Kastning

7. **You Cai Dong**
   Pingba County, Guizhou Province
   Guizhou Province
   Peoples Republic of China
   Carol Vesely

8. **Tian Ba Dong**
   Duyin County, Kai You Area,
   Guizhou Province
   Peoples Republic of China
   Carol Vesely

9. **Las Grutas de San Sabastina**
   Oaxaco, Mexico
   Stephen Lester

MERIT AWARDS (BLUE RIBBONS)

1. **Con Cave**
   Derry Township
   Westmoreland County, Pennsylvania
   Walt Hamm

2. **Sawmill Cave**
   Derry Township
   Westmoreland County, Pennsylvania
   Walt Hamm

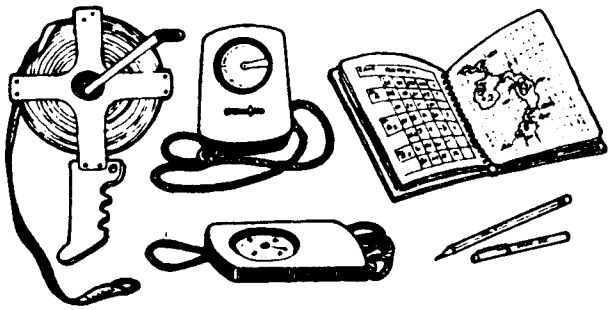
3. **Fixin'-to-Die Cave**
   Garfield County, Colorado
   Hazel Barton

4. **Cave of the Winds**
   El Paso County, Colorado
   Paul Burger

MEDAL AWARD

Millerton Lake Cave System
Fresno County, California
Bob Richards

SURVEY AND CARTOGRAPHY SECTION MEETING



August 20, 1996

by George Dasher

Attendees: Bert Ashbrook, Bill Balfour, Rick Banning, Roger Bartholomew, Dave Black, Barry Chute, Don Conover, Hubert Crowell, George Dasher, Miles Drake, Dave Engel, Andrea Futrell, Mike Futrell, John Ganter, Daniel Hazelton, David Herron, Bob Hoke, Paul Jorgenson, Howard Kalnitz, Tom Kline, Dave Lemberg, Robert Lenz, Phil Lucas, Doug Medville, Hazel Medviille, Pat O'Connell, Jim Pisarowicz, Nancy Pistole, Scott Schmitz, Ted Steinke, Bob Thrun, Carol Vesely, Jim Washington, Beth Ann Webb, Fred Wefer, Arnie Weisbrot, Mark Weisbrot, Stephanie Woodward

The 1996 meeting of the Surveying and Cartograpy Section (SACS) was held during the NSS annual convention in Salida, Colorado. The meeting took place on Thursday, August 8th, in the Salida High School, and was called to order at 12:14 pm by Chairperson Carol Vesely. Carol said that Cartography Salon would be discussed last, as she expected this discussion to be the most intense and would require the most time.

First were the officers' reports. Roger Batholomew, the Vice-Chairman, said that he really appreciated those who had helped with the SACS' session at this Convention. He urged everyone to submit papers for the 1997 Missouri Convention.

George Dasher, the secretary, said that he had written no letters during the past year and that he really had nothing to report.

Bob Hoke, the treasurer, said that SACS had "lots of money." He said that the Section had published two issues of *Compass and Tape* in the past year and that an additional issue was mailed about one and a half weeks prior to the Colorado Convention. He asked for a show of hands of who had received this last issue. Bob also said that the Section presently had 212 members. He recommended that the Section charge $1 for 1 or 2 back issues of the *Compass & Tape*, $0.75 for 2 to 6 back issues, and $0.50 for more than six back issues. He made a motion to this effect, which Mike Futrell seconded, and which passed unanimously with one exception - Dave Engel said that he was indifferent to the motion.

Pat Kambesis, the editor of the *Compass & Tape* was not present at the meeting. Carol gave Pat's report, and said that Pat has some material for future issues; however she needs more articles. Pat also plans to start a new column, called the "Cartographer's Column," and this will profile a map in each issue of the *Compass & Tape*, giving only the positive points of the map, not the negative points.

Carol gave the Chairperson's report. She said that last meeting's goal of having a computer-drafting talk had been obtained, and that Bert Ashbrook and Hubert Crowell had both given good talks on the subject. She said that many of the Section's members were presently unclear on the pluses and minuses of the various cartographic software on the market, and she asked that if anyone can make comparisons between the cartographic software (which might require temporary donations of the software to the reviewer) then she would be appreciative. Bob Hoke said that this would be a good article for the *Compass & Tape.*

Next was Old Business. Bob Hoke said that SMAPS had disappeared from sight, and that on June 11th he had written Doug Dotson a letter specifically asking about the status of his software and specifying that he would like an answer before the Convention. Bob received no reply to his letter, and his next action will be to send an identical letter via certified mail. No one at the meeting knew anything regarding the status of the SMAPS software, and Bob said that people had been trying to purchase it, but that Doug would not respond.

Next was New Business, and Hubert Crowell gave a report on this year's Convention Compass Course. He

said that three teams had entered, and that the winners had a loop closure of 0.56%, He also said that people had been constructing equipment specially to run the contest.

Tom Kline then asked if there was any standardized list of lava cave symbols. This instigated a rather long discussion, and it is not certain that any final resolution or course of action was reached. It was suggested that perhaps this would be a good article for the *Compass & Tape.*

Next was the elections. There was the general consensus that the current slate of officers should remain in office. These are, as reviewed at this time in the meeting, Roger Bartholomew as vice-chairman, George Dasher as secretary, Bob Hoke as treasurer, and Carol Vesely as chairperson. Barry Chute made a motion that these officers continue. Bob Hoke seconded the motion and it passed unanimously.

Finally was the discussion of the Cartography Salon. Chief among the concerns were that George Dasher would like to retire as Salon Chairman as the repeated Convention workload is too intense. Additional concerns are: Is there any way the Salon can give the Society's cartographers more recognition?; Is the Salon driving an NSS-approved map too far in one direction. George had given a talk regarding these concerns in the morning SACS' session, and these issues had not been resolved then.

This discussion took a very long time, and suggestions were made to give more awards, to give an award to first-time cartographers, that the Salon criteria should again be published in the *Compass & Tape*, and (when no one volunteered to replace George)- to have a rotating Convention Cartography Salon Chairman, who will work under George. It is was further suggested that, each year at Convention, there would be a chairman and a co-chairman. The co-chairman would become the chairman at the following convention, and a new co-chairman would come on board to learn the ropes. David Herron, Howard Kalnitz, Scott Schmitz, Bert Ashbrook, Nancy Pistole, Dave Engel, Carol Vesely, Darrel Adkins, and Robert Lenz all volunteered to help with future Cartography Salons.

Hazel Medville then brought up a new issue. This was GNIS, or the Geographic Name Information System, which has been instigated by the USGS. Evidently the USGS is contracting to locate exact coordinates for many geographic features, including cave entrances, and complete lists of several states' wild caves' entrance coordinates have already been added to this system. These lists are now available to anyone on one of the web systems, and these people can obtain the exact coordinates for all the wild cave entrances in many states.

There had been an impromptu meeting concerning this issue before the SACS meeting, and suggestions which were passed on to SACS included that the Hawaii Speleological State Survey recently provided the USGS with a list of all their caves, with the locations marked "unknown"; that there would be an upcoming article in the NSS News on the subject; that persons are trying to work with Roger Cane, the Branch Chief of the USGS supervising this system; and that the individual state cave surveys will all have to soon make some very quick and important decisions.

This was the last of the business to be discussed. Carol adjourned the meeting at 1:33 pm.

Judges Wanted for the 1997 Cartography Salon

by George Dasher, Cartography Salon Chairman

My method of getting people to judge the Cartography Salon is pretty simple. People bitch about, comment on, and critique the Salon and then I ask them to judge. Usually they say yes. I recently used this technique on Doug Medville. Doug said he would judge a future Salon, but not in 1997. His reason: You have too many judges from the east.

Unfortunately, Doug is correct. I do have too many judges from the east. All of the 1995 judges were from the

east, and the people I picked for 1996 were also from the east. All got their jobs by volunteering. So here's the sell. I need judges from all over the country, and given that the 1997 Convention is in Missouri, I badly need judges from Missouri .

If you would like to judge the Cartography Salon, then please volunteer. The judging will take up between one and two-plus days of the Convention, and you will have to attend the Judges Critique on Friday morning. However, it is nothing a person will a little common sense cannot handle. We have written judging criteria (see section to follow), plus most of the Society's cartographers have a pretty-fair idea of what they like about cave maps.

The Bottom Line: I need judges for the Cartography Salon, and I need judges from the midwest and west. **Please volunteer to judge this Salon!!!!**

My vital information is: George Dasher, 5096 Washington Street West, Apartment #101, Cross Lanes, West Virginia 25313, 304-776-8048 home, 304-558-2108 work.

THE NSS' CARTOGRAPHY SALON ORGANIZATION AND JUDGING CRITERIA

by the SACS Cartography Salon Committee[1]

[1]The SACS Cartography Salon Committee was comprised of George Dasher, Bob Gulden, Tom Kaye, Doug Roberson, George Veni, and Carol Vesely.

The following is an explanation of how the NSS' Cartography Salon works, and the criteria by which the maps are judged. The intent is to provide uniform standards by which the maps can be fairly judged, and to aid cartographers in developing better cave maps.

The Cartography Salon is held each year at the National Speleological Society's annual Convention. Prior to the Convention a Salon announcement is placed in the NSS News. Maps can then be mailed to the Salon Chairperson, or they can be hand-carried to the Convention. In addition, maps can also be posted at the Salon solely for display. These maps must be indicated as such.

Prior to (or at the start of) the Convention, the Salon Chairperson will select three judges from different parts of the country to judge the submitted maps. These judges—and the Salon Chairperson may be one of the three—will be experienced cave map cartographers and will not have maps entered in the Salon that year.

The judges have the discretion to divide the maps into three classes determined by the length of the caves. The classes may be modified or deleted entirely at the judges' discretion, based on the number of maps and their cave lengths. If warranted by enough or unusual entries, the judges may create special classes such as First-Time Cartographer, Color Usage, Computer Cartography, Complex Representations, Topo Overlays, etc.

