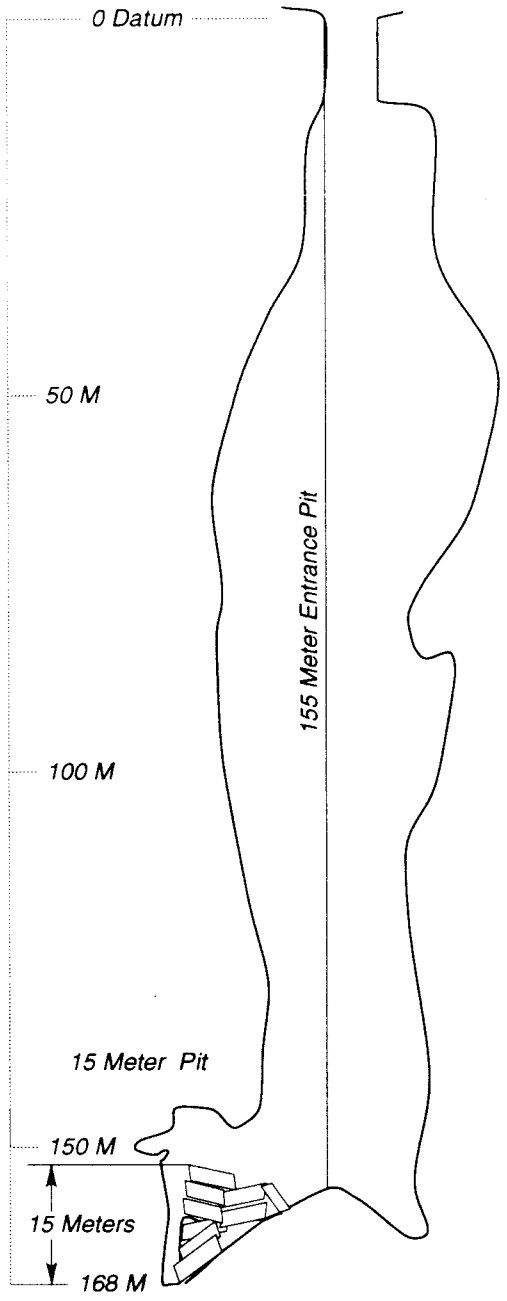
COMPASS & TAPE

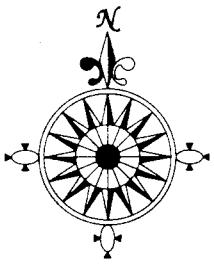
Volume 12, Number 2, Issue 38

POZO DEMADO

QO–70

Queretaro, Mexico





Survey Data

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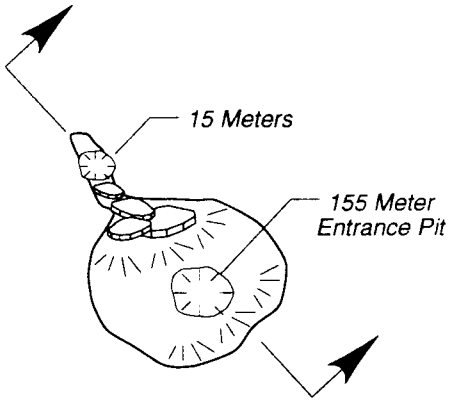
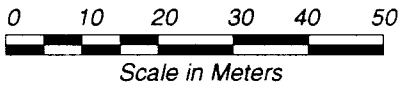
True Horizontal Length —— 35 Meters
Vertical Extent ——— 168 Meters





Surveyed 11–24–93 By :

Gerald Moni
Mark Richardson
Chris Stine

Created On Interleaf 5.2 Software By : David Parr

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 surveying and mapping.

MEMBERSHIP: Membership in the Section is open to anyone who is interested in surveying caves and in cave cartography. Membership in the National Speleological Society is not required.

DUES: Dues are $4.00 per year and include four issue of Compass & Tape. There are normally four issues of Compass & Tape each year, but if there are fewer, then all memberships will be extended to insure that four issues are received. Dues can be paid 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 normally published on a quarterly basis, but if insufficient material is available for an issue, the quarterly publication schedule may not be met. Compass & 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 caving publications. It is the primary medium for conveying information and ideas within the cave mapping community. All membmers are strongly encourage 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. 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 per issue, plus $0.50 postage for one issue or $1.00 for two or more issues ordered at once. Order back issues from the Treasurer.

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

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Inside:

COVER: Computer-Generated Map by David Parr

INSIDE ARTWORK: Linda Heslop

ISSN: 1074-5696

Published in July 1995 by the The Survey and Cartography Section of the National Speleological Society

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SUBMISSIONS

All types of materials related to cave survey, cartography and cave documentation are welcome for publication in *Compass & Tape*. Manuscripts are accepted in ANY form but are most welcome on magnetic media (5.25 or 3.5 inch diskettes) either IBM compatible or Mac format. Typed material is next best though we will accept handwritten material (as long as its legible). Artwork in any form, shape or size is also welcome.

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Message from the Chairman

At the 1993 convention in Pendleton Oregon, I overheard a longtime caver commenting on the Photo and Map Salons. Apparently, he had been out of touch with organized caving and hadn't been to a convention in many years. In his opinion, very little had changed in photography and photo techniques in his absence, but much had changed in cartography. He then went on to marvel at the rich detail of many of the maps displayed in the salon. He also was impressed with a computer generated map that used different colors to highlight various levels and features.

I don't know if I agree with him on photography, but certainly cave maps have come a long way in the past decade or so. Perhaps the two biggest influences on cave cartography have been the Map Salon and the computer (not necessarily in that order). One of the initial purposes of the Map Salon was to encourage improvements by providing a forum to compare maps. The salon also sets standards that every map must meet to win a ribbon, and provides a judge's critique of each entry. Anyone who has followed the salon since its inception in 1978 has surely noticed the overall improvement in the quality of the entries. Each year, it seems to get harder and harder for judges to select the winners. So many maps deserve awards.

The computer has been influencing our data manipulation techniques for a long time. But only in the past few years have advances in hardware and software finally provided us with the power to generate high quality final drafts. But this is clearly only the beginning of the computer's impact on cave cartography. It is now possible to manipulate the cave map in real time on the computer as never before. This allows enormous possibilities for viewing the cave from different perspectives, not easily available on paper. Other data about the cave, and even cave photos, can now be stored on the computer and possibly combined with the map for the ultimate caving presentation. (Virtual reality caving anyone?) I won't even try to predict the impact the computer will have on cave mapping over the next 20 years.

Now, these two influences have converged. Last year, two cave maps displayed on computers were entered in the Map Salon. Because these entries were so different from the typical paper maps, the judges declined to judge them. Some people were understandably disappointed. Recognizing that computer maps would become increasingly more common, the Survey and Cartography Section appointed a committee to develop procedures and criteria for judging these maps. To date, they have generated some preliminary criteria for a Computer Cartography Salon, but more input is needed.

This is where you come in. We all have an opportunity to effect the direction of cave cartography for the future. One way you can help is to attend the discussion session entitled "Forum on Judging Criteria for Electronic Cave Maps" at this year's convention. Offer your ideas about the judging of computer maps. If you can't attend the convention, get in touch with some of the members of the committee and let them know your opinion. Or, write an article for *Compass and Tape* (See "On Guidelines for Electronic Maps" in this issue).

Another way you can help is to spread the word to other cavers, particularly computer oriented friends who may not be part of the Survey and Cartography Section. Encourage these people to join the section. For $5.00 a year the price can't be beat. And our new editor Pat Kambesis has

Perhaps the two biggest influences on cave cartography have been the Map Salon and the computer...

been doing an excellent job of producing quality issues of *Compass and Tape* in a timely manner. In fact, why not ask Bob Hoke to send a potential member a complimentary copy of *Compass and Tape* as an enticement? It would be great if all of the cartographers and computer buffs who are doing cave maps could be part of this process.

In many ways we are on a new threshold of cave cartography. I wonder what that longtime caver would conclude about cave maps if the next convention he attended was ten or fifteen years from now?

See ya' at convention

Carol Vesely
Chairman
Survey and Cartography Section

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LRCFs: We Can Do Better

by Peter Sprouse

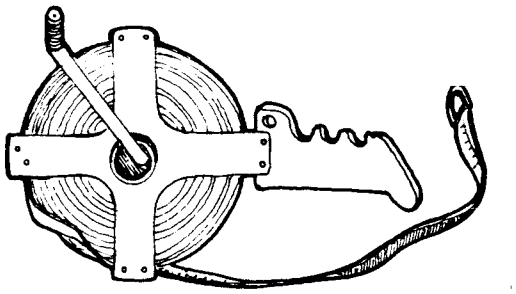
In the Fall 1993 *Compass and Tape*, George Veni authored a commentary on LRCF's or left-right-ceiling-floor measurements. These are typically estimates or measurements of distances to these locations from a surveyed station, ideally at a rough right angle to the passage trend and the passage walls. The ideal in this case, I suppose, being a perfect tube. George mentioned the differing viewpoints that he and I had while teaching a TSA mapping session back in 1992. I'm happy to expound my views on the topic.

In reading George's article, I realize that he misunderstood my approach. He says that I advocate the estimating of LRCF distances while he recommends measuring those distances. Actually, I reject the whole LRCF technique. I believe in a survey based wholly on vectors and sketches, and that angle-less distances are of little use, wasting valuable time that should be spent on sketching.

The LRCF should be substituted with a cross-section drawing. A cross-section is an infinite LRCF, a valuable part of the cave map that provides much more information than four numbers. Modern plan sketching should be done to scale and orientation using a protractor. I believe that the LRCF technique is a relic of a rough sketching style that involved scaling and orienting the sketch on the drafting table; in other words fudging. If a measured distance is needed to a wall, or any other point, go ahead and make it a vector by shooting the two angles. Otherwise you have a crippled distance that is flopping around out there somewhere.

I wholly concur that today's surveys should strive for as long a life as possible before resurvey becomes desirable. I expect that we are in for some major changes with the coming of interactive digital cave maps. We should try to provide as much graphic information as possible for use in that exciting future. Three-D cave maps require 3-D sketching - plan, profile, and cross-sections. Especially cross-sections, the more the better. If I had the computer tools of my dreams, I would scan my plan and profile drawings, correlate them to my baseline vectors, and with cross-sections at 1-meter intervals then proceed to construct a virtual-reality cave map. Should be fun.

