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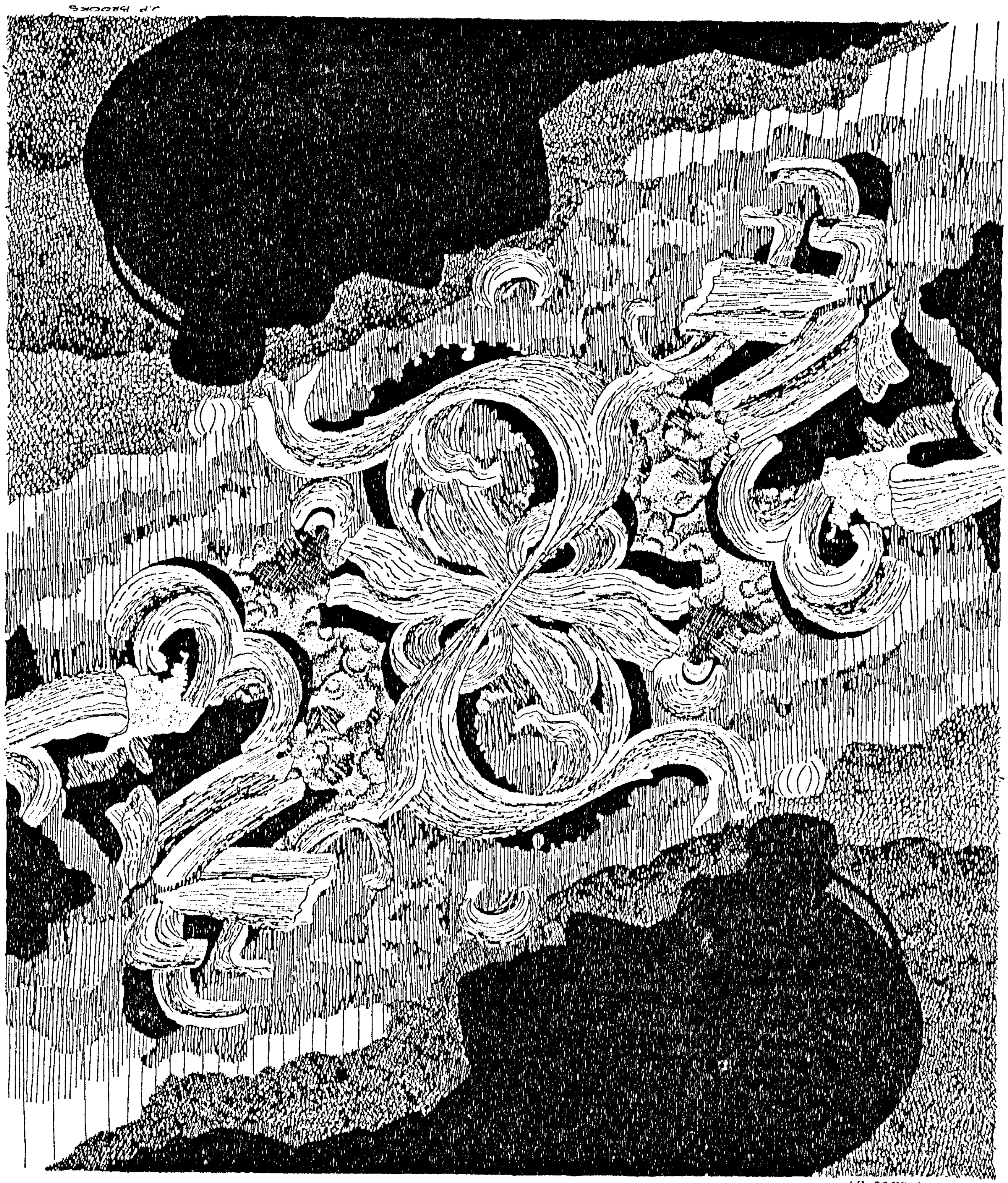

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Survey and Cartography Section - 1989/1990

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A NORTH ARROW AND SCALE FOR STAGE-4 CAVE MAPS

by

Fred L. Wefer

1. INTRODUCTION

In a recent paper in this journal Wefer (1989a) introduced the concept of "stages" in the development of the computerization of cave mapping. These stages span the entire range of activities from performing the basic arithmetic required to produce a cave map (Stage-1) to the direct display of the cave map on the computer graphics screen (Stage-4).

A Stage-4 cave map is a map of a cave designed to be viewed on the computer graphics screen. The information content of the cave map is conveyed via lines, symbols, text, and polygons comprised of pixels on the screen. Extensive use is made of color. The content of the map can be changed at the option of the viewer. Any portion of the cave may be viewed in any 3D direction at any reasonable scale, all at the option of the viewer. Sequences of changes in both content and viewing can be defined interactively by the viewer and played back in a movie-like fashion. The hardware and software which make all this possible are integral parts of the map.

The development of Stage-4 cave maps has required the detailed review of virtually every facet of the cave map. This paper discusses north arrows and scales particularly suitable for use on Stage-4 cave maps.

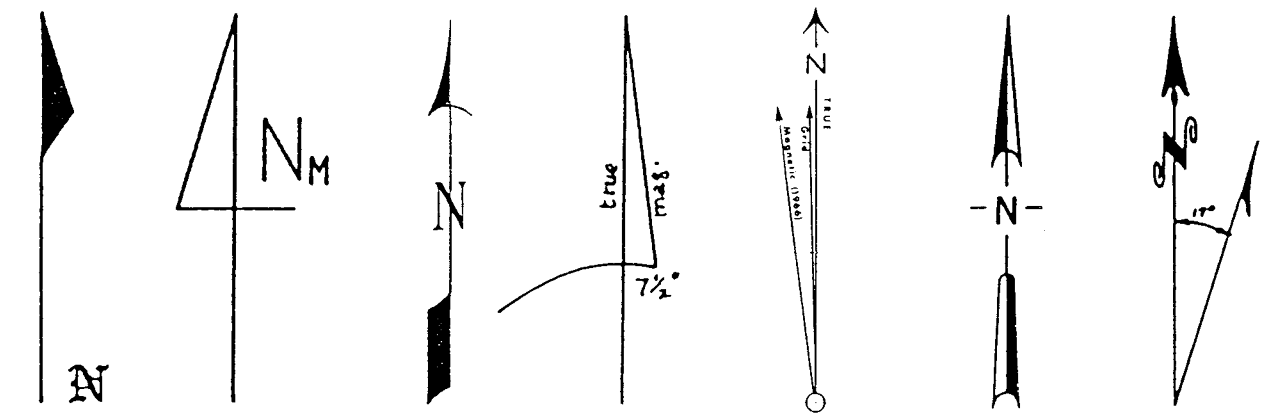
2. BACKGROUND

In most cases the need for both a north arrow and a scale on a cave map is obvious [see Varnedoe (1972) and Ganter (1986)]. Without them the viewer cannot visually determine the direction and distance between two points on the map. Only on some very specialized maps are scales and/or north arrows not needed.