The judges first look for certain mandatory features, without which a map will not be considered for an award. Second, the judges will look at various quality factors and assign appropriate point values to each factor. All maps are assumed to begin with ten points for each factor. If less than ten points are given for an item, the judge will provide the reason for the deduction in the "Comments" portion of the judging form.

Following the first round of judging, where the judges each will work individually, the point totals will be tallied for all the maps by combining the three judges' scores. A maximum of 180 points is possible, plus 90 perk points for a total of 270 points. All maps scoring more than 200 points (a figure the judges may raise or lower based on the year's entries) will receive at least an Honorable Mention (Green Ribbon). From the Honorable Mentions picked, the judges will confer and select the maps which

will receive a Merit Award (Blue Ribbon).

Finally, the judges will confer and select (from among the Merit Awards) the Salon's overall Medal Winner. This Medal winner will be selected independent of the point totals. In addition, and if the judges so desire, more than one Medal Award may be given. On occasion, no Medal Awards are given.

After the awards are posted and the awards presented on the evening of the Slide Salon, a Cartography Salon workshop and discussion will be held at 10 am on the Friday of Convention. The purpose of this workshop is not to glorify the so-called best map, but to provide a forum for discussion and learning from which all cave cartographers may benefit.

All critique forms will be returned to those cartographers present at the workshop. Those critique forms not picked up will be mailed to the individual cartographers by the Salon Chairperson. All maps not picked up at Convention are donated to the NSS Library. Maps can be picked up by a third party provided the cartographer has informed the Salon Chairperson *in writing* that this is the cartographer's wishes. Maps will be returned by mail, provided the cartographer has given or mailed the Salon Chairperson the required postage before the end of the Convention.

No Cartography Salon entry can be reproduced in any way without the cartographer's express and written permission.

MANDATORY REQUIREMENTS

Cave Name: *All* cave maps *must* have a name. This name should neither be too bold or too hard to locate. Abbreviations should *not* be used in the cave name.

Obvious Entrance or Connection with the Rest of the Cave: *All* cave maps *must* have an entrance or a connection with the rest of the cave. If this entrance or connection is not obvious on the map, then it should be marked and made obvious. If the map is of a section of the cave, then the connection of that section with the rest of the cave should be made obvious or marked. If the map is a quadrangle that connects to other quadrangles, then the places where a cave passage "runs off" the edge of the quadrangle are considered as the obvious connection and do not have to be further marked.

North Arrow: *All* cave maps *must* have a north arrow. This arrow should point to true north and, if the cartographer wishes, may include a subordinate magnetic north arrow. A magnetic north arrow by itself is not to be desired; however, if it is shown—either with or without a true north arrow—a date *must* be displayed with the magnetic north arrow. The north arrow must be long enough to be useable, and it is should not be so ornate that it is distracting. The most optimal north arrow includes a true north arrow, a magnetic north arrow, and the date of the magnetic north.

Bar Scale: *All* cave maps *must* have a bar scale, and this bar scale *must* include the linear units. The cave map may include two bar scales, one for meters and one for feet. Ratio scales, such as 1:600, or written scales, such as 1" = 50', are not desired because, if the map is reduced or expanded, then this scale will be inaccurate.

Vertical Control: *All* maps *must* have some kind of vertical control. Usually, in North America, this is shown as either a profile or as vertical symbols. Both methods can be utilized together. If a profile is used, it should include a vertical bar scale and it should be labeled as to type (*e.g.*, Projected Profile, Expanded Profile, or Idealized Profile). If vertical symbols are used, the map should be prominently noted as to whether the units are in meters or feet. These vertical symbols should include (as needed) cave elevations, pit depths, ceiling heights, and water depths. In addition, a zero datum should be labeled near the cave's dominant entrance.

Instead of the two more-popular North American methods of showing elevations, the cave map can utilize contours, either drawn inside or outside the cave passage, or it can use a large quantity of cross-sections and show the vertical on each cross-section..

Date: *All* maps *must* include a date. Features change, both inside and outside of the cave. This date should not be the date of the magnetic date and it should not be a cartographic date. Rather it should be the date of when the cave was surveyed.

Cartographer or Survey Group: *All* cave maps *must* include the cartographer or the survey group's name. Thus, if someone is interested in the cave—be they either a ge-

ologist, biologist, rescue expert, or another exploratory group—they can contact the cartographer or the original survey group. Simply put, the cave map is a scientific document, and it should have an author and a date.

QUALITY FACTORS

Balance and Layout: Does the cave map appear well balanced to the eye? Are some areas of the map blank while other areas are crowded? Did the cartographer make good use of their space?

Drafting Technical Quality: How technically correct is the drafting? Are the line widths consistent? Do the lines end and blend well, without blobs of ink? Are the symbols drawn well? Are the symbols correct? Are the outside walls of the cave obvious? Is there a True North Arrow? Is the magnetic north arrow out-of-date relative to when the cave was surveyed?

Are the line widths consistent? Do the lines end and blend well, without blobs of ink? Are the symbols drawn well? Are the symbols correct? Are the outside walls of the cave obvious? Is there a True North Arrow?

Detail Thoroughness: Is there too little detail? Is there too much detail? Does it extend into every passage? Is it consistent throughout the entire map? Is the detail easy to understand or is it confusing? Are the more mundane floor features shown? Is ceiling detail shown? Are conjectural ceilings or walls shown? Does the detail match the legend or the list of symbols utilized? Would a caver be able to use the map to navigate through the cave?

Vertical Control: How well is the vertical explained? Has the cartographer adequately dimentioned ceiling heights, pit depths, cave elevations, and water depths. Are there too few symbols to fully comprehend the vertical nature of the cave? *Horizontal caves are no exceptions!* Is the Profile View large enough and well centered enough to be understood? Is a vertical scale included with the Profile View? Does the Profile View include the entire cave? How well does the Profile View match the Plan View?

All cave maps which use vertical symbols and all maps of caves with more than one entrance should contain a zero datum. This datum should be a precise, labeled point and should be included on any profiles. Leader Lines to each vertical symbol's exact location in the passage may or may not be utilized.

Lettering: Is the lettering even and consistent? Is it too small or too big? Is it all evenly spaced, both horizontally and vertically? Is the lettering easy to read?

Visual Impact: Does the cartography make the map the cave seem interesting or boring? Overall, how 'good' does the map look?

ADDITIONAL FACTORS

Still other items can be used to enhance the cave map. These include, but are not limited to: Site Details, such as geology and surface features; Complex Representations, such as multi-level caves or cave passages; and Imaginative Innovations, which enhance the understanding up the cave. The use, or lack of use, or poor usage of these features should be considered when the judges assign point values in the various categories.

Cultural Location: This should be included on the *vast majority* of *all* cave maps. A few maps, however, because of the sensitive location of the cave, do not include the cultural location. Abbreviations should *not* be used in the cultural location.

Precise Geographic Locations: This is a hot potato. Some cartographers include them, others do not. It should be remembered, however, that the sole difference between sport and science is good documentation. If the cartographer has not allowed for the map user to locate the cave in the field, then the cave has not been documented in a way that allows the map user to fully utilize the map. What this means is that some sort of location should be provided. It is possible, rather than place a Precise Geographic Location on the map, to place a State Speleological Survey pointer (*e.g.*, a county cave number) on the map. This informs the map user that a State Speleological Survey exists and that this Survey will provide the user with the cave's location, provided the user can authenticate, to the Survey's leaders satisfaction, that the user shares their speleological values. If a Precise Geographic Location is placed on that cave map, and if lati-

CARTOGRAPHY SALON JUDGING FORM

CAVE NAME: **JUDGE:**

CLASSES: 0-500 m 500m - 1.6 km > 1.6 km First-Time Cart Class
0-1640 ft 1640 ft - 1 mile > 1 mile Special Class

MANDATORY REQUIREMENTS:

Cave Name:	Y or N
Obvious Entrance or connection with the remainder of the cave:	Y or N
North Arrow (True North preferred):	Y or N
Bar Scale with linear units:	Y or N
Vertical Control:	Y or N
Date (Survey date preferred):	Y or N
Cartographer or Survey Group named:	Y or N

QUALITY FACTORS	Points (0 to 10)	Comments
Balance and Layout		
Drafting Technical Quality		
Detail Thoroughness		
Vertical Control Quality		
Lettering		
Visual Impact		

PERKS:	Points (0 to 5)	Comments
Site Details: (Surface, Geology, etc.):		
Complex Representations:		
Innovations:		
Cross-Sections:		
Legend (or symbols credit):		
Other:		
Total Points =		

Other Comments — (please use the back of the form if necessary)

tudes and longitudes are used, then *which* latitude and longitude should be stated on the cave map (*e.g.*, are they north, south, west, or east?)

If UTM coordinates are used, then the UTM zone should be stated on the cave map. If state plane coordinates are used, then which state plane coordinate system should be stated. Elevations are always above some datum, such as mean sea level, or one of the North American datums (*e.g.*, the 1927 North American or 1983 North American), and these should be noted on the cave map. Abbreviations are not recommended in labeling the Precise Geographic Location.

Cross-Sections: These are *extremely* important and can often be used to easily determine the relationships of the various cave passages to each other. *When at all* possible, cross-sections should be included on the cave map. Detail inside the cross-sections should be shown and this detail should match the detail on the Plan and Profile Views. Cross-sections should only be omitted in the most complex, crowded maze caves, and only then after much soul-searching. Maps without cross-sections usually do not score well in the Cartography Salons.

Cross-sections can either be drawn next to the cave passage or away from the passage and then flagged with

letters or numbers. Cross-section lines should be arrowed to show the direction of view, they should show the horizontal and vertical relationships of adjacent passages. They should be consistent and should not be confused with passage lines or detail. They should not be squeezed in too close to the cave passage, nor should they be placed too far from that passage.

Type of Survey: This is very important. While most North American cave surveyors choose not to use survey grades, the map should be noted as to its type (*e.g.*, Topofil, Brunton and pace, or Suunto and fiberglass tape). In addition, loop closure accuracy may also be included.