The Art of Lead Tape and Other Related Ramblings



by Tom Moss

Lead tape is often the job that the least experienced surveyor is given. This is a shame, for it can be a most important task within the mapping team. Holding and reading the survey tape is not the most significant thing that the lead tape person does. Most importantly, the lead tape surveyor picks stations, and in doing this can make things either very easy or very hard for the instrument reader. Lead tape is also the person who measures or estimates the passage dimensions, marks stations, and is usually the main lead-finder and lead-pusher. This is not an insignificant job.

In this article, I will attempt to cover the job of lead tape, also known as chaining. I will refer to Fern Cave Project (FCP) standards for surveying, but this is mean to be applicable to cave mapping in general. These standards to which we aspire are, in my opinion, indicative of what should be used for modern cave surveying.

The Fern Cave Project does not require any training for lead tape or rear tape people. However, the instrument class which FCP offers covers chaining and the instrument operator is responsible for overseeing the lead tape surveyor, and performing some on-the-job training if necessary. Ideally, the lead tape person is someone who is familiar with all the survey jobs, and could teach the instrument guy a thing or two.

DECIDING STATION PLACEMENT

Station placement is extremely important in cave mapping, not only to make the survey trip run smoothly, but to ensure that a station can be found later on if needed, and that the survey places minimum impact on the cave. Following are the things to think about when deciding station placement, with the most important first:

Each station should have an unobstructed view to the prior and the next station, and to any leads to which the station will be a tie-in, or connecting point.

Maximize the length of each shot (up to the length of the tape!), but don't pass by any leads. If a station is not placed near a lead, one will have to be placed when the lead is mapped, essentially surveying a portion of the passage twice. Obviously the length of a shot cannot exceed the length of the tape which is usually a 100-foot length.

Place the station for accuracy and ease of compass reading. It is often better to shorten the shot and use a station where the instrument person will be more comfortable, accurate and fast with readings. When considering a station, put yourself in the compass reader's place, and think "Would he really like to lie down in that puddle?", or "Is she tall enough to read from this station?" Place stations to reduce positional error - the error that occurs when the compass cannot be read

exactly from the station. When using Suunto-type instruments, the best station is one at which the compass reader can get behind and then line up both stations with the instrument. This would ideally be about at eye level, but anything that is two to five feet above the floor is ok. Examples of such a station would be the top of a piece of breakdown, a ledge or protrusion from the wall or ceiling, or the tip of a formation. When the station is placed on a flat wall, there is no way to read Suunto directly from it.

Place recoverable stations whenever possible, and always when the station will be used for a tie-in. In placing a recoverable station, try not to use areas where traffic through the cave will obscure or destroy the station. Sometimes it is nice to put a station on a distinctive feature that can be noted in the book, so that it can still be found even after the cave rat steals the flagging tape. Don't laugh, it's happened -- in Fern Cave. On the other hand, sometimes the station has to be floating three inches above your pack sitting on a ledge, in order to shoot through a tight spot. If there is no need to find the station later on, this sort of placement is fine.

Plan ahead. When placing each station, have an idea of where the next station will be. While you're waiting on the sketcher, it's a good opportunity to plan the next few shots, and look for leads too. When evaluating a station, remember that the point will be used for front and backsights.

Dropping a vertical shot is always an option. To create a better station for shooting onwards, or to eliminate those high-angle shots that can't be read accurately, you can do a dummy shot straight up or down when it's appropriate. This technique is especially valuable in tight or low passages. Use the tape to plumb these. When the instrument reader has problems at a bad station, it's fine to move both the target light and the compass up or down a measured distance.

The preceding guidelines for station placement can never cover all the situations. In some difficult passages, the lead tape person will be subject to abuse from the instrument reader for poor station placements, unless she or he is very resourceful. Use your imagination. Often station placement is a trade-off on the above considerations, and comfort is sacrificed for accuracy, or recoverability is blown off entirely.

Sometimes placing stations in snakey passages can be quite a challenge. In passages with alternate turns, the inside corner of each turn is usually the best choice (Figure 1). Note that in each case, the front and backsight can be done from behind the station to minimize positional error. If the passage makes two turns in the same direction, you have to be a bit more creative (Figure 2).

There are two main ways of surveying large rooms. One is to map down the center, and do splay shots to the walls as appropriate (Figure 3). The other is to circumnavigate the room. Most of the time, the sketcher will decide how the survey is to proceed.

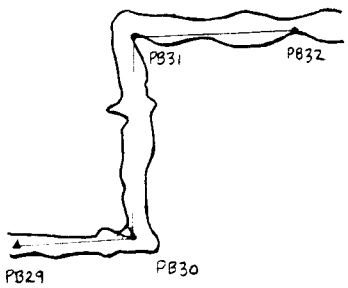


Figure 1. Station placement in passages with alternate bends.

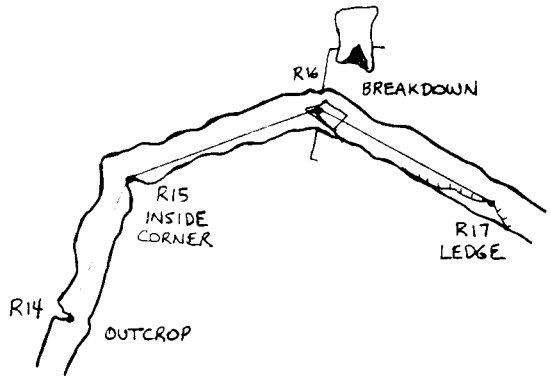


Figure 2. Creative station placement

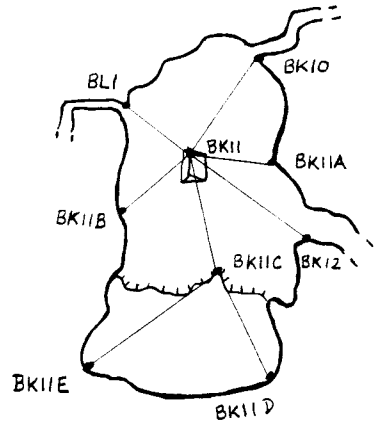


Figure 3. Surveying a large room with splay shots.

MARKING STATIONS

I think it's good to try to minimize station markings. All of us have seen caves where every station is marked with a large circled dot, labeled in two- or three-inch high letters. This is unsightly, in addition to being a poor example for nurd cavers who tend to write on the walls anyway. For stations that will serve as tie-in, it is necessary to make some small mark to indicate the exact station location; either a small carbide dot, or a small "x" scratched into the limestone. Never make any marks on formations of any kind. The tip of a stalactite or stalagmite is ok for a station, if you can keep from soiling it; if it is a notable formation, so much the better for finding the station again.

For recoverable stations at leads and junctions, I like the technique of writing the station number on flagging tape with a permanent marker, and tying the flagging firmly to something near the station. However, these do tend to get picked up by well-meaning cavers, so sometimes it's just best to mark the wall and obscure the markings when the lead is surveyed. A permanent station every now and then is good in large caves; in Fern we use a nylon anchor placed in a 1/4" drilled hole, with an aluminum tag, at major junctions.

After an area has been surveyed successfully, the loops closed, and all the leads in that section of the cave taken care of, the flagging tape can be removed and the station mark rubbed out. At the end of the project (sometime in the 22nd century), all that should remain will be the permanent stations. They will be used to tie in all the high leads into which the cavers 150 years from now will be levitating. Hell, we might even do that before the end of this century...

LIGHTING THE STATION

Lighting the station is pretty easy with LED station targets. I first saw these when Lester Bartel made some for the FCP, but have since found that others developed this idea independently. This consists of a small LED (light emitting diode) bulb that is wired in to two AA batteries. You can also use a small lithium coin-shaped battery, sandwiching it between the leads of the LED and securing the package with duct tape. The main advantage of this target light is that it looks different from everyone's headlamps, so that the instrument reader has no problem seeing which light is the station.

Expensive government studies have shown that if you read to the lead tape person's headlamp instead of the station, accuracy of the survey suffers. If you use your headlamp to light the station, it's important to try to place the light in line with the shot so as not to introduce positional error.

MEASURING THE SURVEY SHOT

Now we get to the obvious subject of reading the tape. When taping, pull the tape tight, but not too tight - there is some stretch factor to the fiberglass tapes most cavers use. Five pounds or so is the recommended tension on mine; this information is printed on the tape near the end. The zero mark is the end of the shackle on the end of the tape. Read to the nearest tenth-foot or centimeter, depending upon what units you are mapping. If you're reading the distance in decimal feet, beware of the tapes that have an inch scale on one side, and decimal feet on the other. It is a common blunder to read the inches scale. Another common blunder is misreading the tape when upside down - I have seen 6 read instead of 9, or even 31 instead of 13.

After reading the tape, if the shot is of any length you will probably want to leave the tape laid out on the floor for the sketcher to use as a scale to place features between the stations. It's handy to have a second tape just for measuring passage dimensions, so that you don't lose time waiting on the main tape. However, it's not a good idea to get too far ahead of the sketcher, who is generally the slowest member of the party. Whatever the lead tape person can do to make life easier for the sketcher will speed up the survey.

MEASURING PASSAGE DIMENSIONS

The lead tape person measures or estimates left, right, up and down dimensions at each station. If you're not sure of your ability to estimate, measure. When deciding where the passage ends, use the size of passage that a person could get into as a guideline. If the passage drops to six inches high, that shouldn't be included as the size of the passage, but could be noted as a dig lead.

Multiple measurements are sometimes necessary (Figure 4). Note that you should use the maximum dimension close to the station for the passage size to be recorded.

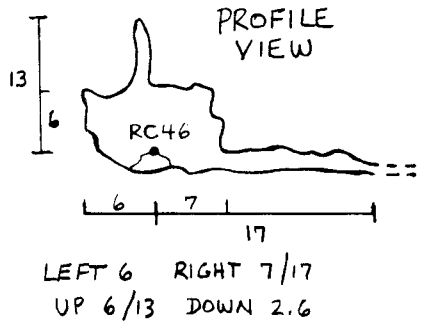


Figure 4. Multiple passage measurements.

Wall Dimensions (Left/Right)

Many people measure left and right walls at 90 degrees from the previous or the next shot, but this sometimes gives you a value which runs straight down the passage and is meaningless. Most sketchers note this as a left/right measurement of "P", meaning passage. To characterize passage size better, you can measure left/right at a heading which splits the angle created by the previous, current and next station (Figure 5). When doing this, you need to have a rough idea of where the next station will be before you can measure left and right.