We begin the discussion by looking at some examples of north arrows and scales from traditional cave maps, to determine some of their desirable properties. Other properties which are peculiar to Stage-4 cave maps will then be discussed.

In Figure 1 are shown some examples of cave map north arrows from several sources. Some characteristics of good north arrows are:

- They have an arrowhead,
- They are long enough to be useful in determining the direction,
- They clearly indicate the type of north direction being shown, (e.g., N_{true}, $N_{magnetic}$, or N_{grid}), and
- They are not cluttered by "nonfunctional detail".



(a) (b) (c) (d) (e) (f) (f)

Figure 1. Examples are shown of cave map north arrows. The sources are: (a) Nepstad (1988), (b) Wefer (1982), (c) Hosley (1971), (d) Hedges et al (1979), (e) Ellis (1976), and (f) Thomson and Taylor (1981).

In Figure 2 below are shown some examples of cave map scales from several sources. Some characteristics of good map scales are:

- They show several divisions of distance,
- They show divisions which are convenient to use,
- They clearly indicate the units being used, and
- They are not cluttered by "nonfunctional detail".

In Figure 3 below are shown some examples of attempts to combine the functions of north arrows and scales. Combining them seems to be more prevalent in 3D applications. Characteristics of good combined north arrows and scales turn out to be the sum of the characteristics of good individual north arrows and scales.

The north arrows and scales shown in Figures 1, 2, and 3 have been enlarged (or shrunk) so that they all have nearly the same lengths. They have also been extracted from their maps, so they are out of context. With these points in mind the reader is invited to think about desirable characteristics of north arrows and scales and to decide which among those shown are good and which are bad.

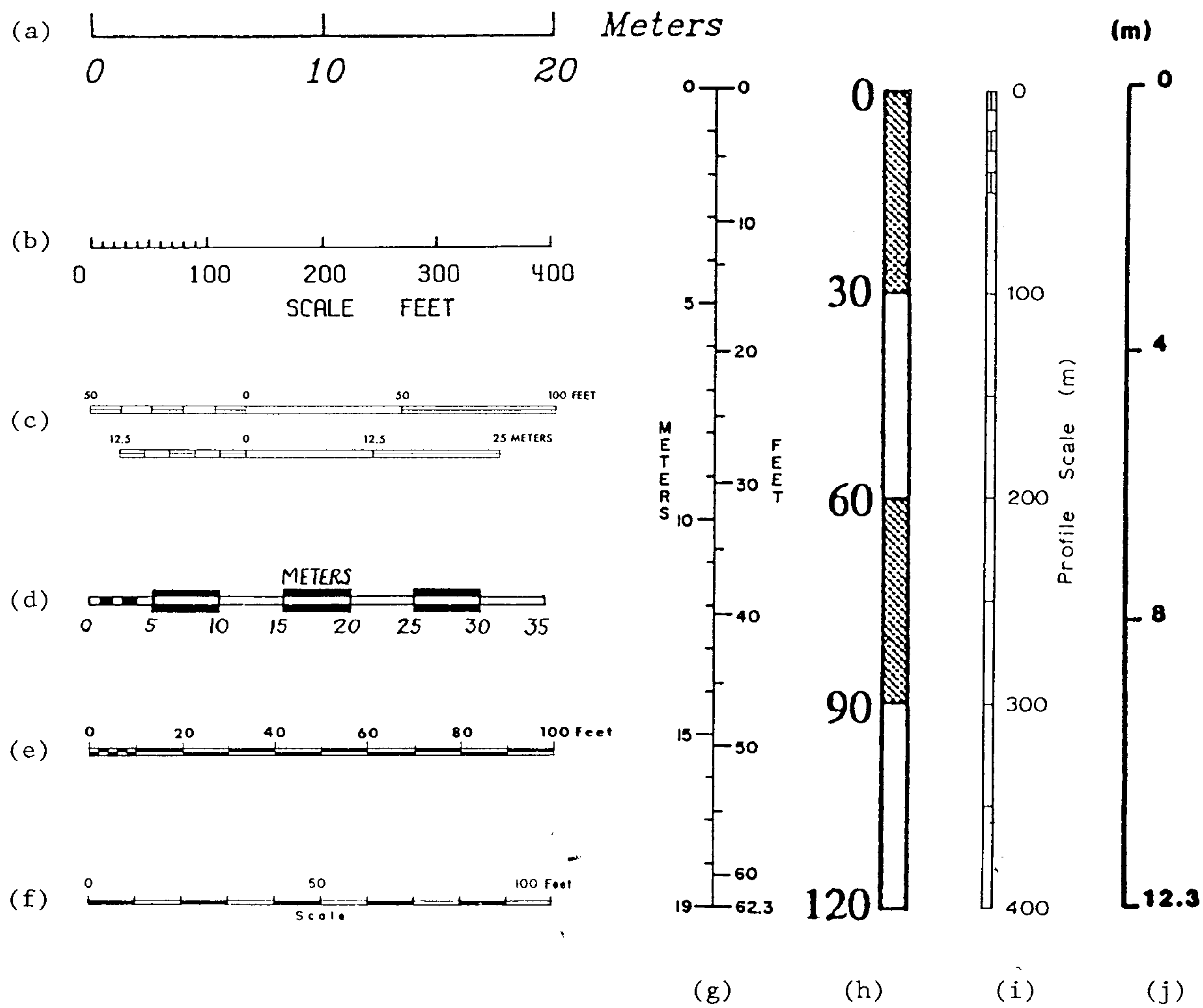
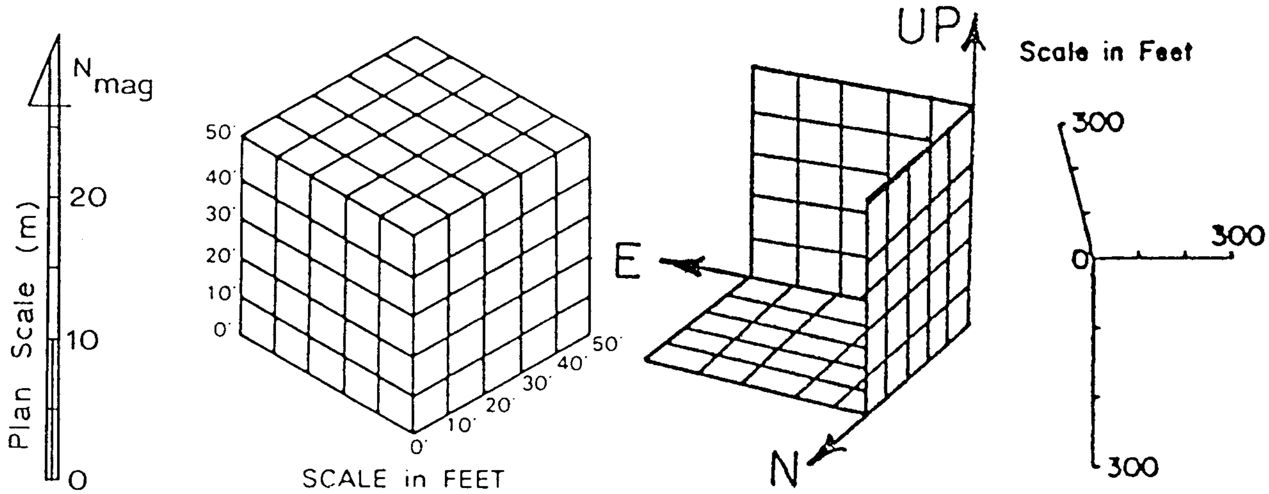


Figure 2. Examples are shown of both horizontal and vertical cave map scales. The additional sources are: (g) Waters (1986), (h) Ganter (1989), (i) Wefer (1989b), and (j) Veni (1985). See Figure 1 for sources (a) through (f).