Legend: As many cave map users are not cavers, it is often a *very* good idea to include a legend with the cave map. All non-standard cave symbols should be explained or formatted into a legend. If there is no legend, then it is good idea to note what set of cave symbols were used.

Length and Depth of the Cave: Most cave maps include the length and depth of the cave. Linear units *must* be included. The length of caves can be measured by one of two methods, surveyed or horizontal length. If no method of measure is noted on the map, it is then assumed that the length is the surveyed length, which is the preferred method. The depth of the cave is the difference between the elevations of the highest and lowest stations or points in the cave. These may or may not be at an entrance.

Passage endings: Passages should be shown as they end. Those passages which became too small for human passage, or are too high, or otherwise beyond the abilities or time of the surveyors, should be should shown as continuing. Passages which ended in the cave should be shown by the cartographer as endings, with no passage continuing. The words "Too Tight" or "Too Small" may or may not be used at the passage endings.

Personnel: It is always a nice touch to say who helped map the cave. Credit may be given to the project leaders, the people who reduced the data, and the cartographers. A thank you can also be given to the landowner or the appropriate government agency.

MISCELLANEOUS

Survey stations should *not* be shown on the final map, unless the map will be used for future geological, biological, or paleontological work.

State or Province Speleological Survey Code Numbers can be displayed on the map. These may be placed in the title block, or they may be displayed in an unobtrusive manner elsewhere on the map. The code number should not be designated in such a way that the map user must have an "inside" knowledge of the Survey to understand the code. If no cultural or geographic location is given on the map, then the State or Province Speleological Survey Code Number must be displayed in a prominent and obvious location on the cave map, as this code is now the only method by which the user can locate the cave in the field.

Unobtrusive notes on the geology, biology, history, or whatever can be included on the map if the cartographer so wishes.

An unobtrusive artistic drawing of the cave entrance or some feature in or around the cave can be included if the cartographer so wishes. These can enhance the map a great deal.

Borders: All maps should include a border. Some maps include double borders. Maps have won awards in the past without borders; however, this is the rare exception, not the rule.

Copyrights are common on many cave maps.

FROM THE CARTOGRAPHY SALON CHAIRMAN:

Some Thoughts on the 1996 Cartography Salon

by George Dasher

The 1996 Convention and the 1996 Cartography Salon are behind us. I would like to make a few comments on the subject. Again...

I gave a talk during the Thursday-morning SACS session regarding the Cartography Salon. In this talk, I raised three questions. These were discussed further during the SACS luncheon meeting, and they are the questions that I wish to address in this article.

Is the Cartography Salon providing adequate recognition to the Society's cartographers?

This is a question which has bothered me ever since I took over the chairmanship of the Salon. It has particularly bothered me given the long hours of tedium which go into surveying the cave, reducing the data, and then drawing the maps.

First, in days of olde, when Ernst and Karen Kastning ran the Salons Presentation on Thursday evening, they allowed each Salon Chairman to bring their winners up on the stage. Paul and Lee Stevens, the current Salons Chairpersons, have many more Salons to deal with and are in a bigger hurry to move to the Slide and Video Salons. They do not allow the ribbon winners to come up on to the stage. They do allow a presentation to the Medal winner. I have never liked this "new" policy, and would like to go back to the old. However, I guess I am going to take what I can get and be happy. Paul would even prefer that I do not allow the audience to applaud between the announcing of the individual winners. The Convention audience does not allow either Paul or I to have an opinion in this matter they applaud, especially for the hometown favorites.

Second, while the Cartography Salon has been very, very good to some people, others who are just as talented and who have entered some-incredibly good maps -have never won a Medal. I personally find this very discouraging. These non-Medal winners number perhaps no more than five, and my distress has been lessened this year by the fact that Bob Richards won this year's Salon with his map of Millerton Lake Cave System. Bob has entered the Salon --by his count - for fifteen years. While he has come close on many occasions, up until this year he had never won the Medal. Now, if those other four or five people who would just win a Medal or two, I could be happy. Trouble is, the young blood is coming up the line, and the young blood is ***damn*** good.

I don't have any answers for these two problems. I just wanted to bitch and make everyone aware of the situation. Perhaps someone out there has an answer. If not, I feel better now that I've bitched.

Is the Cartography Salon making a NSS-approved map, and is Salon moving this "approved map" too far in one direction?

This is another problem which deeply concerns me. The Salon ***has*** made a NSS-approved map, and this map is the map with the highly-detailed plan view with tons of vertical symbols and notes. It is a very good style of map, and one I usually personally employ; however, it is not the only speleo-cartographic choice in the basket. To my knowledge, other possibilities include maps with a clear but less-detailed plan view, and maps with a plan- and profile-view combination the last of which has far less or no vertical symbols. Also European maps and large-scale computer maps tend to get thumped in the Cartography Salon,although I feel some of these maps badly need the Cartography Salon critique.

My efforts to combat this "NSS-approved map" problem is to pick judges from different parts of the country who cave with different caving organizations. This did not happen this year, as three West Virginia-orientated cave cartographers volunteered to judge the Salon. In acknowledging this problem, I want to make all the Society's cartographers aware that there are other speleo-map styles. I hope all will experiment (at least a little) and I hope all will realize that the Cartography Salon's Medal pick is not the cartography-style-to-end-all style. There are other speleo-cartographic styles.

For instance: This year, at the end of the Convention, Doug Medville, came to me wanting to know why one of

There is a big-time something to be said for the simpler map, provided the basic requirements of a cave map are met.

his maps had not won at least a green ribbon. I explained that there were several things wrong with his map: No border, cross-sections which were pinched in close to the plan view, inconsistent lettering, and a lack of entrance names. Doug was not satisfied, but at least we didn't have to step outside and settle things man-to-man. Later, I had a discussion with Nancy Pistole one of the Merit Award-winning maps. This map had a highly-detailed plan view, and it was crammed full of notes, ceiling heights, passage detail, etc. You know the routine. It was a map which typically wins at the Cartography Salon.

But this winning map had been placed on the wall next to Doug's map. And, while looking at the winning map, I again started to examine Doug's map. There was a simplicity there, in Doug's map, that was missing in the highly-detailed map. The passages were more-simply drawn, and they were easy to follow. It made me reconsider this Cartography Salon-approved, highly-detailed map. There is a big-time something to be said for the simpler map, provided the basic requirements of a cave map are met.

And as for the entrance names, Doug told me that I don't understand lava caves, that they have a lot of entrances, and that it is not necessary to name them all. I disagree. I come from an area where we have 5000 little caves and FROs. People bitch that I name all these features. But, without the names, how else can we effectively communicate where we are in the cave, what cave we are in, or what entrance we are using? I think it is very important, when mapping a cave, to make sure that the map provides enough names so that persons using the map can effectively discuss the features (or their location) in the cave. And I think that all the entrances, no matter how many, should be named. Look at Mammoth Cave-its trillion and one entrances are all named.

The last thing: I desperately need help running the Cart Salon. In fact, I would like to resign from the job as chairman or, if I have to, big-time remodel the way the Salon is run.

This is the last item, and it may be the most-important item. The Cartography Salon is killing me. It is too damn much work for one person at Convention, mostly because I run the Salon year after year after year. I don't have any time to see anything of the Convention, and I don't have any time to visit any of the sites in the Convention area. The problem is made worst by the fact I do the Salon pretty-much every year. The regular Convention staff, on the other hand, abuse themselves for only one year. Then they are out of the picture.

I asked at this Convention that someone take over the job of Cartography Salon Chairman. There were no volunteers. No one wanted the work (I had scared everyone off) and people did not know how to do the job.

I have included, with this article, a separate list of the Cartography Salon Chairman responsibilities. Yes, it is a lot of work, and yes it can be brutal. However, if we spread this job out among the members of SACS, then I think the job will become manageable. Among the suggestions made at this year's SACS' meeting were that we could instigate a system where there is a principal and assistant Cartography Salon coordinator. The principal would run the Salon and the assistant would learn the system. The following year, the assistant person would become the principal person and a new assistant would take over. In other words, the workload would rotate.

I cannot attend the 1997 Missouri Convention. Either can many other members of SACS. Ernst Kastning has volunteered to maybe perhaps run the Cartography Salon in 1997. Hopefully, his "maybe perhaps" will become a firm yes. If this happens, then it is my intent at the 1998 Tennessee Convention to ask that a second person help me. This person will then run the Cartography Salon at the 1999 Convention. His (or her) helper will run the Salon at the 2000 Convention. I will continue to coordinate the entire Salon, but from a distance perhaps even from another state. The Chairman would handle, on the enclosed list of Cartography Salon responsibilities, Items 1 through 23, and Item 25. I would handle Item 24, the making of the Medal, if only to provide consistency in the design of the Medal.

This new policy will mean that the Cartography Salon will become a truly-volunteer Salon. We will need Convention Chairpersons, and we will need judges. So please volunteer. The Salon is a workload, but it is nothing someone with a little common sense cannot handle.

One thing I have neglected to mention is that I told my burn-out problem to Paul Stevens, the coordinator for all the NSS-sponsored Salons. He said that, if the Society does not wish to run the Cartography Salon, then the Salon will be eliminated. So: We need the Society's (*i.e.*, SACS) participation badly.

I know the Cartography Salon does have some problems (as do all the NSS Salons). I also feel that it does achieve its three stated objectives. These are: To allow the Society's cartographers to compare and critique their maps, to facilitate communication about cave cartography, and to provide recognition for the Society's cartographers. I would like to keep the Cart Salon, it provides a valuable service to the Society and it has resulted in a much better cave map. But - I need help running the Salon, and I am asking for that help with this article.

Other things in the dark...

On a final note, Bob Thrun took pictures of this year's Merit Award and Medal winners on Wednesday. He then developed, mounted, and pasted up the results. These pictures were shown during the Thursday night Salons Presentation, along with title slides prepared by Rosewell Jones and Bruce Bannerman. The end result was an ***exceptional*** Cartography Salon presentation, despite the fact I was up on the stage butchering the Spanish and Chinese pronunciations, and Bob and I both received many compliments on the presentation the following day.

It is my hope that Bob will continue to take his slides every year, and I would like to thank him in this article for taking the time and making the effort to make the 1996 Cartographic Salon presentation an excellent and exceptional presentation.