An exception to this is the first and last station in a passage, where you'll just have to take the measurement at an angle of 90 degrees to the survey line. In addition to giving more data about

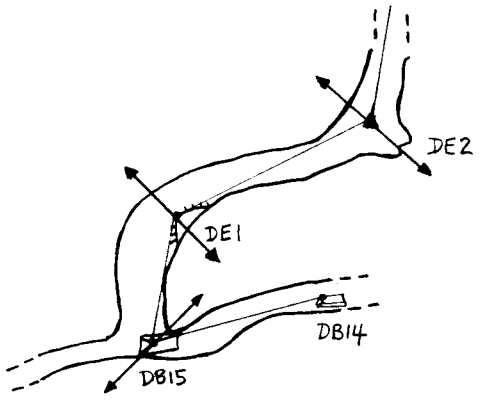


Figure 5. Direction for left-right measurements

the cave, measuring left/right this way makes computer generated maps much more readable when the walls are being drawn, particularly in winding passages. How ever you measure LRUD (Left, Right, Up, Down), it should be done consistently.

Ceiling/Floor Dimensions (Up/Down)

Ceiling heights which can't be measured can be accurately triangulated by using the percent grade scale found on Suunto clinometers. Have one person stand at the station where you want to measure the ceiling height, holding the end of the tape and illuminating a spot in the ceiling above. The instrument person goes off some even distance on the tape, then measures the percent grade inclination to the illuminated spot. The percent grade times the horizontal distance equals the ceiling height.

You then have to correct for the difference between the level of the station, and the height of the instrument where the reading was made.

CHECKING LEADS

Everyone in the survey party is supposed to look for leads, but it is the lead tape person who will probably find most of them, and have time to check them out. The sketcher should record all leads in the book with information about size, air and water flow, and description. When you're investigating a lead, try to specifically check out the information that will be useful for the lead description, then report this to the sketcher to be recorded.

COMMUNICATION

The last thing to discuss about lead tape is one of the most important - communication. If a piece of data is not clearly understood by the sketcher and recorded correctly in the book, everyone is wasting their time. Every time a piece of information is given to the sketcher, make sure that she or he acknowledges and repeats the information. It's less distracting for the sketcher if the lead tape person "packages" information. For example, give LRUD measurements all at one time instead of making the sketcher wait for four different pieces of information.

PANACHE

Lead tape is indeed an art; there is a lot of individual style that goes into each person's way of performing the job. It is a crucial survey task that, when performed with smarts and style, makes the process of cave mapping flow in a natural manner.

Observations on Survey Sketch Quality

by Mike Yocum
with comments by Scott House and Pat Kambesis

He should have his fingers cut off and fried in oil to prevent him from sketching.

Bob Osburn

Bob Osburn's comment may sound unduly harsh to someone who has never tried to draw an accurate map from a sketch that bears little semblance to the cave it is supposed to represent. However, nothing makes you think more carefully and critically (and sometimes angrily) about the details of cave surveying than having to draw a map with notes taken by someone else, especially if the sketch is poor.

Scott House is credited with the proposition that the first step in becoming a competent cave surveyor is to draw a map from someone else's notes. If you begin your surveying career that way, rather than by the traditional method of holding the dumb end of the tape, then by the time you actually get underground with instruments or notebook in hand, you have a far better understanding of what the map maker requires from your field work in order to produce an acceptable map.

Kenneth Thompson and Robert Taylor, coauthors of "An Introduction to Cave Surveying" and "The Art of Cave Surveying," say that:

> "...it is wise to make the following hypothetical assumptions about anyone who might read the notes later including him/herself: (1) they have poor eyesight, (2) they are not clairvoyant, and (3) they will try to blame all mistakes on the field notes..."[1]

They go on to add:

> "Field notes should be complete in and of themselves. Many cave surveyors feel that the field notes, reinforced by their memories, are sufficiently comprehensive to be used for the immediate purpose of making a cave map. Experience shows this supposition not to be true. The field notes should be complete enough to stand by themselves without clarification by the surveyor. If this is not done, the following will result:
>
> (1) lost time trying to decipher the notes, (2) probably a return visit to the cave to clarify the notes (this might be quite difficult if the section of the cave being mapped is four hours into the cave), (3) erroneous information may be placed on the map, and (4) a general mistrust of the surveyor's mapping ability." [2]

Thompson and Taylor give basic, detailed advice on how to avoid these problems. The purpose of this article is not to repeat that advice, but to provoke some thought about sketching by looking at a few good and bad sketches.

My interest in sketching began when processing data for Blue Spring Cave in Tennessee. Blue Spring is a wonderful cave. It's big, it's friendly, it has a fine variety of passages. It has also had a

fine variety of sketchers, not all of them exactly world-class.

Sometimes, the data has errors in it. One way to correct these errors is to look at the sketch. The book-keeper may have written a distance as 16 feet rather than 60 feet. A backsight may have been confused with a frontsight. A reading of 93.5 degrees may have been written down as 39.5 degrees; a positive clinometer reading may have been mis-read as a negative reading, and so on. With a good sketch (drawn to scale, plotted with a protractor, an adequate number of cross sections, etc.) it is often possible to quickly correct errors in the data.

Since my own sketching and book-keeping ability leaves much to be desired (I have committed all of the errors mentioned above, plus a few more), I asked Scott House and Pat Kambesis to help by offering their observations on the sketches. Until recently, Scott was CRF's Chief Cartographer for Mammoth Cave. Pat coordinates the Lechuguilla Cave Cartography project. Both are also involved in drawing up dozens of other caves.

I sent them copies of the sketches that were either at the original size or enlarged, so they had better versions to look at than those reproduced here.

Assume, I said, that these copies are all that you have, and that you are unable to locate the people who did them. Assume further that you have to turn them into a map. What would you have wanted the sketchers to do when drawing the sketch, to make your job easier? In addition, assume that you have to use these to find something in the cave or to make up a lead list. What could the sketchers have done differently to make your job easier?

Their comments, along with my own, follow. Since I have the original notes, I was privy to more information than either Pat or Scott. In one or two places I have made use of that extra information. I have also edited my comments to avoid unnec-

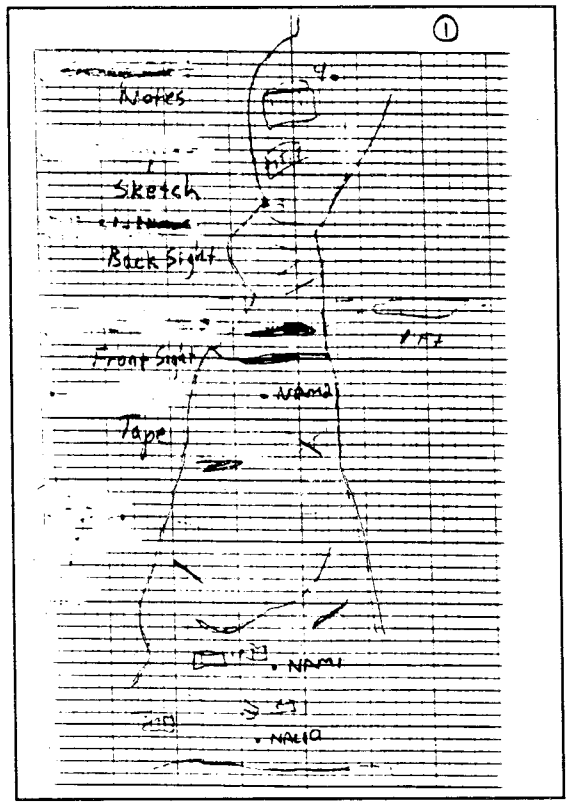
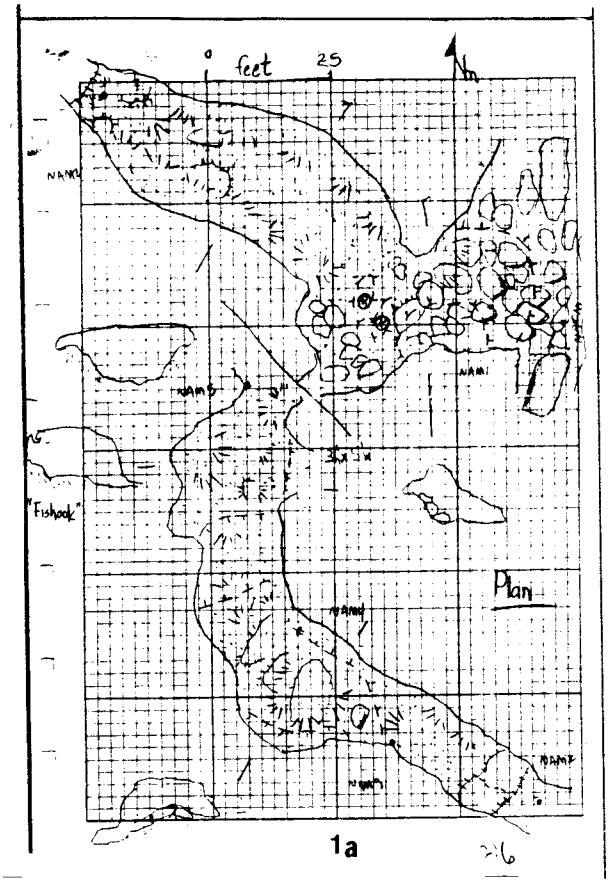


Figure 1



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essary redundancy, e.g., I agree with their opinions in most cases, but saw no point in repeating them. (Initialed comments: **MY** - Mike Yocum; **SH** - Scott House; **PK** - Pat Kambesis)

Figure 1

Figure 1 was done in Blue Spring Cave. I have obscured the names of the crew (which are not usually put on the sketch anyway!) but will admit that I was one of them. This mess is partly my fault. I didn't want to sketch, and the poor fellow who was forced to do it may only have sketched once before, if at all. Either I or one of the other members of the survey party with more experience should have done it. Instead we (stupidly) forced the new recruit to keep book. Perhaps the only positive thing that came of it was that I now have an example of a truly appalling sketch for this article. Figure 1A is a re-sketch which comes closer to what the cave really looks like.

MY: Pluses: the sketch is on gridded paper; there is a page number.

PK: No scale, north arrow is missing. Floor detail lacking. Needs more cross sections. Sketch says very little about the passage.
Pluses: Stations are clearly marked though it would be better if the labels were outside the passage walls rather than on the actual plan.

SH: Really bad sketch, beneath comment....

Figure 2

Although it is not my sketch, Figure 2 has one of my most frequent errors, lack of floor detail, and also one of my most embarrassing ones, getting the hachures on the wrong side. The 25-foot tall dome shown on the second cross-section from the bottom is shown on the adjacent plan as an extrusion down into the passage. The cross section just above NAF-7 is shown facing the wrong way (or else the plan is really screwed up) and there is no ceiling detail anywhere else in the plan except for the 25-foot dome with the reversed hachures.