3. STAGE-4 REQUIREMENTS

Three overriding considerations influence the choice of format for scales and north arrows for Stage-4 cave maps, viz: (1) the area of the map surface is severely limited, (2) the cave can be viewed in any arbitrary 3D direction, and (3) the vertical dimension of the cave may be exaggerated.

Stage-4 cave maps are intended to be viewed on a computer graphics screen, typically an area of approximately 11 x 14 inches or smaller. The scale and north arrow cannot be placed in a legend area in some convenient, otherwise



(i) (k) (l) (m)

Figure 3. Examples are shown of attempts to combine the functions of north arrow and scale. The sources are: (i) Wefer (1989b), (k) Richards (1985), (l) Breisch and Maxfield (1981), and (m) Morris (1976).

unused area of the map. No such area exists. They must either always be displayed on the screen, or always be available for display on the screen, no matter which portion of the cave is being viewed.

Stage-4 cave maps provide the viewer the ability to specify the 3D direction in which the cave is viewed, hence the north arrow and scale must make visual sense when viewed in any direction. All of the north arrows and scales in Figures 1 and 2 fail to meet this requirement, since they all degenerate into straight lines or unintelligible forms when viewed in certain directions.

Stage-4 cave maps provide the viewer the ability to exaggerate the vertical dimension of the cave in order to more easily see relationships between some features on the map. This means that a single scale bar in a single dimension cannot provide sufficient information in both the horizontal and vertical directions. The scale must be multidimensional to correctly reflect a vertical exaggeration.

The above discussed considerations result in the following three derived requirements for Stage-4 scales and north arrows:

- A scale and north arrow must always be available for display,
- The north arrow and scale must make visual sense when viewed in any 3D direction, and
- The scale must be multidimensional and must correctly reflect any vertical exaggeration being applied.

4. STAGE-4 DESIGN ELEMENTS

A computer program now called Interactive Cave Map (ICM) was used by Wefer et al (1983) to illustrate the application of interactive computer graphics to cave mapping. ICM is written in FORTRAN and makes extensive use of a commercial software graphics product called TEMPLATE (a graphics package based on the proposed CORE graphics standard). ICM has continued to be used by this author in the last seven years as a prototype for Stage-4 cave mapping.

A list of design elements which, by experimentation via ICM, have been found to satisfy the above requirements is shown below. These design elements can be divided into two sets, (1) those which are provided by the north arrow and scale themselves, and (2) those which are provided by the functionality of the supporting software.

4.1 DESIGN ELEMENTS PROVIDED BY THE NORTH ARROW AND SCALE

The following design elements are provided by the north arrow and scale themselves:

- Combined north arrow and scale in one 3D icon, here called a "north/scale",
- Distinctly different arrowheads on each Cartesian axis,
- Scale shown on each axis in exactly the same manner,
- Purely textual information placed elsewhere, and
- Nonfunctional detail eliminated.

To conserve space on the screen the north arrow and scale are combined into one icon called a "north/scale". Using distinctly different arrowheads on each axis makes it clear which axis is which, no matter what the viewing direction.

Showing the scale on each axis in exactly the same manner means that any differences in appearance must result from either the viewing direction (an effect which cannot be avoided) or from vertical exaggeration. The numeric factor of the vertical exaggeration is shown elsewhere on the map.

Textual information includes: the distance between tic marks on the north/scale, the type of north being shown, and the numerical value of the vertical exaggeration factor. In order for textual information placed on the north/scale to always be readable, it would need to be present in three orthogonal planes. Rather than clutter up the icon, textual information is placed in a stationary block of text elsewhere on the map.

Nonfunctional detail includes the doodads, curlycues, gimcracks, and gewgaws which some cartographers seem unable to resist putting on their maps. They tend to be distracting and, by definition, add nothing to understanding the cave. In Stage-4 cave maps these nonfunctional details actually interfere with the north/scale or render it totally unintelligible. Note that changing color within the north/scale is here considered nonfunctional detail, hence is to be avoided.

4.2 DESIGN ELEMENTS PROVIDED BY THE SOFTWARE FUNCTIONALITY

The following design elements are provided by the functionality of the supporting software.

- A north/scale always in view:
  - Multiple north/scales within the cave,
  - A north/scale "pinned" on the screen,
- Viewer option to make the multiple north/scales visible or invisible.
- Viewer option to make the pinned north/scale visible or invisible.
- Viewer specified locations for all north/scales,
  - Default locations, and
  - Viewer specified locations.

Two methods are used in ICM to provide a north/scale always in view: multiple occurrences of the north/scale within the cave and a north/scale pinned at some location on the screen.

Multiple occurrences of the north/scale make it more likely that at least one is visible in any given view. If not, the viewer can always move one of them in the cave so that it is visible, or alternatively transform (rotate/scale/translate) the cave so that one is visible.

The pinned north/scale is rotated and scaled with the cave, but its origin remains "pinned" to a fixed location on the screen. Hence if it is made visible it is always in view, no matter what portion of the cave is on the screen.

Both the multiple north/scales and the pinned north/scale can be moved interactively by the viewer. The locations of the former are specified in the coordinate system of the cave. The location of the latter is specified in coordinates on the screen.

4.3 THE ICM NORTH/SCALE

A north/scale which satisfies the requirements listed in Sections 2 and 3 and which has the design features of Section 4 is shown in Figure 4 below. This is the north/scale currently employed in program ICM. Some additional things to note about the ICM north/scale are:

- The coordinate system is right-handed, with the +X axis pointing east, the +Y axis pointing north, and the +Z axis pointing up.
- The icon is contained entirely within the three principal planes, i.e., the XY, the YZ, and the XZ planes.
- There are five divisions of distance on each coordinate axis.
- The first distance division in each principal plane is shown by a square polygon correctly defined for hidden line removal.
- The arrowheads are defined as follows:
  - North arrowhead = two solid triangles, one in the XY plane, one in the YZ plane
  - Up arrowhead = two short lines slanting downward from the tip, one in the XZ plane, one in the YZ plane.
  - East arrowhead = two open prongs, one in the XY plane, one in the XZ plane.
- The entire north scale is a single user defined color.