Last thing:

So far, only one judge has volunteered for next year. Any other takers? This is a ***most-serious*** request!

CARTOGRAPHY SALON RESPONSIBILITIES

1.) Interface with Paul Stevens, who is in charge of all the NSS BOG-sponsored Salons. Paul will take care of the stuff which goes in the NSS News, so you do not have to worry with this.

2.) Interface with the Convention staff ahead of time. Tell them that a display area about 150 feet in length and about 8 or so feet high is required. This area should be well lighted, in an area of the Convention that people can find, and air conditioned. Also, because of the long length of the judging, it may be required that the area be open 24 hours a day in the Tuesday-Wednesday time slot. It also works really great if you have someone of the Convention staff with which to interface. Make sure you know how the maps will be hung (tape, push pins, etc.)

3.) It should be stated in the Convention Guidebook that the Cartography Salon starts onMonday morning. It should most-definitely be said that the Cartography Salon Critique is at 10 am on Friday. It is also nice to say that the Salon ends at noon on Friday.

4.) Find three (sometimes four) judges. Optimally, this should be done before the Convention begins though this is often done at the Convention. The three judges should be from different parts of the country and from different caving organizations. Tell the judges in writing before the Convention that they are the judges. Mail Paul Stevens a list of the judges.

5.) Receive maps in the mail before Convention. Make a list of who has entered what maps. If the entrants want other people to pick up their maps at Convention, this should be stated clearly in writing.

6.) Copy about 150 of the Judging Forms. Also make sure you have enough ribbons for the Convention. The Cartography Salon ribbons are not identical to the other NSS Salon ribbons - they say "Cartography Salon."

7.) Be in the Cartography Salon area all day on Monday. Receive the maps as they come in, and hang them or make sure they are hung on the walls. Continue the list of who has entered what maps. Make sure that no contestants give maps to the Convention Staff, as these maps are often stuck in an out-of-the-way corner until the end of Convention -then the panic begins.

8.) The Convention should make a computer available. Make sure this will happen and, on that computer, type in all the entries and entrants to make sure the spellings are correct. This is particularly important for the foreign entries. The available computer should not be Norma Peacock's daily-rag computer or the registration computer.

These computers have other priorities and you will get kicked off. Having a computer available is a very serious help at Convention. Most likely no more than two or three hours of computer time is required.

9.) Make sure that the NSS Book Store knows you are going to be donating a big bunch of maps to the NSS. Make sure they know that this donation will take place on Friday afternoon - when they already have one foot in their car.

10.) Make sure the judges get their backsides judging. The judges should judge the maps at least once individually. They should then participate in a final judging round as a group. Remind the judges that they have the absolute final say as to the number and type of categories. Also remind them that most judges simply lump the maps into one big category and judge them in that manner. Judging is a lot of work and the lumping makes things a lot easier.

11.) Don't donate blood. You don't have the time and you need the blood.

12.) Make sure the maps are still hanging on the wall each morning. If not, tape or tack them back up.

13.) Oversee the judges' group judging and make sure they don't do something really dumb. Remind them, if necessary, that the Cartography Salon has on occasion given no medals (1982) and two medals (1981 and 1992). Also, it is not necessary to give a set number of ribbons.

14.) Hang the award - get the judges to help. The judging must be finished before Thursday morning at about 9 am. Usually it finishes at about 6 pm on Tuesday.

15.) Give Rosewell Jones a list of who won what. This list should be in the order you will be presenting the winners, and it should include a list of the judges with their caving organizations. Also, if Bob Thrun so desires (and he has recently so desired) he will make slides of the winning maps. Coordinate with him on this and make the Bannerman-Jones Team receives Bob's slides. Also make sure Bob's name is added to the credits of those who helped with the Salon Night presentation.

16.) Present the winners at the Salon night. Try to talk quickly to keep the evening moving; try to talk slowly to give the Cartography Salon winners their proper recognition. Pronounce all words correctly. The audience will give you no choice on your speed of talking - they will applaud between winners, especially home-town winners.

17.) Attend the Cartography Salon critique on Friday morning and make sure that it goes well.

18.) Take down the maps. Allow those entrants who want their maps to take them, destroy those maps where the entrants wanted them destroyed (it happens!), and roll up the remainder of the maps for donation to the NSS. Use the map rolls in which the maps arrived. Make sure ALL the critique sheets go home with the entrants who are present-this saves you work on the long run.

19.) Donate the rolled maps to the NSS at the NSS Book Store.

20.) Go home, get a good night's sleep, and then type up exact records of what maps were entered and what maps won.

21.) Mail all the critiques and ribbons to those entrants who did not attend the Convention - and to those entrants who did not pick up their critiques at the Convention.

22.) Mail a thank you letter to all the judges.

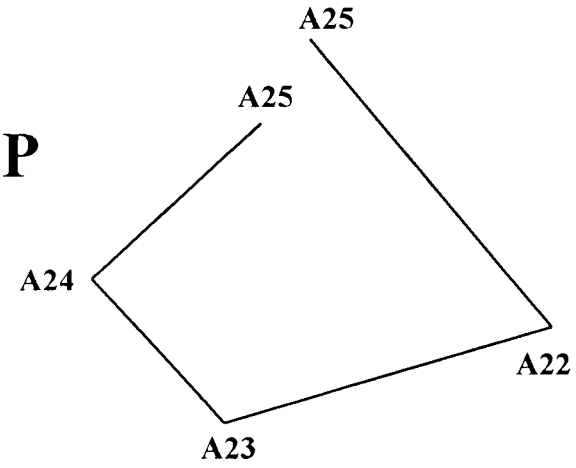
23.) Type up a short report for the NSS News and The *Compass and Tape*. This report should include a synopsis of what happened at the Salon, and it should include only the winners. Mail this report to both magazines.

24.) Have a Medal Award made. Mail the Medal Award to the winner. Make sure the Medal winner received the Medal - a phone call is required here.

25.) Write up a report and figure up your expenses. Mail both to Paul Stevens. A check should come from the NSS within about a month of your submittal. Make sure Bob Thrun is paid for his slide film.

Chairpersons would handle, on the enclosed list of Cartography Salon responsibilities, Items 1 through 23, and Item 25. I would handle Item 24, the making of the Medal, if only to provide consistency in the design of the Medal.

THE PROBLEM WITH LEAST SQUARES LOOP CLOSURES



by Larry Fish

Most cave surveyors assume that the best way to close a loop in a cave is to use an algorithm based on the "Least Squares/Simultaneous Equations" (LSSE) method. This is probably due to the fact that LSSE itself is based on sound mathematical and statistical methods and is widely used by land surveyors. It also partly due to the fact that it has the aura of being a complicated, sophisticated and esoteric algorithm. This idea is so pervasive, that no one ever examines the possibility that LSSE might have flaws when it comes to cave surveying. This is exactly why I am writing this article. I think that LSSE, although mathematically sound, is not the best method of CLOSING cave survey loops. I think that it is a very good tool being used for the wrong job.

Here is my argument in a nutshell: LSSE is a very powerful mathematical and statistical method with many uses. But, in terms of CLOSING cave loops, Least Squares/Simultaneous Equations is best suited for dealing with random errors that are evenly distributed across the whole cave. However, evenly distributed, random errors are not the biggest problem in cave surveying. Localized blunders are the biggest problem in cave surveying and LSSE does not handle blundered loops very well.

Let me give you some background. There are three kinds of errors that occur in cave surveys: random errors, systematic errors and blunders.

RANDOM ERRORS

Random errors are small errors that occur during the process of surveying. They result from the fact that it is impossible to get absolutely perfect measurements each time you read a compass, inclinometer or tape measure. For example, your hand may shake as you read the compass, the air temperature may affect the length of the tape, and you may not aim the inclinometer precisely at the target.

There are literally hundreds of small variations that can affect your measurements. In addition, the instruments themselves have limitations as to how accurately they can be read. For example, most compasses don't have markings smaller than .5 degrees. This means that the actual angle may be 123.3 degrees, but it gets written down as 123.5.

All these effects add up to small random variations in the measurement of survey shots. Around a loop, these random errors accumulate and cause a loop closure error. Even though these errors are random, the accumulated error tends to follow a pattern. The pattern is called a "normal" distribution and it has the familiar "bell" shaped curve. As a result of this pattern, we can predict how much error there should be in a survey loop if the errors are the result of small random differences in the measurements. If a survey exceeds the predicted level of error, then the survey must have another, more profound kind of error.

SYSTEMATIC ERRORS

Systematic errors occur when something causes a constant and consistent error throughout the survey. Some examples of systematic errors are: the tape has stretched and is two cm too long, the compass has a five degree clockwise bias, or the surveyor read percent grade instead of degrees from the inclinometer. The key to systematic errors is that they are constant and consistent. If you understand what has caused the systematic error, you can remove it from each shot with simple math. For example, if the compass has a five degree clockwise bias, you sim-

ply subtract five degrees from each azimuth. Systematic errors are usually dealt with by calibrating instruments on a survey course, or by adding correction factors to the survey data.

BLUNDERS

Blunders are fundamental errors in the surveying process. Blunders are usually caused by human errors. Blunders a mistakes in the processing of taking, reading, transcribing or recording survey data. Some typical blunders are: reading the wrong end of the compass needle, transposing digits in the survey book, or tying a survey into the wrong station.

Blunders are the most difficult errors to deal with because they are inconsistent. For example, if you read the wrong end of the compass needle, the reading will be off by 180 degrees. If you transpose the ones and tens digits on tape measure, the reading could be off by anything from 0 to 90 feet.

HOW COMMON ARE BLUNDERS?

Blunders are extremely common in cave surveys. For example, in Lechuguilla Cave, 32 percent of the loops have blunders in them. In Wind Cave, 25 percent of the loops have blunders in them. (These are a conservative figure, because it is impossible to tell whether each loop has only one blunder in it.) By extrapolating, I have concluded that in surveys like these, there is at least one blunder in every 40 shots.