MY: Gridded paper was not used, pages were not numbered.

PK: North arrow lacking. No scale, No floor detail, passage characteristics as reflected in the cross section not shown on the sketch.
Pluses: There are cross sections, ceiling heights, stations are clearly labelled.

SH: poor sketch, unacceptable quality

Figure 3

Figure 3 has no page number, no floor or ceiling detail. I don't know what the little "L"s or arrows mean. Having access to the data, I can add that there is a 90-degree turn in the passage where it says steep slope up."

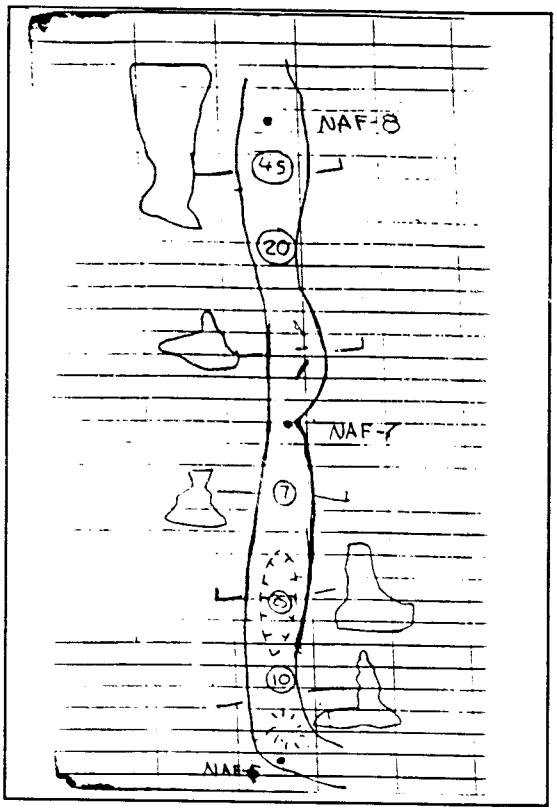


Figure 2

MY: Pluses: Its on gridded paper.

PK: No north arrow, no scale, need to use more map symbols instead of notation. Needs more cross sections. Sketch is sloppy and hard to read. Cross sections need match lines (with view directions) to sketch. Ceiling heights would be nice. Need better description of leads (dimensions, description)

Figure 4

Figure 4 has no page number and could use more detail. The passage averages 50-70 feet wide and is not quite as barren as the sketch suggests. Still not bad.

PK: North arrow missing. Could use more symbolic floor detail. Good cross sections. Nice, neat sketch. Cross section at N25 does not match passage; also doesn't match ceiling heights.

Pluses: There is a scale indicated

SH: (made no comments on this sketch --ed.)

Figure 5

Figure 5 has no page number and is not on gridded paper. However, on the plus side, there is a survey line. In contrast to Kambesis' view (below) that a plotted survey line detracts from the sketch, I agree with House that a plotted survey line can help the cartographer when drawing the map, as well as aiding the sketcher in laying out and proportioning the sketch.

PK: No scale or north arrow. Plotted survey lines detracts from the sketch. Cross sections need match line with view direction. Passage shape detail on cross-sections not indicated on sketch, (change in ceiling heights, slopes etc. not shown on sketch.) Could use more symbolic floor detail. Ceiling heights would be nice.

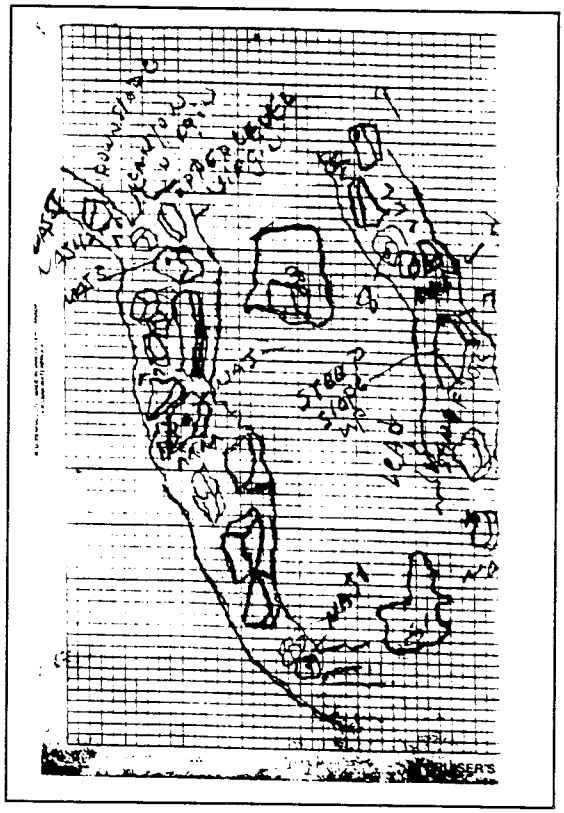


Figure 3

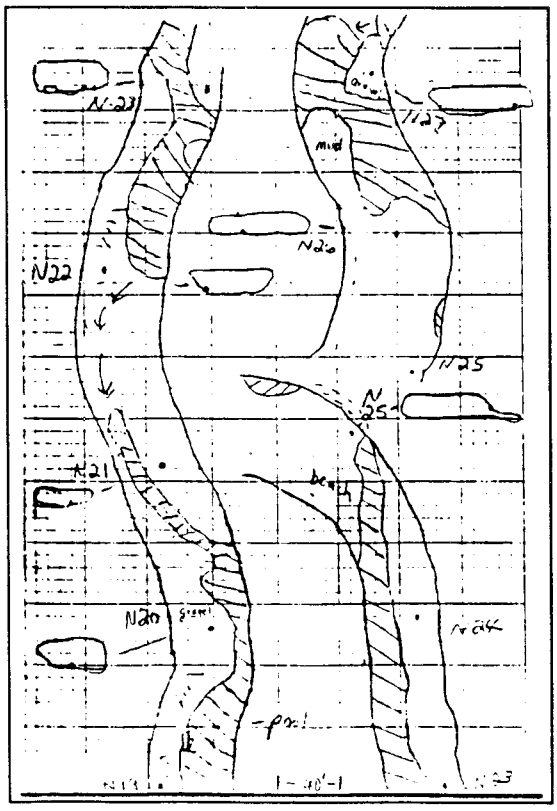


Figure 4

SH: Book messy. Watch passage widths; compare AJ1 with AJ6. Need passage dimensions on all leads. What does "tight" mean? Need symbols for floor sediments. Ceiling height changes not shown. Cross sections have only faint resemblance to sketch view. This is truly a "sketch" done in the impressionistic style. Sketcher needs to take time and draw carefully. what is the line on the floor? Is this a stream? There are ways of showing it correctly.

Figure 6

Of the sketches so far, this is the best yet. But there is no north arrow, which gave me problems when making up a lead list for this cave. As a rule, sketchers have north at the top of the page. I had gone through a bunch of sketches pulling out and describing the locations of leads. All the sketchers had the top of the page as north. I was halfway through this sketch when I realized that the sketcher had not placed north at the top of the page. It wasn't a major problem but it was a waste of time that could easily have been remedied by the sketcher having the presence of mind to put a north arrow on the page. there is no page number.

PK: North arrow and scale are missing. Needs more symbolic floor detail. Needs more cross sections.
Pluses: Neat sketch. Stations clearly marked. Good lead descriptions.

SH: Poor quality sketch

Figure 7

There is no page number. Apart from the omissions noted by House and Kambesis, this is generally a good sketch from someone who regularly turns in good sketches. However, in spite of promises to do so, this sketcher has consistently failed on his last few trips to place permanent survey stations in a flood-prone cave in which it

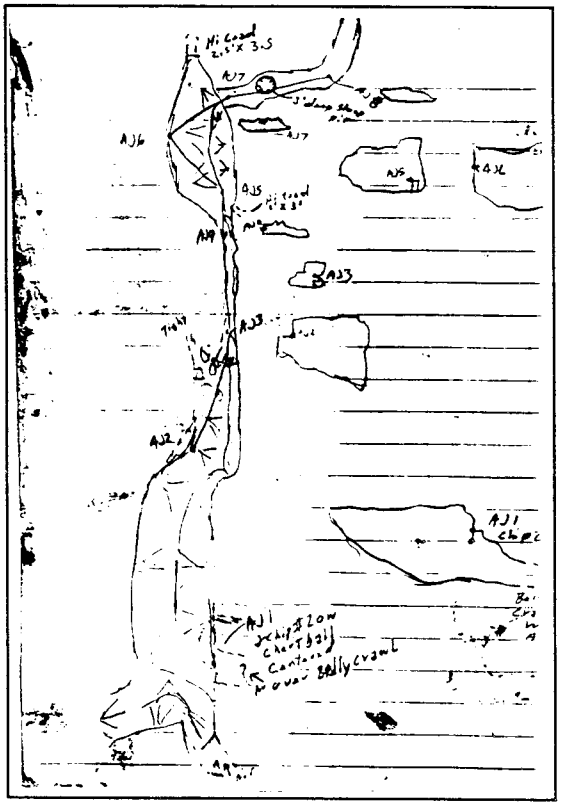


Figure 5

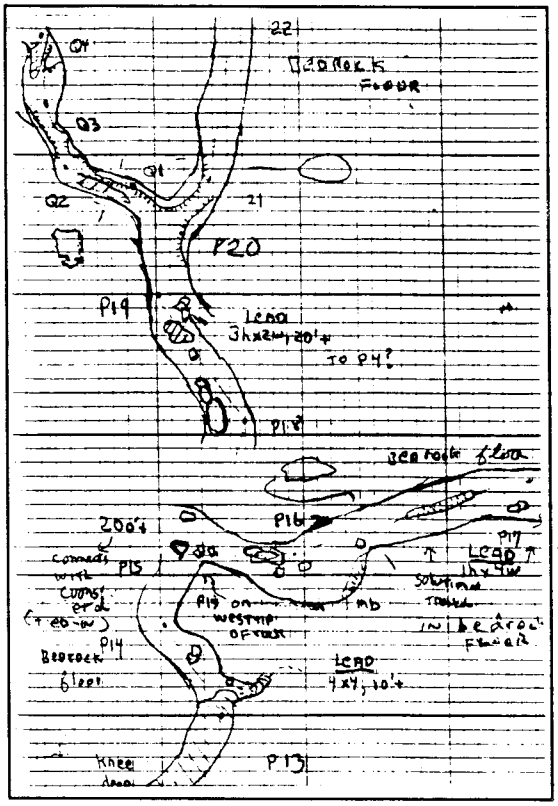


Figure 6

is crucial to be able to recover stations. In one instance, even though the sketch was good, that major omission meant several hours of others cavers time wasted on re-surveying a passage in order to find a tie-in station. It is bad enough to have to re-survey a passage because of erroneous data or a poor quality sketch. It is even worse to have to re-do good work simply because the surveyor didn't have the presence of mind to bring along a few poker chips (*for permanent survey stations - ed).*

PK: North arrow and scale are missing. could use more symbolic floor detail (are there sediments on the floor, or is it all bedrock?)
Pluses: Good cross sections, lead descriptions, nice neat sketch.