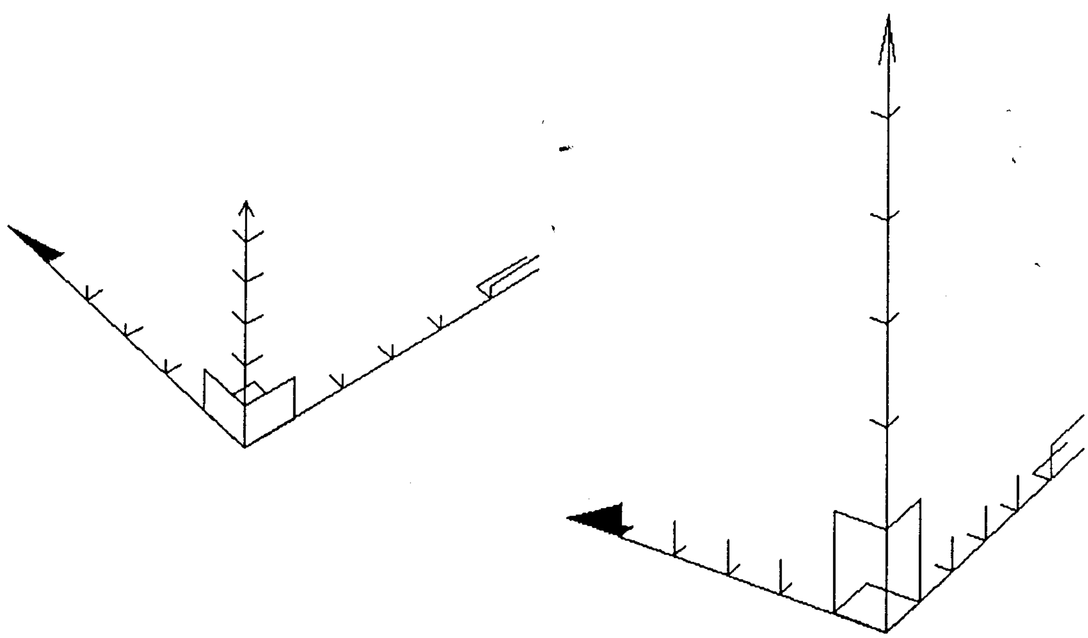


Figure 4. Two views of the ICM north/scale greatly enlarged to show details of the axes and arrowheads. The left one has hidden line removal applied. The right north/scale has a vertical exaggeration factor of two and no hidden line removal.

Figure 5 below shows the ICM north/scale viewed in the following directions: horizontally north, horizontally east, vertically downward, and horizontally north with a factor of two vertical exaggeration. If the design of the ICM north/scale is as good as the author thinks it is, then which is which will be obvious.

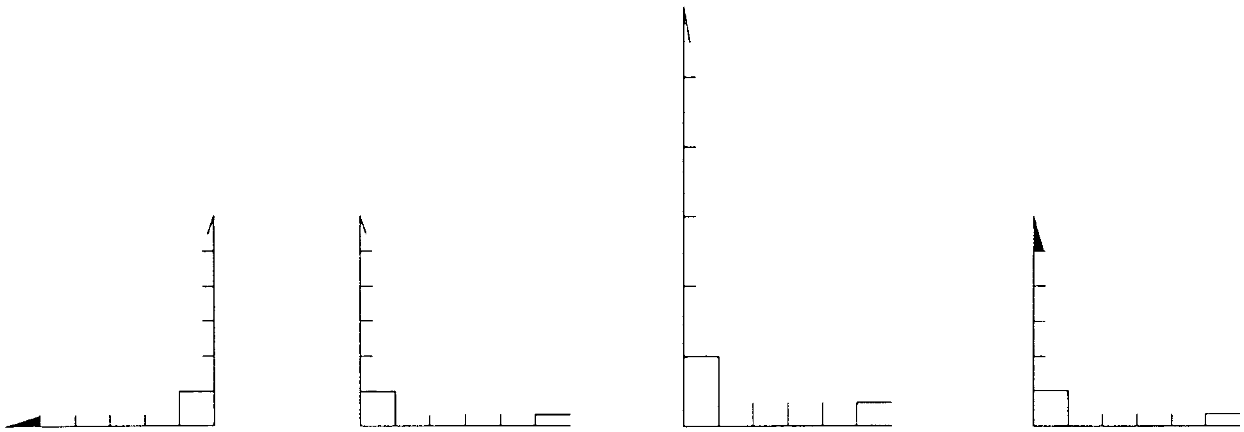


Figure 5. Several views of the ICM north/scale in principal directions, i.e., viewed along coordinate axes.

An example of the use of the ICM north/scale in a real application is shown in Figure 6 below. From the north/scale icon it is apparent that the line of sight is to the southwest and slightly downward. The digital readouts along the bottom of the screen confirm this and provide some additional information. For example, the subscript "g" after the letter "A" means the azimuth is based on grid north. The note "T = 5." means that the tic marks on the north/scale are five meters apart.

5. SUMMARY AND DISCUSSION

The traditional north arrows and scales shown in Figures 1 and 2 may be suitable for Stages-1, -2, and -3 cave maps, but they fail to meet the basic requirements for Stage-4 use. The constraints posed by limited surface area, arbitrary 3D viewing, and possible vertical exaggeration must be taken into account. The requirements for a north arrow and scale for Stage-4 cave maps have been defined.

The ICM north/scale icon presented in Figures 4, 5, and 6 is the result of considerable experimentation over a period of several years. Experience has shown that it satisfies the requirements set forth above. This icon provides a well defined 3D object which will be used in the next paper of the series to discuss 3D map viewing, its definition, and its control.