Paul Burger did a careful study of blunders during of a recent resurvey of the commerical section of Cave of the Winds (Colorado). He found that one in 20 shots had a blunder. These figures are impressive, because these surveys were very carefully done in relatively easy, well lit, concrete-trailed walking passages. In more difficult caves, the blunder rate goes up rapidly. For example, in Groaning Cave (Colorado), a cold, wet, alpine cave whose entrance elevation is at 10,000 feet (3050 meters), 50 percent of the loops are blundered. All of this means that any survey with more than a few hundred shots, must have several blunders in it.

If you have some good loops and some bad loops, least squares will take the errors and distribute them more or less evenly across both the good and bad loops. This has the effect of contaminating the good loops with errors from the bad loops.

LEAST SQUARES AND RANDOM ERROR

Let's start by looking at some of the characteristics of random errors. First of all, random errors, by their very nature, tend to be small. For example, you wouldn't expect to find random errors much more greater than an inch, a tenth of a meter or a degree in each shot.

The second important characteristic of random errors is that, over the long run, they have a tendency cancel each other out. This is easy to see. For example, if your errors are truly random, sometimes you may read the compass slightly positive. Other times you may read the compass slightly negative. The net effect is the positives and negatives cancel out. Taken together, these two characteristics mean that the total error in loops with only random errors is relatively small.

The LSSE method is designed specifically to deal with random errors. It is in fact the best method of dealing with random errors. But if you have a survey that has ONLY random errors, it makes very little difference which algorithm you use! This is because the errors are so small that even a relatively simple algorithm will work as well as LSSE. In other words, there is no particular advantage to using LSSE if you have random errors.

Let me give you a real world example. I extracted a 1000 foot loop from Groaning Cave that had a relatively random looking error pattern. It was 64 stations long and had a 9 foot closure error. Analyzing the loop gives a standard deviation of about 1.0 (given a two degree variability in azimuth and inclination and tenth of a foot variability in length.) If you are not familiar with the concept, a standard deviation of 1.0 means that the error is about what you would expect if the errors are random. I closed this loop using both COMPASS and SMAPS and compared the result. SMAPS uses LSSE and COMPASS does not, so it a good way to analyze the difference. The maximum difference between the two loops was less than a

tenth of a foot. I also did another experiment using a 2000-foot connected network of three loops of similar quality. The differences between SMAPS and COMPASS were less than three tenths of a foot.

LEAST SQUARES AND BLUNDERS

Now let us look at blunders. One of the big selling points of LSSE is that it closes all the loops in the cave simultaneously. This is exactly what you want when you have evenly distributed random errors, but with blunders it causes problems.

Let's look at this in detail. LSSE handles blunders in exactly the same way it handles errors. That is, it distributes them evenly across the cave. This would be fine if all the loops in the cave were either all good (with only random errors) or all bad (with only blunders), but that is rarely the case.

In the real world, most cave surveys have a mixture of both good and bad loops. If you have some good loops and some bad loops, least squares will take the errors and distribute them more or less evenly across both the good and bad loops. This has the effect of contaminating the good loops with errors from the bad loops.

One way to deal with this problem is to design the LSSE algorithm so that you have independent control over how the program adjusts each shot. This is usually called something like the "confidence factor" and most LSSE implementations have this feature. Basically, you adjust this "confidence factor" to compensate for good and bad shots, surveys and loops. In other words, you give a higher confidence factor to the shots in the good loops and a lower confidence factor to the shots in the bad loops.

This almost works, except that you have a new problem: there will always be some shots that are shared by both good and bad loops! This creates a logical contradiction: you can't have a shot that is both good and bad at the same time. You could deal with this by setting the confidence factor for shared shots to a value halfway between a good and bad confidence factor. But, once again this would degrade the good loops by allowing a bad loop to alter shots in the good loop. The process is even more complicated if you have lots of loops which share common shots.

The way you close loops has a profound effect on the accuracy of cave statistics. This is true anytime you have two parallel loops connecting parts of a cave.

LOOP CLOSURE AND CAVE STATISTICS

The way you close loops has a profound effect on the accuracy of cave statistics. This is true anytime you have two parallel loops connecting parts of a cave. For exmple, let's say that you are trying to determine the depth of a cave and there are two loops that connect to the deep point. One loop closes very well, and the other loop has a large blunder in it. Obviously, to get the most accurate measurement of the cave's depth, you want to ignore all the shots in the blundered loop and only use the shots in the good loop. If you use LSSE, the errors from the blundered loop will contaminate the good loop degrading the accuracy of the depth measurement.

SHOULD BLUNDERED LOOPS EVEN BE CLOSED?

Some people say, that you shouldn't even try to close blundered surveys, and there is a good argument to be made for simply discarding all blundered loops and immediately redoing the survey. In fact, some survey programs refuse to close any loop that has a large error and appears to be blundered.

I think that blundered loops are exactly the reason you need loop closure. If a loop is good, it doesn't need much help from a loop closing algorithm. But if the loop is bad, it needs lots of help just to make the data even minimally useful.

The problem with discarding blundered surveys is that it is difficult to get people to go back and resurvey caves. I have been trying for more than 10 years to get people to go back and resurvey the front part of Groaning Cave. Look at Lechuguilla. There are 245 loops with errors greater than three standard deviations. Wind Cave has 132 loops with errors greater than three standard deviations.

Chances are very slim that you are going to get people back in these caves to fix all the loops. For one thing, cavers aren't very excited about resurveying known passages. For another, the old survey stations are often lost, unreadable or moved, making the resurvey process much more complicated than just remeasuring the shots in an individual loop. At the very least, it can take years to correct bad loops.

In the mean time, people want maps and you can't draw very good maps from unclosed plots. If loops are left unclosed, all the errors in the loop pile up at the closing station. This creates plots with large offsets in the middle of passages or junctions where the angles are all wrong. When you try to draw a finished map around an unclosed loop, you have to nudge the lines around to make everything look right. In effect, you are closing the loops by hand. Obviously, in this day and age, when everyone has a computer, you shouldn't have to close loops by hand; even when there are large blunders. In fact, I think that the one of the most important purposes of loop closure in cave surveying is to make drawing maps easier!

THE BEST APPROACH TO LOOP CLOSURE

If least squares is not the best approach to loop closures in caves, what is? I think, the best approach has to accomplish three things:

1. It must be able to deal with blunders.
2. It must be able to deal with random errors.
3. It must be able to deal with a mixture of both.

The most important thing is that the data in the good loops must be protected from the errors in bad loops. This implies that good loops must be closed separately from bad loops. Thus, the first step is to find the best and worst loops. This means sorting all of the loops in the cave according to quality. Basically, you want to locate all the individual loops, calculate standard deviations for each loop and then sort them into a list ordered from best to worst.

The next step is to close the loops in a way that segregates the good loops from the bad loops. You could use the LSSE method on all the good loops and then on all the bad loops as separate steps. This leads to a number of thorny problems like: what exactly is the threshold between good and bad, and what do you do with good loops that are separated from each other by bad loops?

The easiest way to close the loops separately is to close the loops one-at-a-time taking the best loops first. Once a loop is closed, the shots in the loop must be protected or locked to prevent them from being adjusted along with subsequent loops. This technique has several advantages. First, because it doesn't require simultaneous equations it is much faster. Second, it preserves the accuracy of the best surveys, while at the same time isolating the errors and blunders to the worst surveys where they belong.

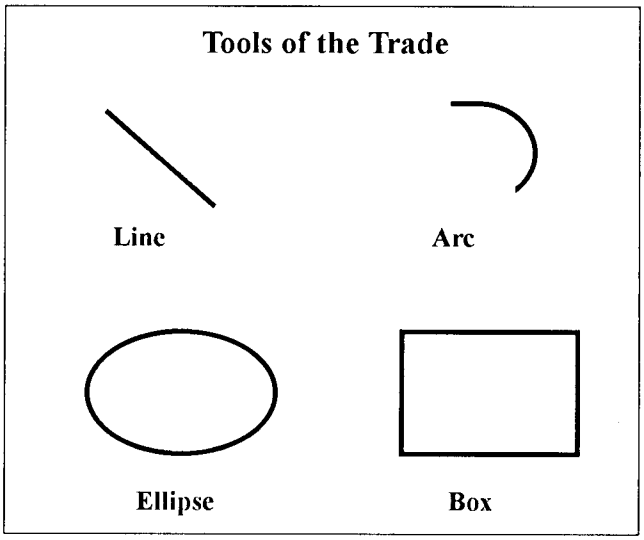
ERROR ANALYSIS AND BLUNDER DETECTION

In addition to closing loops, a survey program should have the ability to detect and locate blunders. Detecting the existence of a blunder in a loop is fairly simple. You begin by making an estimate of the accuracy and variance of the survey instruments. From this, you can make a prediction of the size of error for each individual loop, if the errors are random. To do this, you simply apply the variance of each instrument to each shot in the loop and calculate the standard deviation for the whole loop. Loops whose errors exceed two standard deviations have a greater than 95% chance of being blundered.

Locating the actual individual blundered measurement is more difficult, but, at least in some instances, is possible. The COMPASS blunder location process is described in detail in another article (*Compass & Tape, Vol 12, No. 4*), but the basic process is simple. The program adjusts each measurement in the loop, trying to reduce the error as a much as possible. The adjustments that are most successful are the most likely candidate for blunders.

This generally results in several good candidates for the blundered measurement. To narrow the choices further, the program checks to see if the blunder candidates are a part of other loops. If a measurement is truly blundered, then it should show up as a blunder in every loop in which it is a part i.e., if a shot is a part of five different loops, but appears to be blundered in only one of them it is very unlikely that it is the blunder.

Computer Graphics for Cave Maps



by David Parr

For over 23 years, I have been an illustrator. Within that time I've seen many new and innovative devices come and go - some very helpful and some not. I can remember hesitating before buying my first set of rapidograph pens. Were they great? Certainly not, but they were a vast improvement over sticking the pens in the ink well, and eventually they got to be quite good.

In the mid-eighties the company I work for finally decided to obtain for me a computer to do my technical illustrations. I was not happy with the idea because at that point, the computer generated illustrations were very cold with no personality. Finally in 1991, the equipment arrived. The tech heads starting running wires and pushing buttons and before long, there was a big one-eyed monster sitting on my desk starting at me.

What I had received was Interleaf 5.0 software on a Digital workstation. Interleaf is a high-end publishing system with a graphics package included. The salesman told everyone I could do my illustrations better and quicker (I was not convinced.)