SH: Not too bad. No survey line drawn in. Stations hard to see (E8-9). No symbolization of floor sediments (just plain I assume bare rock!) People should put in more ceiling heights for areas other than at stations. Should use standard survey paper for recording data; also need to use four digits for azimuths (010.0) for clarification.

Figure 8

The best of the lot. It has a page number, north arrow, and scale. My only addition to this would be a better description of the leads.

PK: Cross sections need view direction. Leads need to be described.

SH: Nice sketch with good detail. How big is the lead at T56? How high is the dome at T53 and what are the dimensions of the leads? Sketch ought to include survey line; this makes it much easier to sketch in the cave and to transfer the sketch to the map later on. Cross sections could use lithology and sedimentation.

****

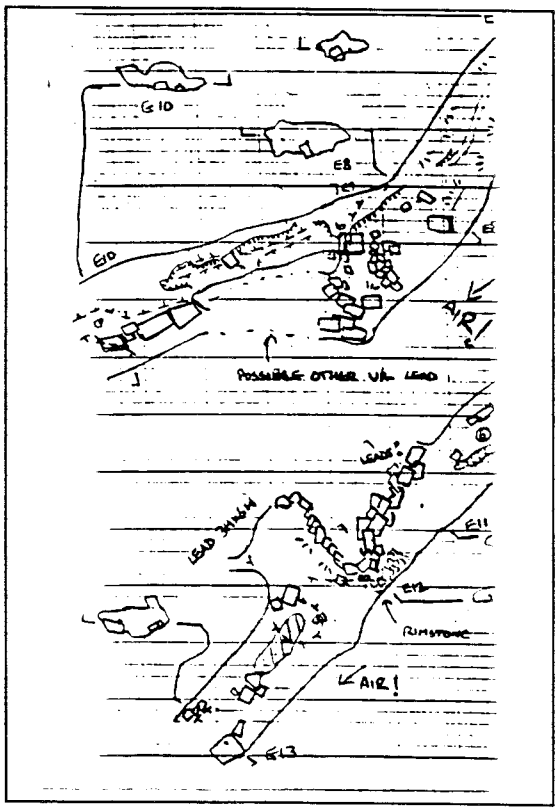


Figure 7

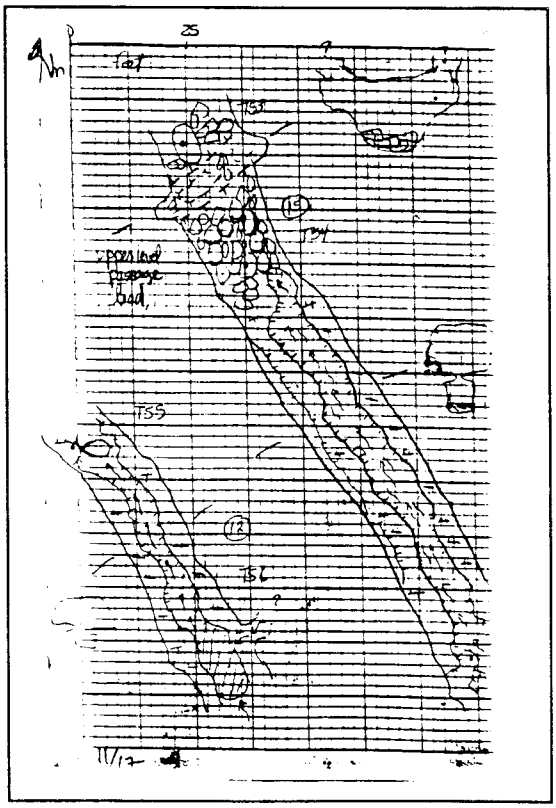


Figure 8

Kambesis' final general comment is that she would like to have seen the data that goes with the sketches in order to determine if the notes were actually plotted and sketched to scale. Most weren't.

Often there are subtle, or not so subtle, pressures to produce a large quantity of data rather than a high quality survey

House's final comments are: write four digit azimuths; draw the survey line in; clearly add notes as to the nature of the leads; put in ceiling heights at any place that needs them; show the lithology in the cross sections; and, take your time.

All of the sketches could have benefited if more time and thought had been given to them, but that is not always easy to do when you are actually surveying. Often there are subtle, or not so subtle, pressures to produce a large quantity of data rather than a high quality survey. I have been on many trips where the amount of footage at the end of the trip was valued far more highly than the final usefulness of the notes. Those having this viewpoint are never the ones who make maps.

The key seems to be to take your time and concentrate on what you are doing.

NOTES:

1. Thompson, Kenneth C., and Taylor, Robert L., 1991, The Art of Cave Survey ing, Missouri Speleology, Vol. 31, Nos. 1-4 p. 65.

2. ibid, p. 65.

Creating Electronic Maps from True to Scale Cave Survey Sketches

by Garry Petrie

Some people have questioned the need or usefulness of creating cave survey sketches to scale. But recent advances in computer hardware and software has made it possible to move these images into a complete electronic map of the cave. During the spring, several cavers gathered in southern Washington to do some re-mapping of Poacher's Cave. I drew the sketches in Figures 1 and 2 and 3.

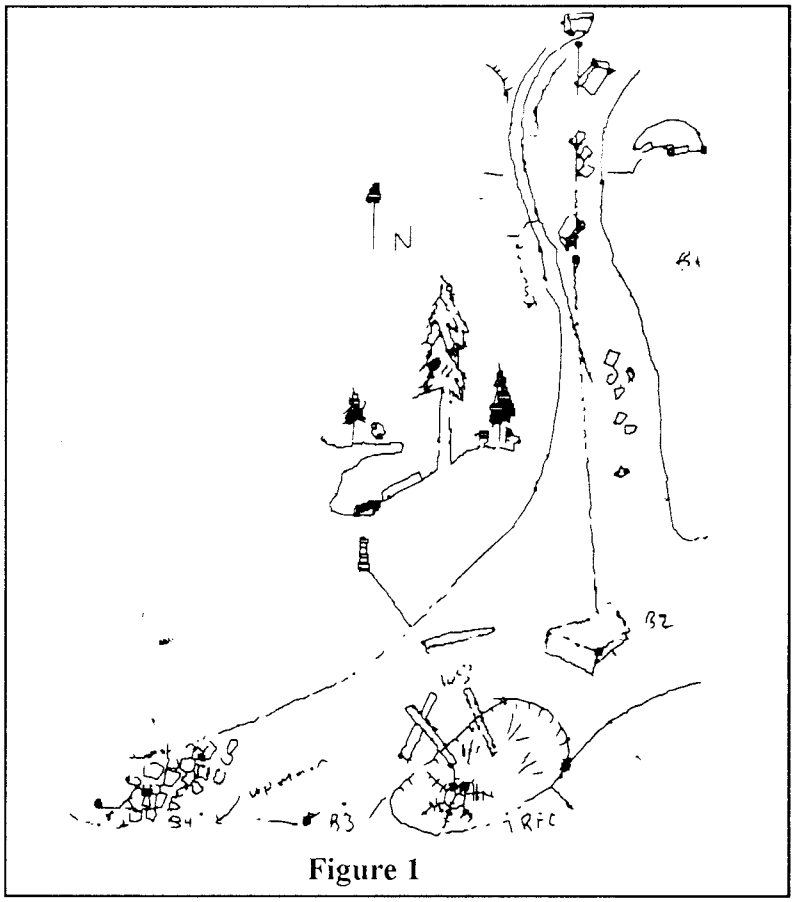


Figure 1

File Formats:

These images are "PCX" files and are raster images. There are two problems with this. First, PCX files are not accepted by AutoCad, the software I had chosen to do the complete cave map. AutoCad accepts vector images, either "DXF" files or PostScript files.

The second problem is in the nature of these two types of image formats, raster and vector. Typically, vector drawings are characterized by lines and raster by objects. Because of this, a vector drawings should be one tenth the size, in terms of memory usage, of raster images. While it is possible to work with PCX files in a program like CorelDraw, the nature of cave maps lends itself to vector based drawing programs.

Converting PCX Files:

To convert the PCX files to PostScript files, I used the program CorelTrace. This program can processes images in several different ways, such as object character recognition (OCR) and outline tracing. The mode I used was "Center Line"

Figure 2

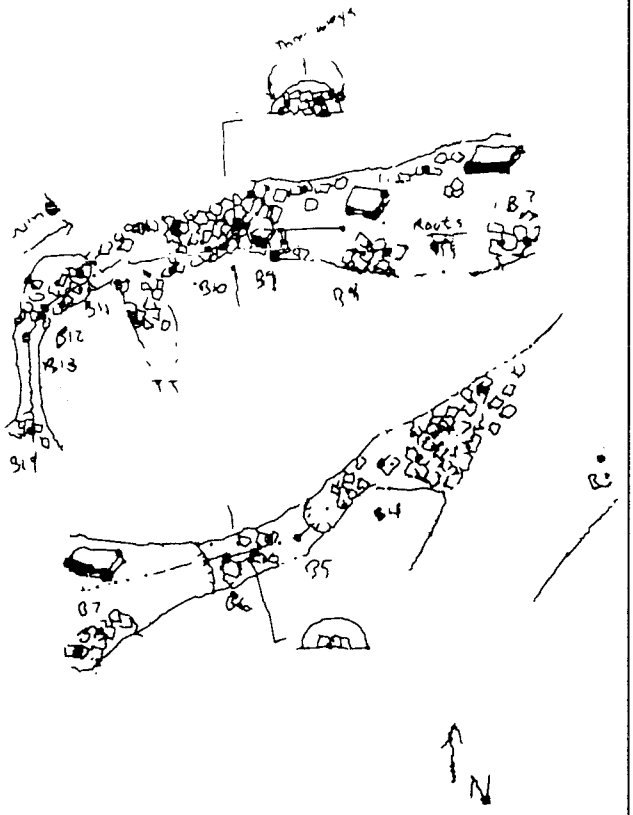


Figure 3

tracing, which draws a line down the middle of black regions.