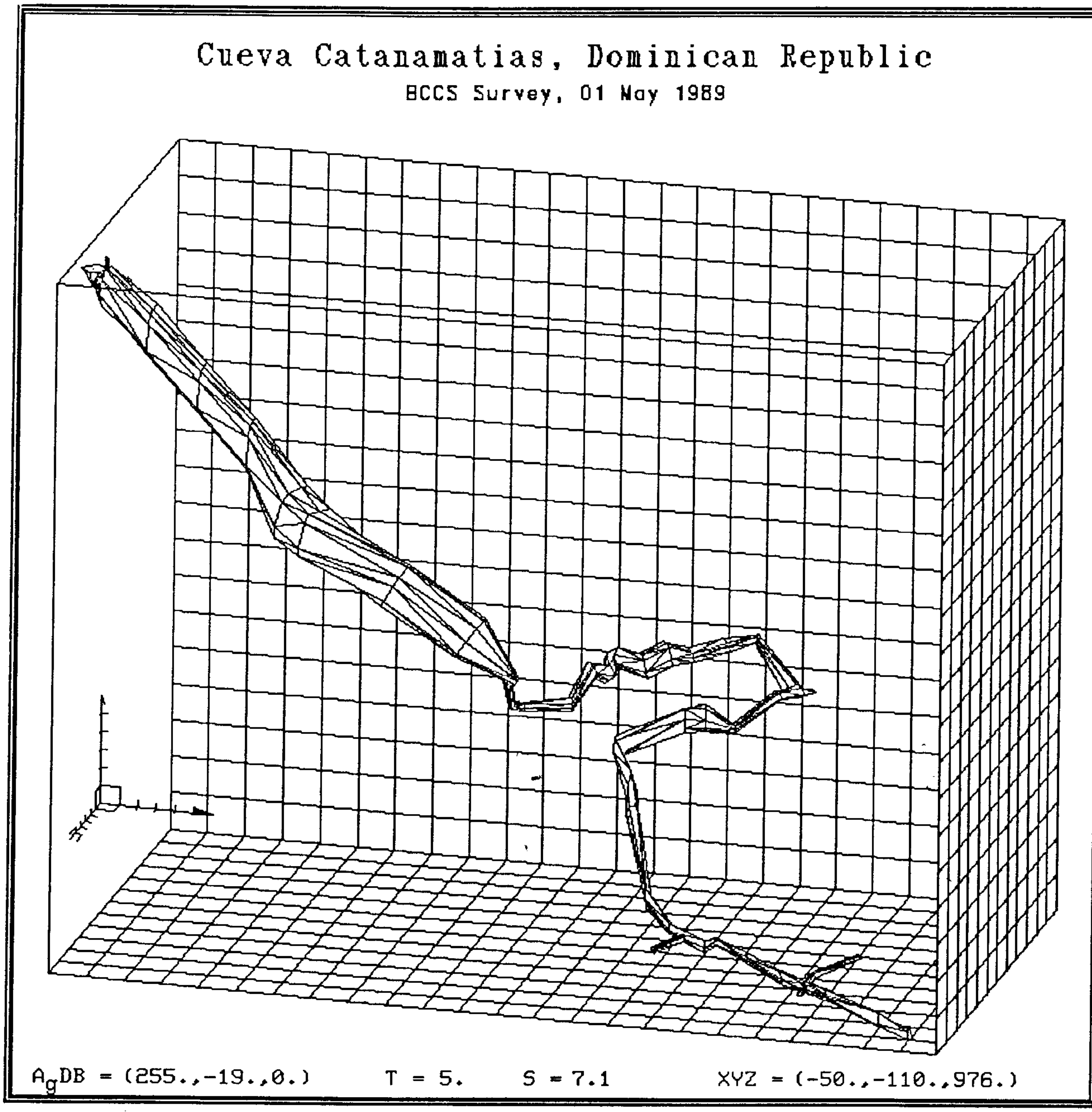


Figure 6. This hardcopy of a Stage-4 cave map is an example of the use of the ICM north/scale. The tic marks on the north/scale are five meters apart. The north arrow points to grid north.

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SUUNTO MODIFICATIONS FOR A LIGHT ROD
by Lang Brod

A friend of mine, a beginning cave surveyor, has purchased a Suunto compass which he is using for surveying. He was disappointed with the plastic rod which he used for inclined sights, so he asked me to construct a bracket for the compass which would hold a glass rod. Furthermore, he wanted the rod held out away from the body of the compass so light coming from a station at a steep angle below the compass would be visible, as well as one from above the compass. After a bit of design effort, I produced a design which satisfies the requirements and which can be fabricated by a reasonably skilled machinist. As shown in the assembly drawing, Figure 1, the bracket consists of four pieces, two for the right side and two for the left side. Each set consists of one side rail which fits along the upper side of the compass and an angular block which is attached to it with three 0-80 brass screws. Each side rail is then attached to the compass with three additional 0-80 brass screws. When the two brackets are fixed to the compass, the angular blocks rest just beyond the front of the compass body; in fact, each Angular block touches the compass at one point of tangency with the curved front edge. Each angular block contains a shallow cylindrical depression which serves as a seat for a 5 millimeter (0.200 inch) glass rod cut to one inch long. When in place, the glass rod is held about 1/32 inch above and beyond the edge of the compass body.

The metal pieces are cut from 6061-T6 aluminum alloy, a hard metal resistant to deformation. All pieces were out from 1/4 inch stock, although thicker material could be used and cut down. The side rails were prepared from a 1/4 X 1/2 bar about 4 inches long. A slot 3/8 wide by 3/16 deep was milled in one side of the bar, forming a U-shaped channel; one side of the channel was then milled away to form a 1/4 X 1/2 x 1/16 aluminum angle. One word of caution: the four aluminum pieces comprise two pairs; each pair consists of two pieces which are mirror images of the pieces in the other pair. Thus, to prevent mistakes, it is advisable to lay out the hole patterns on the side rails while they are still together in one piece. The holes can then be drilled and the angle can then be cut into two pieces and the edges trimmed.

The angled blocks are more complex. To facilitate fabrication, the two blocks were cut into rectangular blocks with square edges, and subsequent cuts were mostly made at angles of 30 or 45 degrees, as shown in Figure 2. Except for the first 30 degree cuts, each block is held in the milling vise by clamping across the 1/4 inch thickness. Steps 1 through 3 are completed, and then each of the two side rails is assembled to its respective angled block. To insure perfect alignment of the assembled pieces, the holes for the 0-80 threads should be drilled while the pieces are held together in the proper position. For this purpose, a .043 drill (size no. 57), matching the holes in the side rails, is used. The holes are drilled into the angled blocks, using the side rails as drill guides. After drilling, the holes should be enlarged at least to .046 diameter. The .046 diameter hole is slightly tight for a 0-80 tap, so that the hole should preferably be enlarged to 1.25 mm (.049 inch), if possible. For additional comments on drilling and tapping, refer to the assembly comments later.

After tapping the 0-80 holes in the angled blocks, the holes in the side rails should be enlarged to .063 diameter. The pieces should then be reassembled and screws installed to check for fit. After screw fit is verified, the holes in the side rails can be countersunk for flat head screws, if desired.

After the subassembly step and subsequent disassembly, the angled blocks are ready for the next major machining operation. In step 5, the upper edges are bevelled at 45 degrees with an end mill ground to a 90 degree point. In step 6, the lower corners, which served to support the blocks during previous machining operations, are cut away. With each block in the milling vise for step 6, the 90 degree end mill can be reinstalled and the bevel of step 7 can be cut. The main objective of steps 5 and 7, as well as subsequent steps, is cosmetic; as shown in the end view of step 7, the 45 degree bevels simply remove surplus metal from the four corners around the light rod seat, thereby eliminating unnecessary sharp edges.

After step 7, the parts are reassembled with the 0-80 screws as shown in step 8, which shows optional rounded screw heads. In step 8, a small projecting corner on each side rail is bevelled at 30 degrees so that it is flush with the angled block. This operation is somewhat difficult to do by machine; it may be better to cut away the projection with a fine tooth file. With this same file, all sharp corners on both pieces can be rounded so that no sharp corners or projections remain. Mounting the Brackets: The subassembly operation shown in step 8 produces two brackets, essentially identical except that one is the mirror image of the other. These two brackets should be placed on the front top side of the compass and held in place by hand, tightly. The distance between the inner ends of the two angled blocks should then be measured, preferably with a vernier calipers; the separation should be approximately .800. The depth of the two .203 diameter cylindrical seats should also be measured. The separation of the blocks plus the depths of the two seats, should equal the maximum length of the glass rod.