Before I go any further I should point out that this was the first computer I'd ever laid my mud-stained fingers on. After a few false starts and many mistakes, I started producing illustrations. They weren't by any means great works of art but I was starting to make the computer do what I wanted it to do. I actually looked forward to coming to work each and every day to work out problems. Another thing I should mention is that after I started working with the computer all my ink pens dried up and were never used again.

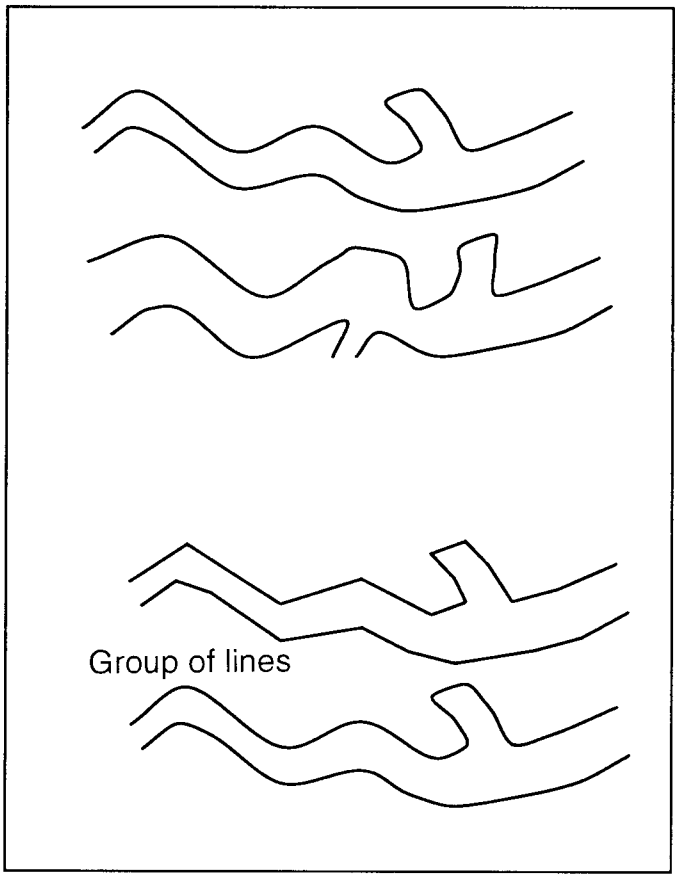
Doing graphics on a computer is really not much different than doing them on the drawing board. The skills, the tools, and the final output, are the same; you just take a different road to get there

TOOLS OF THE TRADE

Doing graphics on a computer is really not much different than doing them on the drawing board. The skills, the tools, and the final output, are the same; you just take a different road to get there. If one thinks about it, a drawing is basically a group of lines and arcs of different thickness. The trick is putting them in the right places. Most graphic programs worth anything give you a menu or pop-up with a line, arc, ellipse, and box (ellipses being closed arcs and boxes are groups of four lines). These are your basic drawing tools. Once these tools are selected, they can be sized, rotated, sheared, reflected (vertically or horizontally), edge changed (by weight, shade, color and pattern) and given a name. So as you can see, there are lots of possibilities.

THE B-SPLINE CURVE

A very useful function I found for drawing cave walls is the B-spline curve. The B-spline takes a group of vector lines and converts them into one continuous curve. One can either draw in this mode or convert a group of lines to it. The B-spline is also fully editable meaning



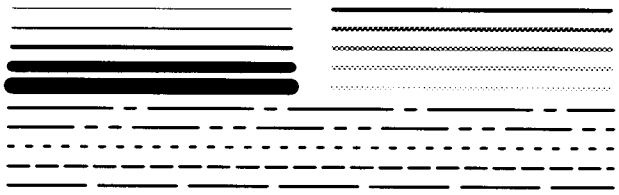
each line segment can be moved, sized or rotated to make it look more like the in-cave sketch or to later add that overlooked lead.

The B-spline is not without its faults. I've found that if the B-spline group contain too many line segments, printing problems can occur. The best bet is to use several B-spline groups instead of one large one.

Almost all drawing programs allow you to draw freehand with the mouse. The better ones average your movements and convert them to a B-spline curve to create smooth and flowing lines. Without this feature your freehand drawing will probably look like it was done by a nervous 3-year old.

LINE WEIGHTS, STYLES, AND SHADES

Any cartographer worth their weight in guano knows that line weights play an important part in the visual impact of a map. Computers give you many choices in the weights, styles, shades (anything from invisible to black



and white) and colors. Unlike maps done with ink pens, line properties can be changed in a matter of seconds. Below are some of the choices one has.

Also, when a line is created on a computer and assigned a thickness it will always stay that thickness whether it is enlarged or reduced in the computer.

OBJECTS WITH FILLS AND PATTERNS

Sometimes one might feel a little ambitious and want to put some fills or patterns on a map to give it more impact. Fills can only be put in objects that are linked together. You can also create or alter existing patterns and fills to your own liking. Like the B-spline curve, too many elements in the group may lead to printing problems. Below are a few examples

GROUPS, LEVELS AND NAMED GRAPHIC OBJECTS

When a drawing is created in a computer one needs to manage the drawing by grouping certain objects together. For example passage walls might be one group, cross sections another, and the AB survey another. This logical

grouping of objects allows one to make changes in line weights and all other common properties the objects share.

Objects can also be put at different levels or stacked on top of each other for shading, passages overlapping, or cross sections/profiles with rock-type patterns behind them.

Some programs even allow you to assign a name to a group of objects or any object in that group. For example I can click on the AB survey with my mouse and the computer tells me the survey starts at A-37 and goes to AB-78. If I go inside that group I can choose AB-67 and it tells me the station number, the elevation or any other information I might want to key in it.

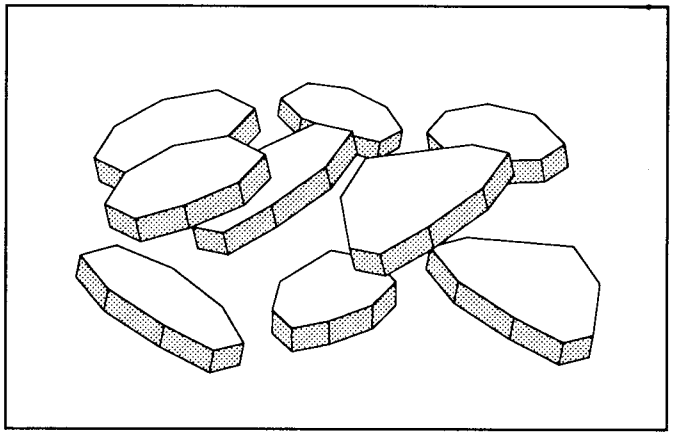
BUILDING A LIBRARY OF CAVE SYMBOLS

One of the greatest features of computer graphics is to be able to create a library of frequently used symbols. A breakdown block can be created one time and stored in the library. Then it is simply a matter of cutting or copying the object and pasting it into your cave map. The breakdown block can then be altered to your liking in a matter of seconds. My library contains ceiling heights, slopes, drop-offs, formations, breakdown blocks and north arrows.

GRAVITY AND GRIDS

To make sure lines and arcs are tightly joined together, computers use gravity. The amount of gravity can be adjusted by keying in to the computer the size of the radium where you want the points to join, at the tips of the lines, or corners of the objects. Gravity is essential for creating objects with fills. Gravity can also be turned off when not needed.

Grids can be useful in cave maps for estimating non-measured distance in caves, such as the left, right, up and down distance used for measuring walls, ceilings and floors. The spacing between the grids can be adjusted to any size. For example, you might set the major grid, for 10 feet. Then 2-foot spacing for the minor grid can be used. The grid can also be used for lining up and formatting graphic objects and lettering.



SETTING THE SCALE AND ZOOMING IN

In order to keep a cave map from being too large one must choose a realistic scale with which to draw the cave. After the scale is set, lines and objects can be dimensioned and measured. One can also zoom in and out of chosen areas for a closer look or to draw fine details.

FONTS CAN BE FUN

One of the most tedious parts of creating maps on the drawing board is the lettering. It is very time consuming and once it is done there is always that misspelled word, wrong placement or use of the incorrect font size. With computers it couldn't be any easier to choose the font style and size - point to the desired location and type. Don't like where its at then grab it and move it. Don't like the style or size, take a couple of seconds and change it. Run it through the spelling check. If you find a mistake, choose and replace.

THE BIG ONES

There was a time when I believed that I could put a 15-mile long cave in one document. Everything went fine for a while and then with each new element I added, the document got harder and harder to open. It soon got to the point where I was lucky if it opened at all. In order to make the cave map more manageable I divided it into quadrants of 900 x 1100 feet that would fit on a 8-1/2 by 11 inch sheet of paper. This worked out quite well. To see the whole map, I just tape the sheets together and mount them to a large 4 x 12 foot piece of cardboard. For in-cave use I just take copies of the quadrants that I need into the cave for locating survey stations and possible leads