This mode does have some limitations, a square or circle are converted into bands or layers, much like the lap boarding on the side of a house. But for open field lines the program yields good results. After the tracing process, the resulting image is exported as a PostScript file. The file can then be imported into AutoCad using the "PSin" function.

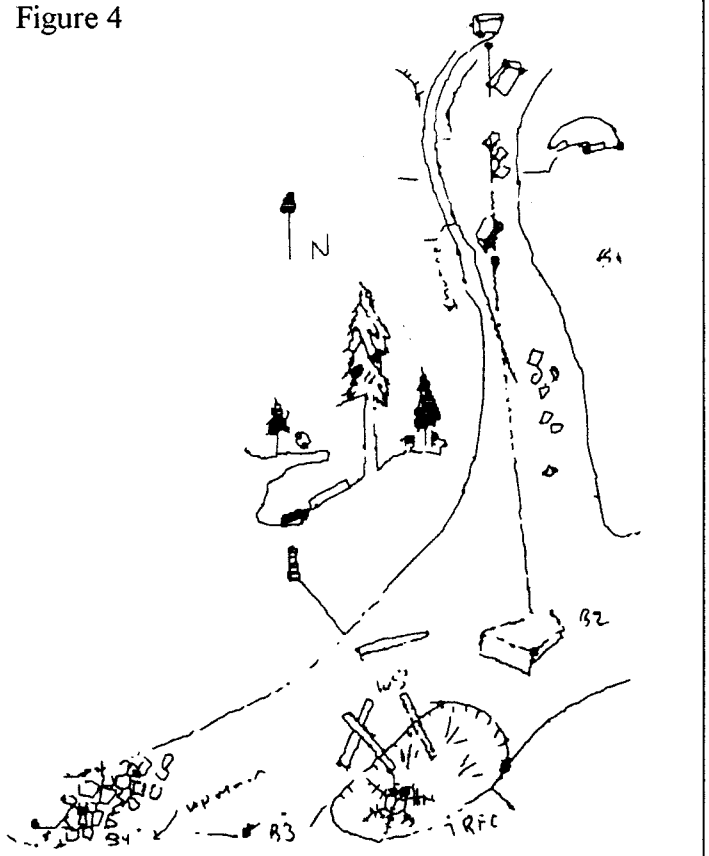
Once in AutoCad, the image can be cleaned up, removing any noise created in the imagescanning or any dirt in the original sketches. Figure 4 shows Poach 1after image processing and clean up.

Drawing in AutoCad:

The final drawing has been assembled in AutoCad in three steps. First the lineplot produced with KARST, a home brew cave survey program, was imported in to AutoCad using the "DxfIn" function. KARST correctly scales the DXF file to what ever the base units are. That is, if the cave survey was done in decimal feet, then one AutoCad unit equal one foot.

The next step is to insert the individual sketch pages previously edited and saved with AutoCad. The main difficulty in this step is to scale the sketches to the line plot. But after several attempts and measuring the distance between two

Figure 4



stations several times, the correct scale factor is found. In this case, it was 1.6.

The individual sketches are moved into place by overlapping the corresponding station symbols. In the last step, the individual sketches are "exploded" so that their components can be edited. This is necessary to clean up the overlapping sections of two neighboring sketches and as in the Figure 2 sketch, merge disjoint sections of the drawings. In this last step, the station names and line shots were removed and the text converted into AutoCad text.

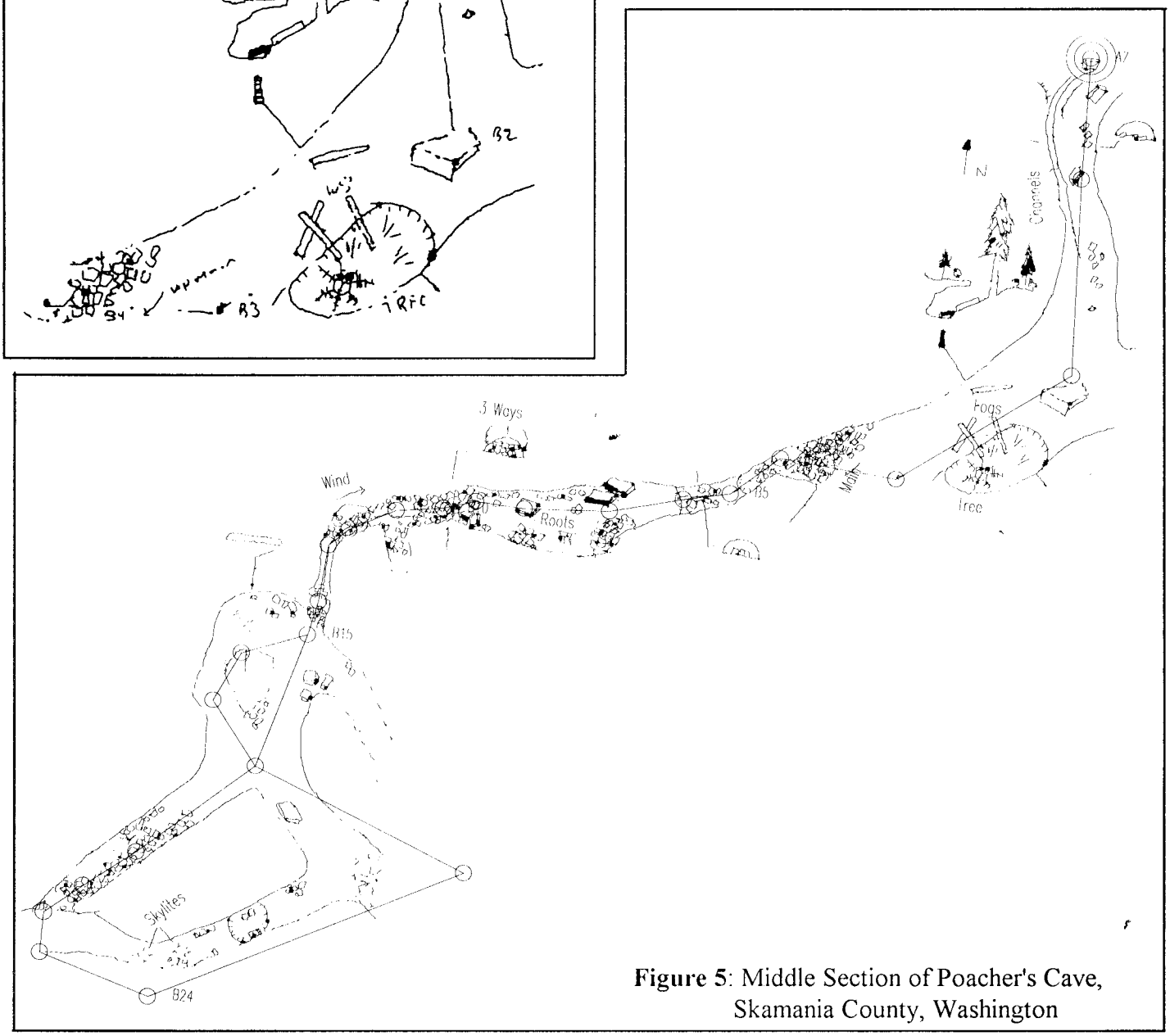


Figure 5: Middle Section of Poacher's Cave, Skamania County, Washington

On Guidelines for Electronic Maps

compiled by Pat Kambesis

At the 1994 Cartography Salon (Brackettville, Texas) there were two electronic map entries. The contestants both set up computers and displayed the maps to the judges and anyone else who was interested. Because the electronic maps were so different than the traditional paper maps, the judges felt that the entries needed to be judged with a different set of criteria. No such criteria existed, the judges did not have time to come up with any, so consequently, they decided not to judge the entries.

The judging of electronic maps issue was brought up and discussed at the Survey & Cartography session and a committee was appointed to come up with guidelines for judging electronic maps at the 1995 Cartographic Salon. Angela Morgan was appointed head of the committee. Members included Thom Engel, Scott Schmitz, Mark Johnston, Pat Kambesis and Bob Thrun. Hubert Crowell and Carol Vesely were later added to the committee.

Following is a compilation of written input from various members of the committee. Keep in mind that these are just suggestions on how the guidelines should be determined. The committee will makes its final recommendations before the 1995 NSS Convention.

Hubert Crowell wrote to the committee with questions, suggestions and ideas on what should be judged and how. Following are Hubert's initial questions and suggestions and comments:

What should be judged when dealing with electronic format maps?

Should the cave only be judged and not the software and/or hardware used to display the cave.

Should the software and/or hardware only be judged?

Should the software and/or hardware and cave be judged together?

"I am in favor of A, and that Electronic may be any device for displaying a cave, Computer, CD player, Slides, movies, or whatever. The work is still performed by the cartographer and the software and hardware are just the tools. I would expect we will see many cave maps using the same software but using different format."

What time frame should be allowed for each entry and how should the entry be presented?

Should the contestant present the entry to the judges in a given time frame and answer questions from the judges. (This was tried at the 1994 Convention).

What should be judged when dealing with electronic format maps?

Should the entry be self-displaying within a time frame and no operator required, allowing the judges to view the material in the same manor as the paper maps?

Should the entrees be on Disk with instructions on how to start?

"I am in favor of all of the above as long as the judges are not required to understand or operate the equipment and/or software other than turning it on or executing a run command. The amount of data that could be presented by a computer could be more than the judges would have time to review. Therefore, I believe that the contestant should select the best features of the cave and show them within a fifteen minute time frame. The judges could then view this more than once if needed.

How should the winners be determined?

By a list of requirements and a perfect score, then taking off where deficient

By selecting categories and judging each from 1 to 10 with 10 being a perfect score.

By voter cards for all viewers to fill out and place in a box, no judges required.

All of the above.

Entries can be scored in each category on a 1 to 10 basis (10 being a perfect score). For each category discard the highest and lowest judge and add for highest score. Possible categories include:

First Impression
Requirements
Technical Information
Artistic Qualities
Understanding of Cave
Ease of Use
Visual Impact
Innovations

Guidelines for each category:

First Impression: If you were overall impressed with the entry then award 10. Subtract 1 for each time you were confused or not impressed with a part of the presentation. Hint, use the work space to make a mark for each time you were confused, then add them up at the end of the presentation. This way you will not be distracted format the presentation by having to take notes.

Requirements: All entries should score a 10 here in order to win an award. It may be possible that an entry may have the highest score but not have all the requirements. Subtract 2 for each missing item not shown during the presentation.