To prepare the glass rod, use emery paper of 180 grit or finer to flatten one end of a 5 mm glass rod, and slightly chamfer the sharp edge. Mark off the required length with a fine tip marking pen, and scribe a groove at the line with a triangular file. Grasp the rod firmly on either side of the groove, place the rod in tension, and then bend it, so that it snaps at the groove. If the rod is slightly longer than the desired length, or if the break is slightly angled, the broken end can be shortened and straightened by rubbing it over the emery paper with a back and forth motion. After chamfering the second end, place it in the rod seats and check the fit while the two brackets are tightly held against the compass. If the length is proper, the rod will fit snugly into the brackets while allowing them to lie flat and tight against the compass body.

When the proper length of the glass rod has been achieved, the configuration of the brackets can be checked. If all parts have been properly fabricated, the two brackets with the glass rod between can be placed on the front of the compass, with the two angled blocks tangent to the compass body. In this position the glass rod is sufficiently above and forward of the compass body so that (1) the glass rod is wholly visible from the rear of the compass, and (2) the rod (except for the enclosed ends) can be wholly illuminated by a light source ranging from 90 degrees below the compass to 90 degrees above the compass. Actually, there is very little chance of the inclination being above or below 60 degrees, but the configuration allows full 180 degree coverage.

Final Assembly: After it has been ascertained that the brackets are correct, the final assembly step is at hand. With small clamps, the two brackets can be clamped to the compass so that the side rails are tight against the compass body and the angled blocks are tangent to the curved edge of the compass at the front. After clamping the hole position, the side rails should be checked. The two .043 holes in the top of each rail should lie at equal distances (0-5 in.) from a line passing through the compass pivot point (the center of the transparent window) and perpendicular to the sides of the compass. An appropriate line can be drawn on the compass with a very sharp pencil and a machinist's square. The same pencil can be used to mark the position of the holes on the compass. The two top holes, when extended down into the compass, should penetrate the aluminum body well away from the plastic, liquid filled canister containing the drum dial. The one side hole should penetrate the center of the flat side of the compass at its very end, close to the curved edge. After verifying the position of all six holes, the compass is ready for drilling.

With the brackets clamped in place and serving as drill guides, the six .043 diameter holes can be started, drilling to a depth of perhaps 1/32 inch. The brackets can then be removed, and a final verification of the hole position can be made, if desired. The four holes in the top side of the compass can be drilled to the 1/4 inch depth with little worry, as the aluminum at these holes should extend through the entire compass body, .600 inch. The two holes in the sides of the compass should be drilled more carefully and should not exceed 1/4 inch under any condition. It goes without saying that these operations should be carried out most carefully to avoid damaging the compass or breaking off a drill in the hole. The drill should be sharp, the compass should be firmly supported on the drill press, and a good lubricant should be used. Lubri-Out, a product of Sherwin, Inc., is a good lubricant for this purpose. The product is a grease-like semi solid which can be applied by finger to the end of the drill. The drill should be allowed to cut only a short depth before backing it out and brushing away the metal chips. The drill is then relubricated prior to insertion. A good feel is essential, so that if the drill unexpectedly breaks through, it can be stopped before any damage Is done.

After the six holes are drilled, they can be enlarged to .046 diameter, or to .049 diameter if a 1.25 mm drill is available. The holes are now ready to be tapped, which is a most critical step. A good quality tap should be used, and it should be held in a pin vise rather than a tap handle to permit careful manual control. The tapping operation should be very carefully done, using a good lubricant, such as Lubri-Cut. The tap should be threaded in only a short distance before removing it, wiping off the chips, and relubricating. The tap should turn easily at all times; in no case should it be forced. Special care is required as the tap approaches the bottom of the hole, and the required torque should be carefully monitored by judging the "feel" of the tap as it is turned in. It is preferable to avoid the bottom of the hole and stop just short of touching it. With correct screws, it is only necessary to have 1/8 inch of full thread, plus a slight bit more as a margin for error. If preferred, a bottoming tap can be utilized to cut the last few threads to full depth.

When all six holes have been tapped and cleaned, the holes in the brackets can be enlarged to .063 diameter. As in the case of the six screws used in the subassembly, these mounting screws can also be round head types, but flat head screws are preferred so that there is no projection above the metal surfaces. If flat head screws are chosen, it will be necessary to countersink the clearance holes, thus requiring a countersink. When the bracket holes are complete, the brackets can be mounted.

When carrying out the final mounting step, all screws should be tightened securely to prevent loosening and possible loss. After a brief period of operation to verify the function of the light rod, it might be advisable to temporarily remove the screws and apply Lock-tite or nail polish to the threads prior to reinsertion. Such a step is of course not carried out lightly, as the screws thus treated are difficult to remove, which may be necessary if it is necessary to replace the glass rod. The glass rod will be immune to most treatment except a hard, direct impact