THE LEARNING CURVE

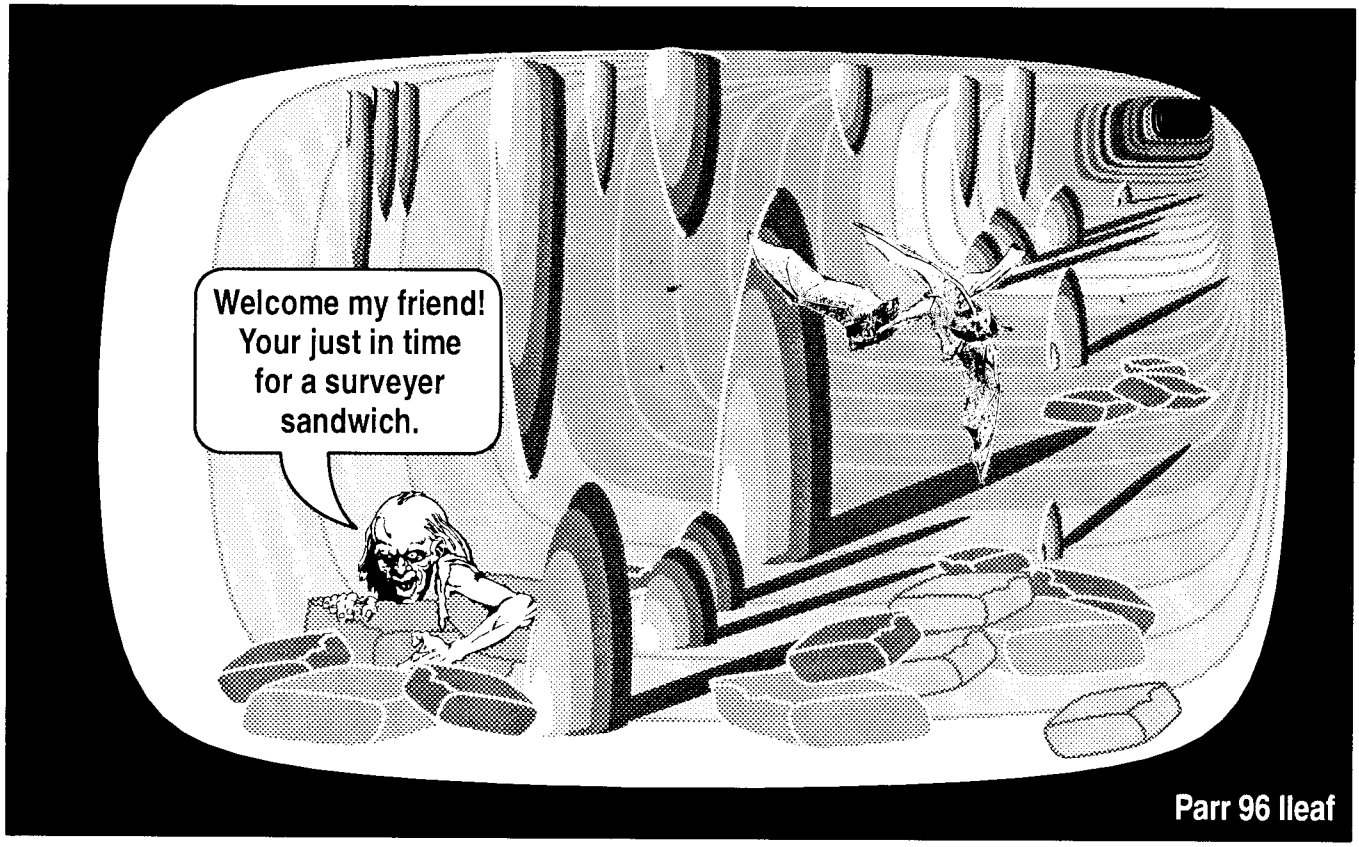
Learning to draw on a computer can be a very humbling experience. It can be very frustrating when you know what you want to do but can't find that simple command that takes you there. The trick is to be patient, take small bites and never give up.

There is no doubt in my mind that any skilled cartographer with time, can produce better cave maps in less time with a quality computer program. I figured that my productivity has increased at least 5-fold from what it was on the drawing board and after several months of heavy use I was told that my computer illustrations looked better than my inked ones.

THE TIP OF THE ICEBERG

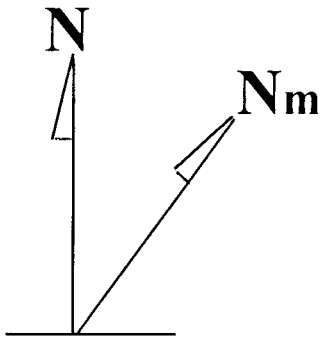
This outline only touches on the possibilities and features of computer graphics. There are books several inches thick on graphic programs and they still only cover certain aspects of the program. My preferred program is Interleaf but after some training on Micro Station, AutoCad, CorelDRAW and EMS, I believe I could create cave maps on any of them given time. The thing to do is to get a good program (you get what you pay for) and put lots of quality time into it.

At this point and time, the programs are a little too expensive for most cavers to afford. But as time goes by and prices come down, almost every cave cartographer will be producing maps on a computer and loving every minute of it.



No Excuse for Not Knowing Magnetic Declination

by Bert Ashbrook



Better cave maps show the declination between magnetic and true north. At one time I used the declination from 7.5-minute topographic maps, but because declination changes significantly over time, this source is often out-of-date. I've also heard of people using aviation sectional charts, which have current isogonic lines on them, but which are expensive ($7.00 each) and not easy to find.

A couple of years ago, I found a better way. You can call Jill Caldwell at the USGS National Geomagnetic Information Center in Denver, Colorado (303-273-8486). Tell her the latitude, longitude (to the nearest minute is fine), and the date of your survey, and she'll run the USGS computer to tell you the declination and it's rate of change. Jill will also tell you that figures are considered accurate to within a half degree, although she gives them to the tenth of the minute. Significant digits be damned, it's still better than you'll do without using astronomy.

Cheap bastard that I am, I call at nights or on weekends and leave a message. USGS then uses your tax dollars to call me back during the day when the rates are higher. You can also dial up the USGS computer and run the program yourself, although I've never done it.

The computer-generated data cannot be accurately projected into the future, but it does go back a few decades. This is important occasionally when mapping a big cave which has been surveyed over decades. It can also have other unusual uses.

I once read a historical (18th century) description of a local cave which said that the cave trended southwest. I mapped the cave, and it actually goes south. I was puzzled until I had a stroke of genius: the historical description must have referred to magnetic direction, and the magnetic declination must have changed a lot in over 220 years!. Jill didn't have computer data back that far, but she sent me a series of charts of declination vs. time vs location. Interpolation of the charts proved beyond a doubt that the magnetic declination in Pennsylvania 220 years ago was about the same as today, and that the old description was just plain wrong. I guess what seems like a stroke of genius is sometimes just a stroke.

Anyway, there is no good excuse for not including magnetic declination on your maps. Because declination changes over time, this is important information to incude on cave maps. All it takes is a phone call.

Cartographer's Corner

by Pat Kambesis

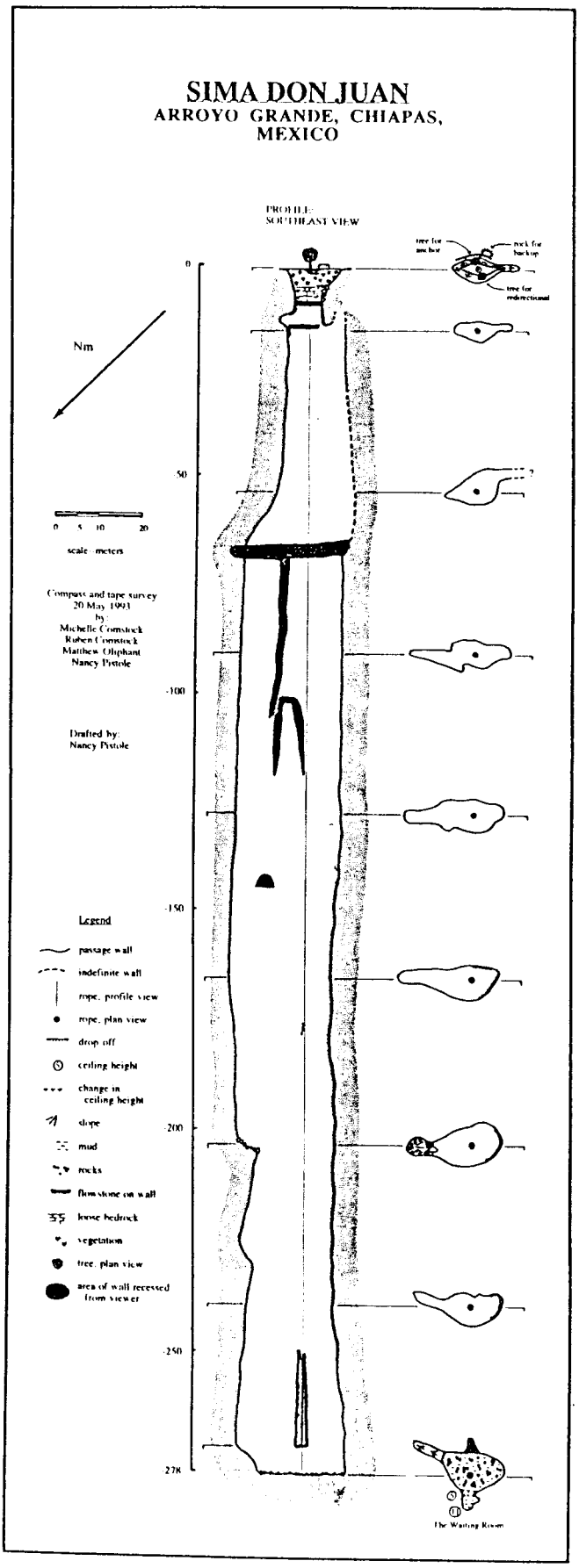
STACKED PLAN VIEWS

Caves with a predominantly vertical component, irregularly shaped shafts, and pits with multiple balconies, undercuts, ledges and formations make it difficult to show a clear and easy-to-understand plan view on the map. Attempting to show all of this vertical complexity in the plan view makes an impressively complicated rendering that at times is near impossible to decipher. Leaving out all of the offending complexity makes for a more readable map that is deceptively simplified (especially for the party who plans to use the map for traversing the cave). Omitting the plan view completely and featuring only profile views is an acceptable solution in some cases but requires that the map user put in some hard study of all of the profiles in order to really understand the nature of the cave. The best solution that I have seen to this cartographic problem is the use of stacked plan views with leader lines to the profile. .

The map of Sima Don Juan (by Nancy Pistole) is a good example of use of this technique. Rather than portraying this 278-meter deep shaft as having a uniform, gun-barrel configuration, Nancy chose to use a series of nine plan views which show the irregular nature of the shaft. By using this method she didn't have to sacrifice surface detail at the entrance nor floor detail at the bottom.

Another excellent example of stacked plans can be seen on Sotano de Los Novios (by Barb Luke), the map featured on the front cover of this issue of *Compass and Tape*. This 134-meter deep pit is slightly offset and has a small horizontal component. The stacked plans show the very irregular nature of the offset section and allow inclusion of cross sections on the horizontal trend.