Cave Name
Obvious Entrance or connection with remainder of cave
North Arrow
Scale and linear units
Vertical Control
Date Surveyed
Cartographer or survey group name

Technical Information: This is very open ended, start with 0 and add .1 for each time you note a piece of technical information being displayed. Again make small marks in the work area as you view for technical data. For examples, cross

sections may have dimension, or notes on geology, biology, minerals, etc. A high score in this category may be only a 2 or 3.

Artistic Qualities: Personal judgment call, look for good photos or cross sections with lots of detail.

Understanding of cave: If you leave the presentation feeling that you have been there and it was a good experience the score high.

Innovations: Start with 0 and add 2 for each major innovation, anything that is not normal but helps the viewer to better understand the cave.

Visual impact: Personal judgment call, were you still impressed after studying the presentation in more detail, was the presentation well balanced, did you feel you learned something.

Thom Engel and I responded to Hubert's comments and suggestions. I was in agreement on most of Hubert's points. Thom, on the other hand, had a different perspective on things. His comments made Hubert and I rethink some of our initial ideas. Following is a summary of comments and suggestions made by Thom, Hubert and myself and submitted to the committee for review and consideration.

What should be judged?

Engel

At this time, I feel we cannot judge just the cave. Certainly, the nature of the cave is important, but so is the software. Eventually I can foresee a time when electronic cave maps (ECM) may be like virtual reality and the user will feel like he or she is doing the cave. (I also foresee this becoming a standard format.) In the meantime, I do not see any rationale for divorcing the maps from the medium. I will try to make my point.

We have standardized many cave mapping symbols. We expect non-standard symbols to be included on a legend. We do this so the map is useful. If we separate software and cave in the ECM, then we are potentially eliminating usefulness as a judging criteria for ECMs.. Some of the criteria we use to judge maps are based on technique - neatness etc. If we drop the software from that which is judged, aren't we eliminating technique from judging?

I think we need to keep software. Perhaps we need two categories: one for maps produced using original software and one for those produced using off-the-shelf software. Just as we have criteria for assessing technique for the drafting of paper maps, we could and should work out criteria for ECMs.

Crowell

I was in favor of the idea that Electronic may be any device for displaying a cave: computer, CD player, slides, movies, or whatever. However I must agree with Thom, you cannot divorce the maps from the medium. The credit must go to the person submitting the map who may in most cases be the author of the software or there may be no software involved. I believe that we should encourage authors of software to submit maps. Unless they are more than three entries they should not be judged but mentioned for show only. This would probably mean no judging this year.

Kambesis

I believe that electronic maps should be judged on how well the cave passage and passage relationships are depicted, on whether the mandatory elements are shown and on what information is provided and represented. Initially my opinion

was that electronic maps should be judged solely on those criteria. However, the presentation of these criteria is also important. Consequently the presentation medium needs to be considered i.e. the software/hardware.

PRESENTATION

Engel

I am opposed to the idea of a 15-20 minute walk-through by the programmer. We don't let a cartographer show us only those parts of the cave map that are best. We look at the whole thing when judging a paper map, an ECM should be no different. Further, I personally believe that the user front-end is very important. I'd submit that an ECM that requires a walk-through by the programmer is probably not ready for judging. The judges should be able to sit down with the ECM and with a minimum of instructions navigate through it without much difficulty. If an ECM can be used only by one or two trained in the arcania of a certain program, the map is of little usefulness and, therefore, of reduced value.

If my attitude seems unnecessarily rigid, I would offer a compromise that "ease of use" be a judging criteria. Thus, entries that required a walk-through because the program was too complicated would score a zero (0) in this category.

One reason we do not use the same criteria for ECMs as we do for paper maps is that they are so different...

Thom Engel

Crowell

I suppose we should drop the time limit for judging and leave that up to the judges. With respect to presentation:

The map can be presented to the judges by the cartographer

The entry can be self displaying

The entry can be presented on disk with instructions on how to start and display the map.

Kambesis

From the standpoint of the judges, a time limit is probably desirable; unless we come up with two sets of judges, one set to judge the traditional maps and a second to judge the electronic format maps.

It doesn't matter to me how I access the map (whether its presented by the cartographer, self-displaying, or presented on disk with instructions). In all cases, the entry should display the most important features of the cave plus the mandatory elements as defined by the salon, and show them within a reasonable time frame. Also, it is from the presentation facet that the software/hardware should be judged or considered.

Judging criteria

Engel

One reason we do not use the same criteria for ECMs as we do for paper maps is that they are so different. Of the mandatory elements, I question the north arrow. Certainly a direction indicator is necessary but I think that adhering rigidly to a north arrow makes little sense. A direction of view indicator seems more usable.

Of the technical information, I think we'll see a time when detail thoroughness will become meaningless. With the increase in VR technology, undoubtedly some ECM will string together digital "photographs" of a cave, allowing the

user to literally walk through the cave, choosing any lead. With such a system, the ECM will naturally have much detail

Crowell

Mandatory elements - every entry should contain the following information. How this information is presented or accessed is up to the cartographer.

All entries should score a 10 here in order to win an award. It may be possible that an entry may have the highest score but not have all the requirements. Subtract 2 for each missing item not shown during the presentation.

Cave Name
Obvious Entrance or connection with remainder of cave
Direction of View
Scale and linear units
Vertical control
date or dates surveyed
List of surveyors or survey groups.
Cartographers name; date or version

Kambesis

In my original "mandatory elements" recommendations I suggested a North arrow. Thom is correct in that the North arrow (as displayed on paper copy maps) is really not pertinent. As he suggests, a direction of view indicator would be more pertinent

I would like to see some minimal geographic location reference i.e. county & state, country. Also it would be good to combine "direction of view" and "scale and linear units" into one element as these elements need to be present on any type of map

All the mandatory elements (as per Crowell's list above) should be present in some form. If a mandatory element is missing then the entry does not qualify for an award.

The two pieces of technical information that I think should be mandatory are cross sections and detail thoroughness. Examples for detail thoroughness include information about pit depths, ceiling and dome heights , composition of the passage floor. I would recommend the following mandatory elements:

Cave Name
Minimal geographic information (county, state, if in foreign country include the country name)
Obvious Entrance or connection with remainder of cave
Direction of View /Scale and linear units
Vertical control
Cross Sections
Detail thoroughness
Date or dates surveyed
List of surveyors or survey groups.
Cartographers name; date or version

Optional Technical information can include:

lead descriptions
profiles and associated information
geologic, mineralogical, geographic, hydrogeologic, historical or archeological information, rigging or other technical requirements (in order to negotiate the cave)

For judging purposes, each mandatory element can be worth 1 point. Each category of technical information can be worth 1 point also.

Understanding the Cave

Engel

This will be tricky. To understand a cave we often must stand back from it. That is a major reason we map it in the first place, I suppose. Certainly, an ECM with its ability to provide views of a cave from multiple angles, offers the potential to understand a cave better than a conventional map.

Still, I am concerned that some ECM's might fail this test. It is a very important criteria in the judging of an ECM..

Crowell/Kambesis

Is the presentation clear and concise giving a good understanding of the nature and orientation of the cave? If symbols are used is a legend available?

Artistic Quality and visual impact:

Engel

I agree, I think, with combining these, but at this time I am not convinced that ECMS have any real "artistic quality." I guess we will see.

Kambesis

I would combine artistic quality and visual impact because these are both subjective qualities that are difficult to analyze and define. They both affect one's first impressions of a map representation - so I left that category (first impression) out.

Crowell

Was the presentation and format visually pleasing and well balanced?

In order for the innovation to be relevant it must augment the viewer's understanding of the nature, orientation and layout of the cave ...

INNOVATIONS

Engel

Yes a good idea. For complex caves with multiple levels the ability to remove levels to clarify relationships would also be nice. The concern, however, is with changing judges, we will need to a maintain a "corporate" memory of what is an innovation and what isn't'. This will require a good definition of "innovation"

Crowell

Any element that is not standard but gives the viewer a better understanding of the nature and orientation of cave (a list of previous innovations should be maintained for future judges). Elements that enhance the presentation can include: 3-D projections (or other complex representations); "fly throughs" i.e. the viewer gets a sense of actually moving through the cave passages; database information about the cave which may be access through the presentation; ability to remove levels to clarify relationships etc.

Kambesis

Uncommon, unusual and creative ways of presenting relevant information about the cave should be considered an innovation. In order for the innovation to be relevant it must augment the viewer's understanding of the nature, orientation and layout of the cave (see elements included in Crowell's comments above.)

I'm not sure about keeping a list of previous innovations if it mean that if someone did a certain thing two salons ago, though this "thing" is still rarely used, then it is no longer considered an innovation? If everyone starts using an innovation it will eventually becomes standard (and ceases to be an innovation).

SCORING OF ENTRIES

Engel:

No comment at this time - though I wonder whether some criteria should be more equal that others i.e. given greater weight. (We sort of do that now with the Mandatory Elements for the paper maps.)

Crowell

The entries are scored in each category on a 1 to 10 basis (10 being a perfect score). Categories can include:

Requirements
Technical Information
Understanding of Cave
Ease of Use
Artistic Quality & Visual Impact
Innovations

Kambesis

I would add Presentation to this list as this is where the software/hard elements comes in.

Also, in order for an entry to be qualified for an award it must contain all the mandatory elements as suggested in either Crowell's or Kambesis' judging criteria comments.

The entries are scored in each category on a 1 to 10 basis (10 being perfect score). Scores for all the categories are totaled and that number is the scored rating of the presentation.

This is similar to how the traditional maps are scored. I think that would work fine for Salon judging. We don't want a method that is too complicated or time consuming considering the number of maps that may, at some point be submitted. Someone suggested that a separate group of judges rate the electronic maps. Considering how difficult it is to get judges, this may be impractical at this time. However, there may be a time in the near future where the electronic entries require a separate set of judges.

These suggestions have been forwarded to the committee and it is hoped that they can submit guidelines for judging electronic maps at the upcoming convention. As our experience with making, viewing and dealing with electronic maps evolves, so will our guidelines for judging the maps.

Whatever guidelines get instituted at the upcoming salon, will be subject to review and revision for future salons. Consequently, there will be Survey/Cartography forum on electronic map guidelines at the 1995 Survey and Cartography session. Anyone who is interested is encouraged to attend. The session will be set up as an open forum so that the issues related to criteria for judging electronic maps can be discussed. The input from this session will help establish judging criteria for future salons.