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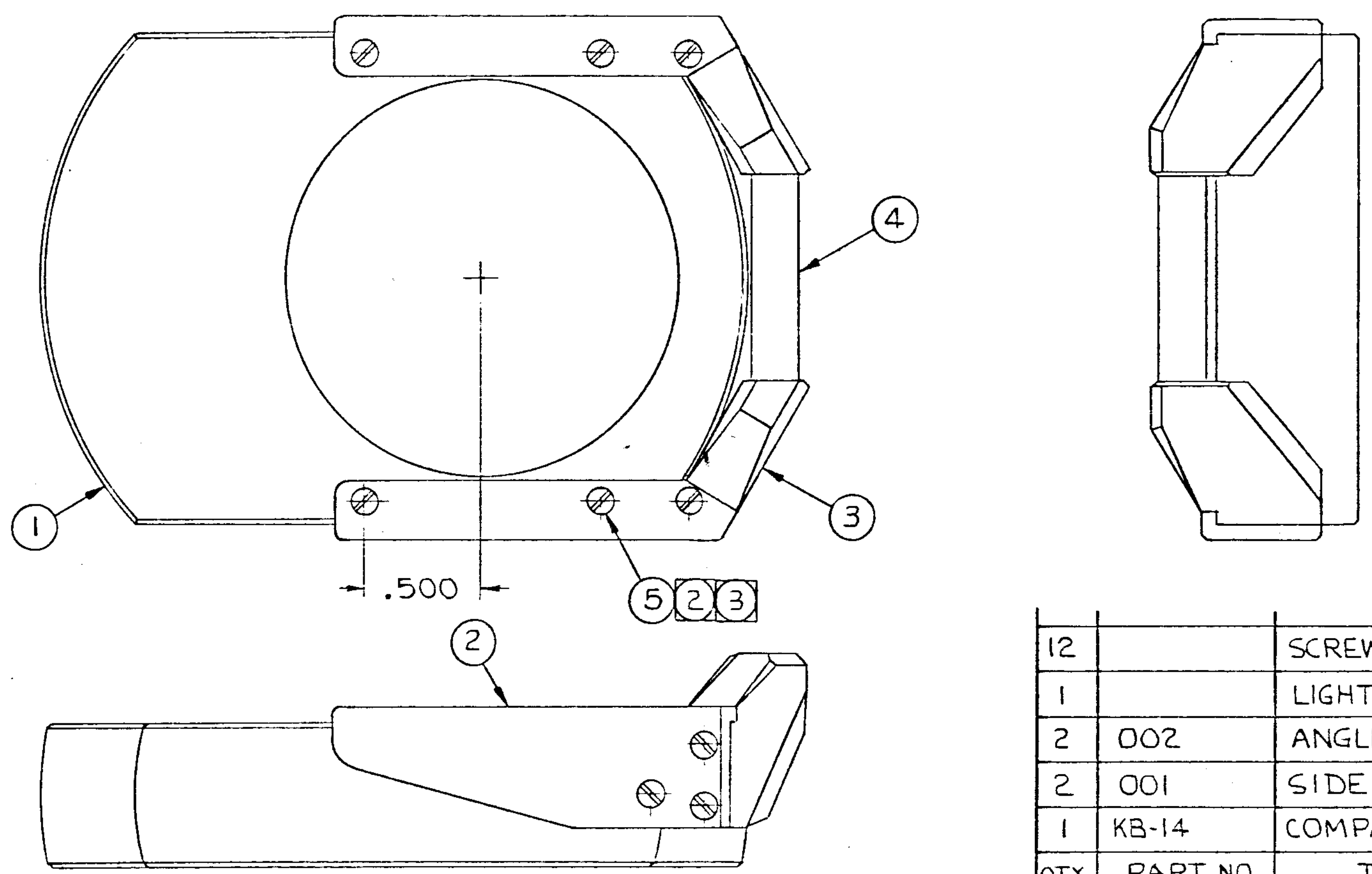
from a rock or hard metallic object, but it could be broken. With the light rod assembly in place and held with flat head screws, the compass can still be inserted into the vinyl carrying pouch provided, where it probably should be kept while not actually being used.

In use, a small but bright light source in the cave will be both reflected from the rod surface and internally reflected and refracted to produce a planar dispersion of light rays from the rod. Observed from the rear of the compass with the pupil of the eye slightly over the rear edge of the compass, the dispersed light will appear as a linear vertical sequence of closely spaced bright spots. The compass is correctly aligned when the spots are superimposed on the extended image of the internal (black) cursor line. To prevent errors arising from compass tilt, the compass should be levelled so that the upper and lower edges of the drum dial are nominally parallel to the upper and lower edges of the rectangular inner window observed through the lens.

A Note Of Caution: The geometric relationships of this design have been carefully worked out; for best results, the dimensions shown on the drawings should be faithfully followed. The juncture between the side rail and the angled block is especially critical, as two out of the three screws lie close together. If the two threaded holes are too close, they may intersect; if too far apart, one hole may break through the metal, weakening the bracket. Likewise, any attempt to modify screw size will either cause interference or a weakened part. If anyone wishes to redesign the bracket, they may do so at their own risk. For redesign, a drawing scale of 10:1 is recommended, at least in critical areas. The screws used to assemble the brackets and hold them to the compass must be absolutely non magnetic, and brass screws are the only common type of screw which will suffice. Both the screws and the aluminum are relatively common and should be readily obtainable. The 5 mm glass rods are commonly used as stirring rods in chemical laboratories.

Parallax Considerations: Some questions have been raised about the possibility of parallax errors with a glass rod sight. Parallax errors are caused by an apparent displacement of two objects at two different points of view. In the Suunto compass, the cursor line and the drum dial are not in the same plane. To prevent errors arising from different eye positions, the field of view inside the compass is constrained by a narrow aperture, so that the eye cannot be moved very far without completely blocking the internal view. Thus, for any fixed compass position, the cursor line and dial position constitute a unique direction, irrespective of slight eye movements.

When the cursor line is superimposed on a distant target, eye movement likewise has no effect, because the target is so far away. Such apparent stability is not the case for a nearby object. A simple experiment with a vertical wire fixed to the front of the compass will show that a slight shift in eye position will produce an appreciable apparent shift in object position. Might not such an apparent shift occur with a spot of light appearing on the surface of the glass rod? Thankfully, the answer is no! The image of the distant spot of light, refracted or reflected by the glass rod, remains in a single vertical plane, and that image appears at a distance, directly above or below the true image. Inasmuch as the refracted/reflected image also appears to be distant, parallax is negligible. Though parallax has absolutely no effect, the compass must still be perfectly level to obtain a true compass reading for an inclined line of sight.



QTY	PART NO.	DESCRIPTION	ITEM NO.
12		SCREW. 0-80 x .19, BRASS	5
1		LIGHT ROD	4
2	002	ANGLED BLOCK	3
2	001	SIDE RAIL	2
1	KB-14	COMPASS (SUUNTO)	1