And finally, check out Cueva de Abril (118-meters deep) on page 25 of this issue. Peter Sprouse took a po-



tentially confusing representation (see Entrance Plan and Lower level outlines on top right of map) and made things crystal clear with the use of six stacked plan views.

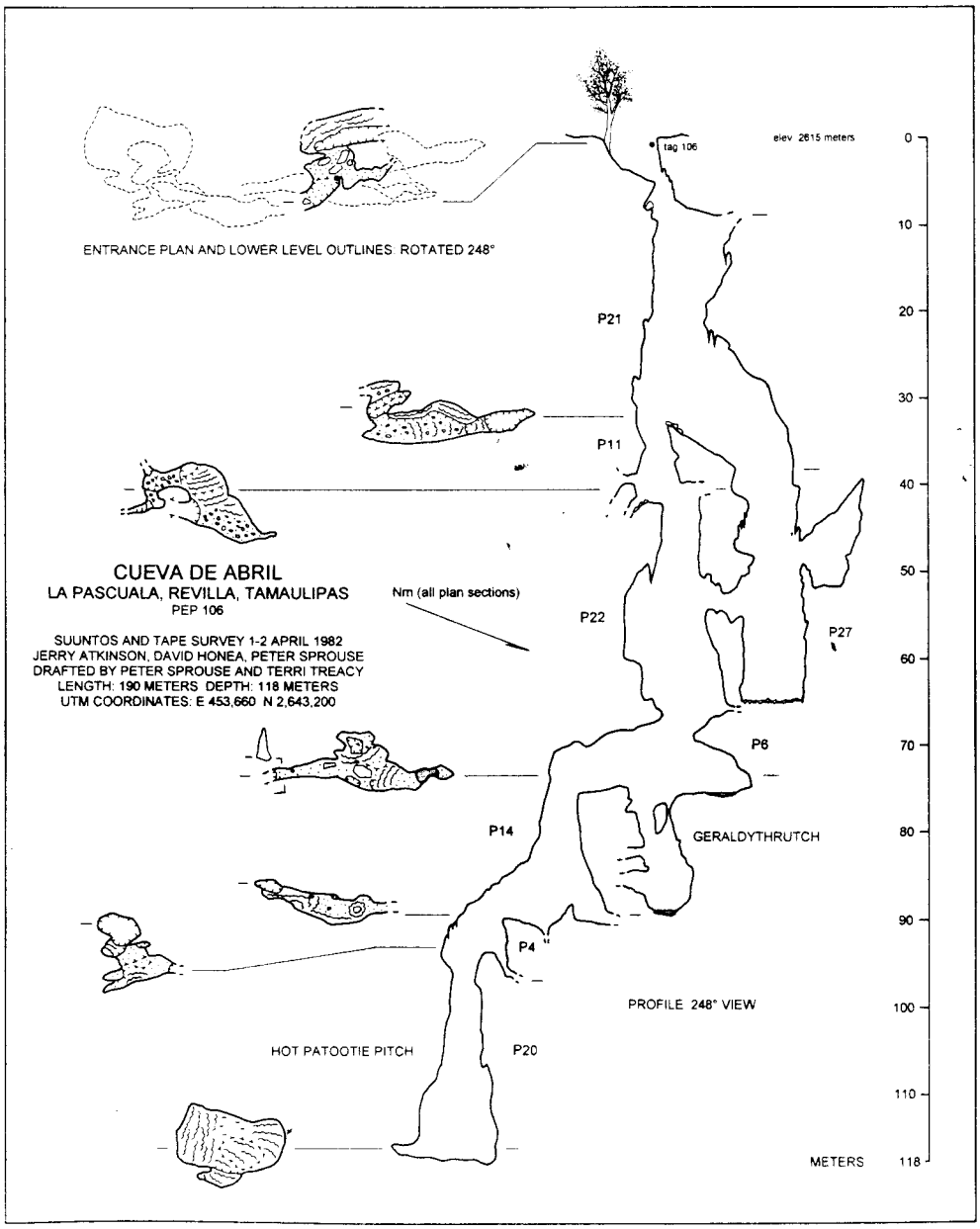
The stacked-plan views technique allows the cartographer to portray complex passage relationships and to show floor detail (and cross sections if desired) at all levels from the surface all the way to the bottom without sacrificing clarity and readability. These views are easy to incorporate and they enhance the user's understanding of the nature, complexity and overall configuration of the cave. And isn't that what we, as cartographers, are trying to capture in our cave maps?

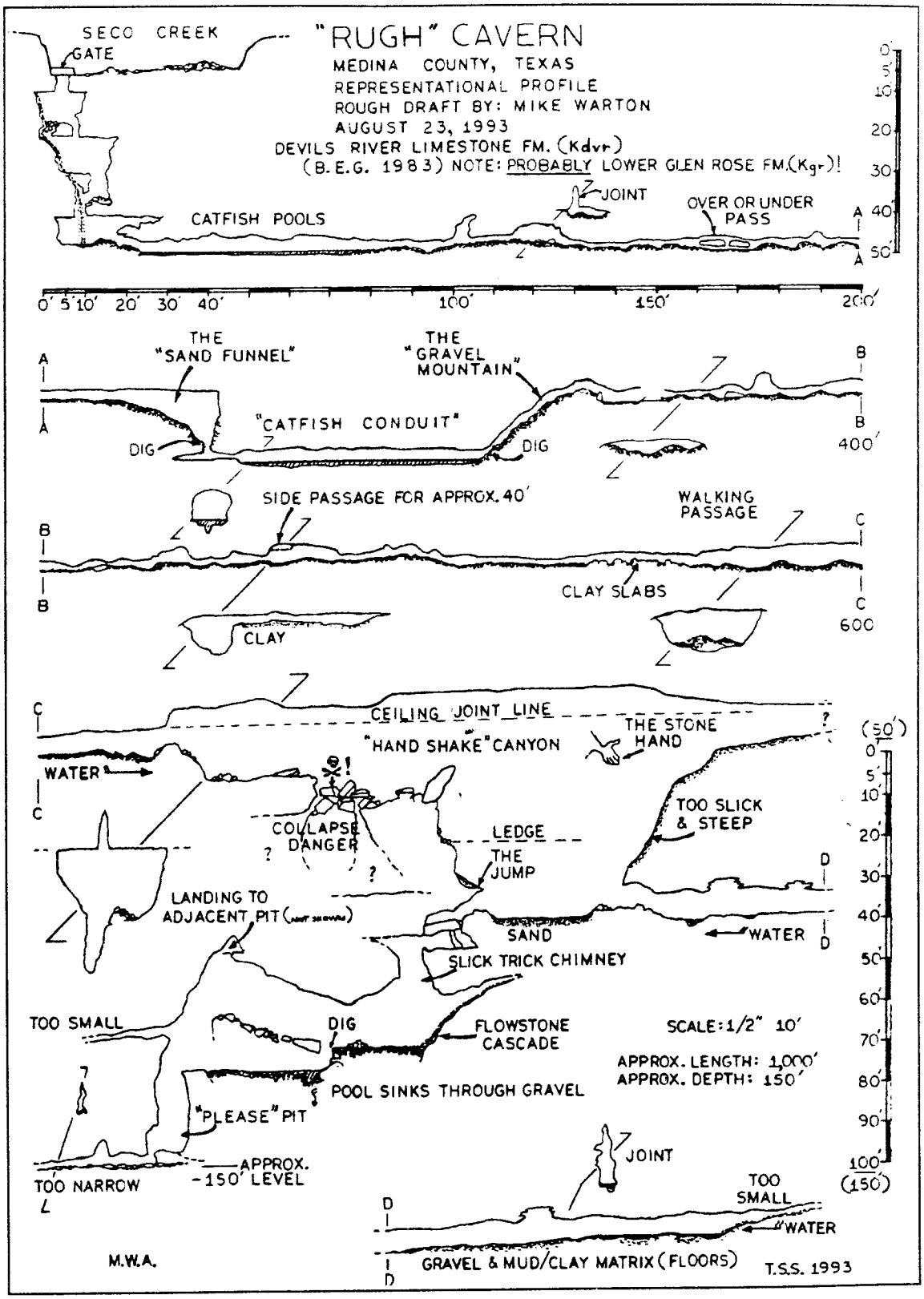
References:

Sotano de los Novios, by Barbara Luke, *The Death Coral Caver*, No. 6, October 1996, p. 11

Cueva de Abril, by Peter Sprouse, *The Death Coral Caver*, No. 6, October 1996. p. 27.

Sima de Don Juan, by Nancy Pistole, *AMCS Activities Newsletter*, No. 20, October 1993, p. 8




"RUGH" CAVERN
MEDINA COUNTY, TEXAS
REPRESENTATIONAL PROFILE
ROUGH DRAFT BY: MIKE WARTON
AUGUST 23, 1993
DEVILS RIVER LIMESTONE FM. (Kdvr)
(B.E.G. 1983) NOTE: PROBABLY LOWER GLEN ROSE FM.(Kgr)!
SECO CREEK
GATE
CATFISH POOLS
JOINT
OVER OR UNDER PASS
0' 5' 10' 20' 30' 40' 100' 150' 200'
THE "SAND FUNNEL"
THE "GRAVEL MOUNTAIN"
"CATFISH CONDUIT"
DIG
DIG
400'
SIDE PASSAGE FOR APPROX. 40'
WALKING PASSAGE
CLAY SLABS
CLAY
600
CEILING JOINT LINE
"HAND SHAKE" CANYON
THE STONE HAND
WATER
COLLAPSE DANGER
LEDGE
THE JUMP
TOO SLICK & STEEP
LANDING TO ADJACENT PIT
SAND
WATER
SLICK TRICK CHIMNEY
TOO SMALL
DIG
FLOWSTONE CASCADE
SCALE: 1/2" 10'
APPROX. LENGTH: 1,000'
APPROX. DEPTH: 150'
POOL SINKS THROUGH GRAVEL
"PLEASE" PIT
APPROX. -150' LEVEL
TOO NARROW
JOINT
TOO SMALL
WATER
GRAVEL & MUD/CLAY MATRIX (FLOORS)
M.W.A.
T.S.S. 1993
(50')
(150')