Survey Standards

SURVEY STANDARDS FOR HIDDEN RIVER CAVE PROJECT

by Mike Yocum

The survey of Hidden River Cave is being conducted for the American Cave Conservation Association (ACCA). Management and organization of the survey is the responsibility of the Survey Management Committee (SMC). Our goal is to produce an accurate map of Hidden River Cave for use by geologists, biologists, hydrologists, and others interested in the study and conservation of caves. The map will be on display in the American Cave and Karst Museum, and therefore must be of the highest quality, both scientifically and *aesthetically.*

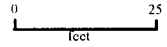
1. Survey notes are the most important part of the documentation process of any cave. They are used not only by cartographers for drafting the map, but also by researchers who are doing scientific study in the cave. In addition, notes on leads are used to generate lead lists for future trips. Survey standards are established in order to assure consistent, good quality survey notes and to provide as much information as possible about the cave.

   The sketcher, who is also the default trip leader, is accountable for the quality of the survey notes. It is the responsibility of the sketcher to produce in-cave sketches that are neat, concise and clearly labeled. Inadequate and/or poor quality sketches may render the efforts of the survey team unusable and may require sending in another team to either re-do the sketch or, if necessary, the entire survey. In order to assure good quality sketch-notes, all sketchers who participate in Hidden River Cave survey trips must be approved by the Survey Management Committee. Those interested in sketching in Hidden River Cave must submit a copy of their work (an in-cave generated sketch, plus the accompanying data) to Mike Yocum. The notes need to be approved by the SMC prior to the sketcher's initial survey trip. A list of currently approved sketchers can be obtained from Mike Yocum.

2. All compasses and clinometers should be calibrated before each trip by taking readings at the compass course set up near the entrance to the cave. CRF

trips should also run the course at Maple Springs. Readings are recorded in the survey book. Be sure to record the serial number from the instruments. This will ensure that the calibration data can be matched to the proper instruments.

3. In-cave sketches should be recorded on standard gridded survey paper. A north arrow (orientation at the discretion of the sketcher) should reside on each and every sketch page.

4. The scale for sketching is either 20 or 25 feet to the inch, or at a scale which shows adequate passage detail. The scale of the sketch really depends on the size and nature of the passage and is left at the discretion of the sketcher. A bar-scale 

rather than an "inches per foot" notation should be indicated on each and every page of the sketch notes. (Because survey notes may be Xerox-enlarged or reduced, a scale indicated as 25"=1 inch, for example, is useless. A bar scale will always be accurate no matter what the percent reduction or enlargement.)

5. All instrument readings have both a frontsight and a backsight. If conditions are such that this is impossible, or will reduce the accuracy of the data, then a double frontsight or a double backsight can be used instead, and noted in the book. Front- and backsights should agree within 2 degrees for compass readings and 1 degree for the inclinometer. If front- and backsights don't fall within the required tolerance, do the readings again. If the instrument reader feels more confident about one of the readings than the other, that reading should be circled on the data page.

6. Frontsights and backsights should be taken with the same instrument.

7. Sketch detail should portray the most striking physical features of the passage or room in proper orientation. These features include prominent slopes, large scale breakdown, ledges, pits, domes, abrupt changes in ceiling height, ceiling and floor channels, water (pools, streams, lakes, sumps, etc.), large formations or formation areas and leads. It is also important to indicate, either symbolically or by notation, the composition of the floor (smaller breakdown, talus, bedrock, flowstone, mud, etc.)

8. In order to show the actual shape of the cave passage, cross sections need to be drawn at every station. If there is a significant change in passage shape between stations, then a cross section should be added between stations to illustrate this. If cross sections are consistent over long stretches of the survey line, then one every hundred feet (or 5 stations) will be adequate. Make sure that the location of the cross section and the view direction are clearly noted on the sketch.

9. Passage dimensions (left/right - ceiling/floor) should be recorded at the "from" station. Be consistent in how these dimensions are determined. When the passage width (left-right) exceeds 15 feet, the passage width should be measured. If a room exceeds 15 feet in diameter, spray shots from a central station (or stations) should be taken to define the walls.

Ceiling heights over 30 feet are difficult to estimate. Tall ceiling heights can be determined by graphic triangulations i.e. plotting out the triangulation angles on the gridded survey paper then actually measuring the ceiling height from the sketch.

10. Permanent survey stations should be set at every 10th station and at every passage junction. The station should be clearly marked and placed in such a manner as to withstand caver traffic and flooding. Each permanent station should be clearly labeled as such in the survey notes. As noted earlier, trip leaders must provide their own permanent station markers, and will be asked to show them before being granted permission to enter the cave. White poker chips are preferred, although other methods will be considered.

11. Geological, mineralogical and biological observations should be noted on the sketches. Also, direction (or change in direction) of air flow (along with the outside surface temperature), and direction of stream flow should be included in the notes.

Anyone interested in participating in the Hidden River Cave Project can contact Mike Yocum, 329 East Main Street, Frankfort, KY. For those who wish to sketch, please submit a copy of your in-cave generated sketch to Mike.

Graphical Solution for Determining Ceiling Heights

by Pat Kambesis

Ceiling heights can be determined by several different methods. Triangulation measurements can be used to figure ceiling heights trigonometrically. The percent grade reading taken from a point on the floor (FROM station) to a point on the ceiling can be multiplied by the distance between the FROM station to a station directly below the ceiling point (TO station). The product of these measurements gives ceiling height. If you are sketching to scale (using protractor and ruler) this passage dimension can also be graphically determined by setting up a simple shot (see illustration) and measuring directly from the sketch.

Pick a point on the ceiling to be measured (Station 1). Establish a station directly under this point (Station 1a). It helps to have a strong enough light that will spot this station i.e. electric.

Set another station (Station 2) some distance from Station 1a. The vertical angle between the two stations must be zero. Tape this distance and note it on the sketch.

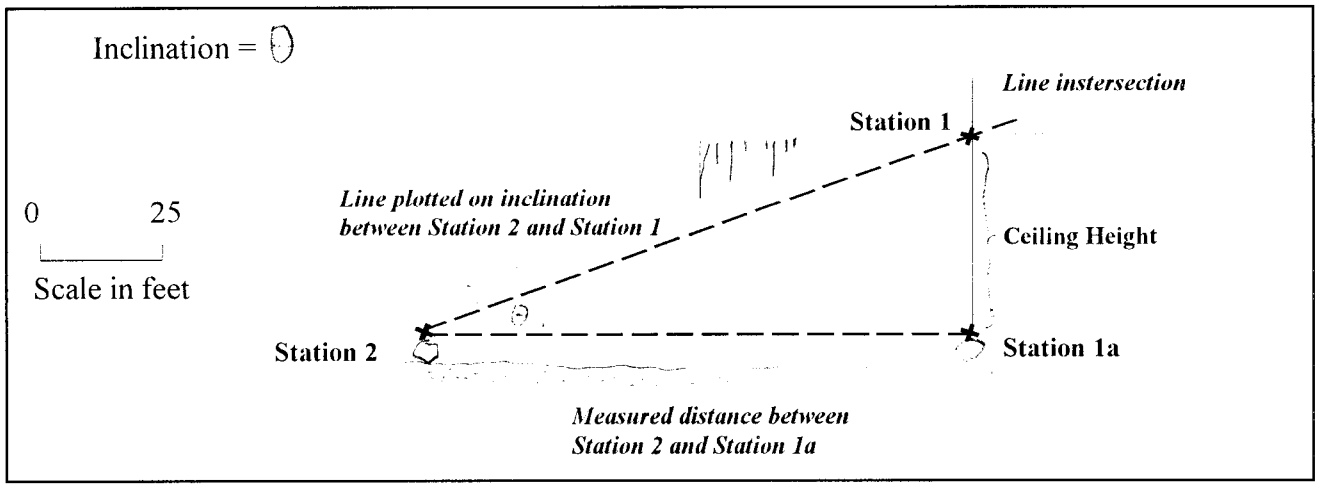
Take an inclination reading from Station 2 to Station 1 (located on the ceiling). Note this incliniation on the sketch.

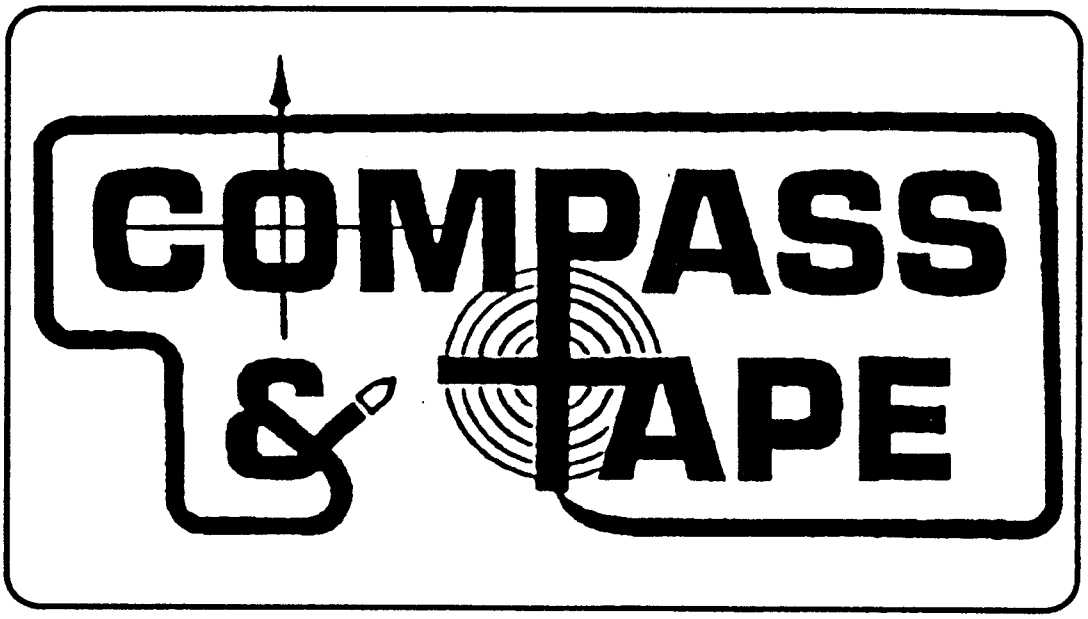
Plot this data in the book in profile as follows:

Using your protractor, plot the inclination between Station 2 and Station 1 and draw a line that connects the two stations on the sketch.

Scale the distance between Station 2 and Station 1a. Draw a horizontal line that connects these two stations.

From Station 1A draw a line that is perpendicular to the measured distance and extend it upward until it intersects the inclination line. This point of intersection is the distance to the ceiling (Station 1) from Station 1A. Using your ruler, measure the perpendicular line that connects Station 1 to Station 1a - this is the ceiling height.





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