LIGHT ROD ASSY

SCALE: 2/1 APPROVED BY: DRAWN BY L. BROD
DATE: 20 SEPT 89 REVISED

SUUNTO MODIFICATIONS

FIGURE 1 DRAWING NUMBER 003

3 ITEM 5: ROUND HD OPTIONAL; FLAT HD PREFERRED
2 MATCH DRILL FOR 0-80 THD
1. ITEM 3 TANGENT TO COMPASS BODY ON ASSY

NOTES

11 X 17 PRINTED ON NO 1000H CLEARPRINT

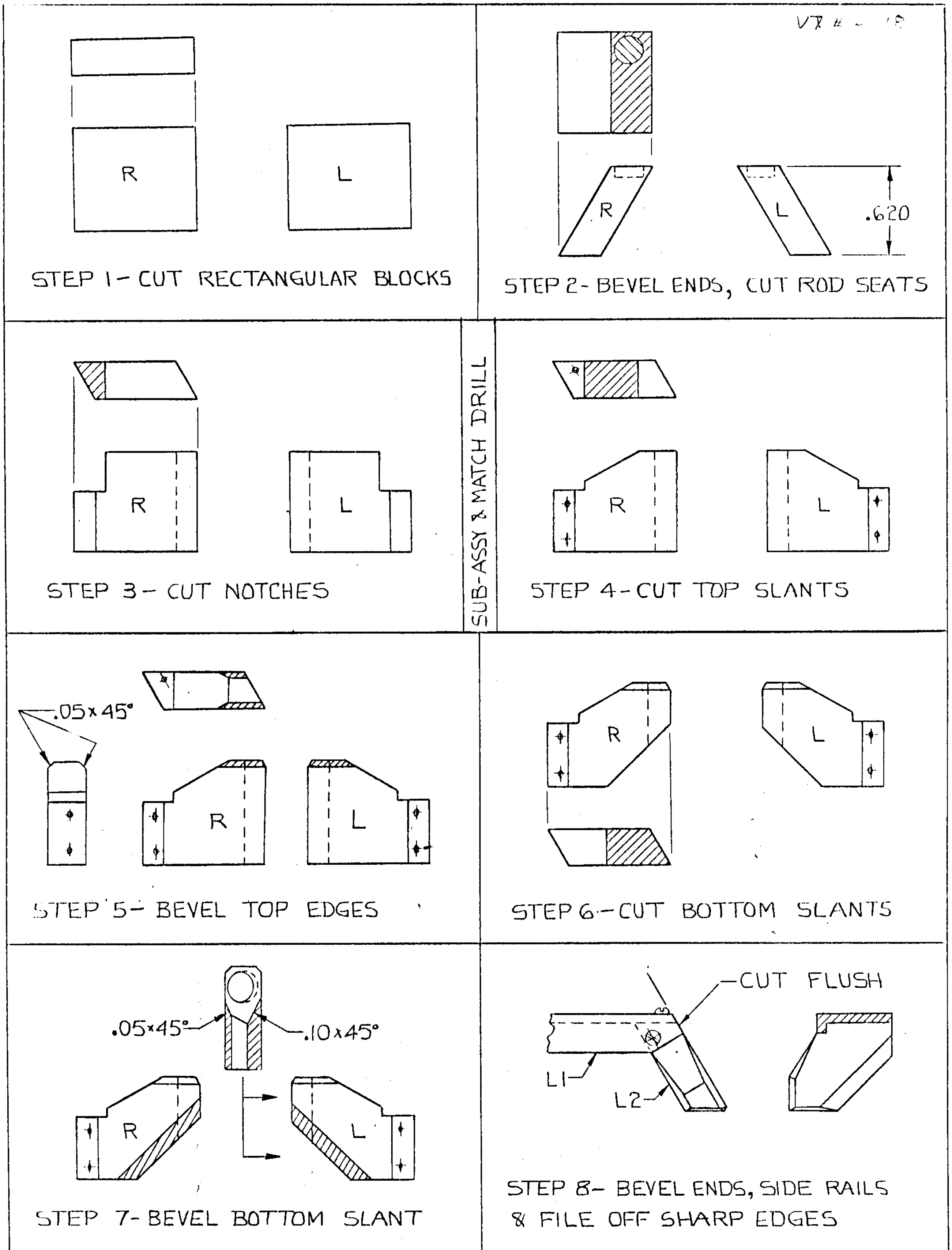
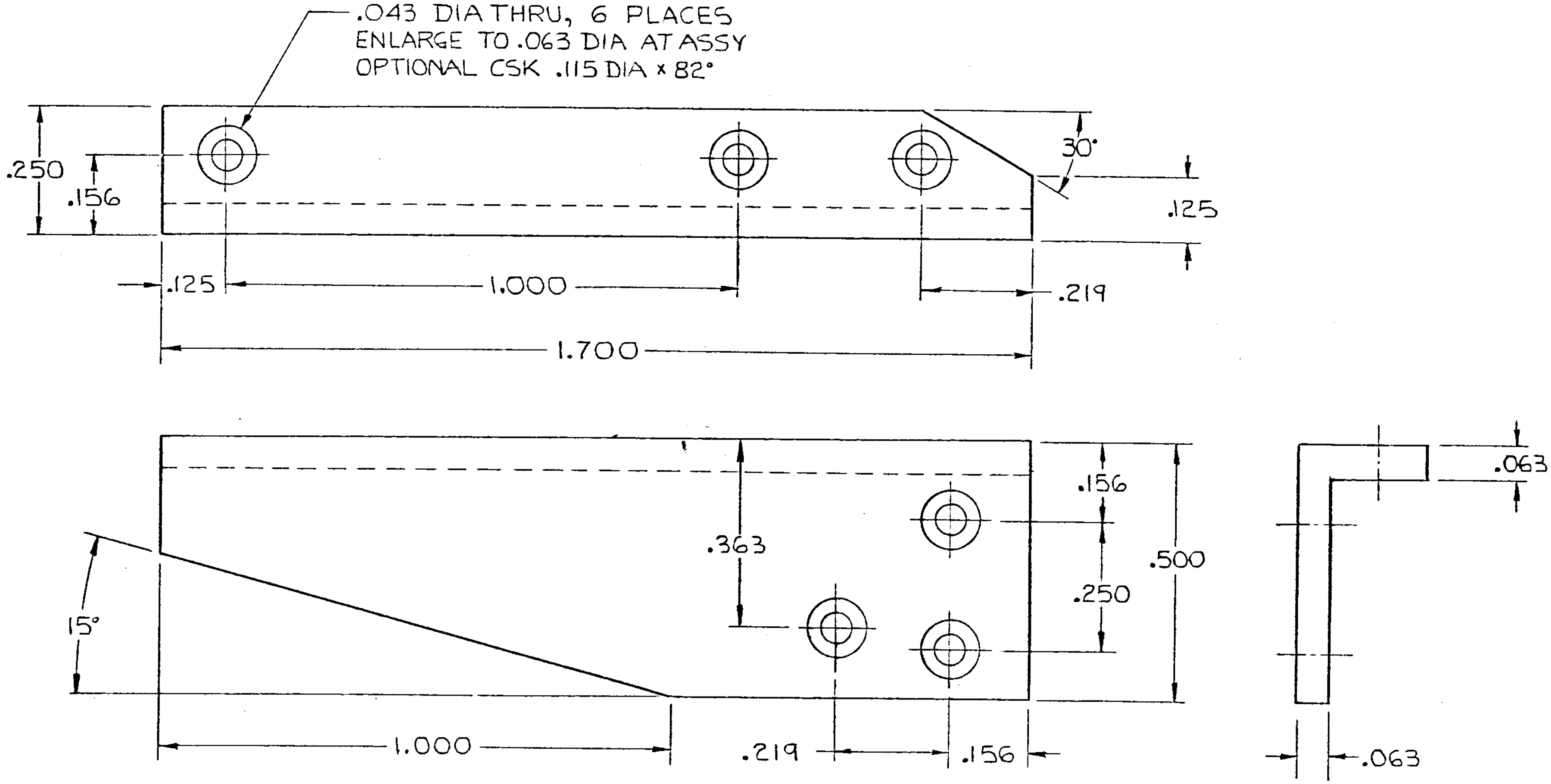


FIGURE 2 - SUGGESTED SEQUENCE OF MACHINING OPERATIONS
HATCHED AREAS SHOW SURFACES MACHINED AT EACH STEP



4. RIGHT SIDE SHOWN, LEFT SIDE IS MIRROR IMAGE
3. RETAIN SHARP EDGES UNTIL AFTER ASSY
2. DIMENSIONS IN INCHES, TOLERANCES ±.005
1. MATERIAL: ALUMINUM, TYPE 6061-T6

NOTES

SIDE RAIL		
SCALE: X 5 DATE: 15 SEPT 89	APPROVED BY:	DRAWN BY L. BROD REVISED
SUUNTO MODIFICATION		
FIGURE 3		DRAWING NUMBER 001

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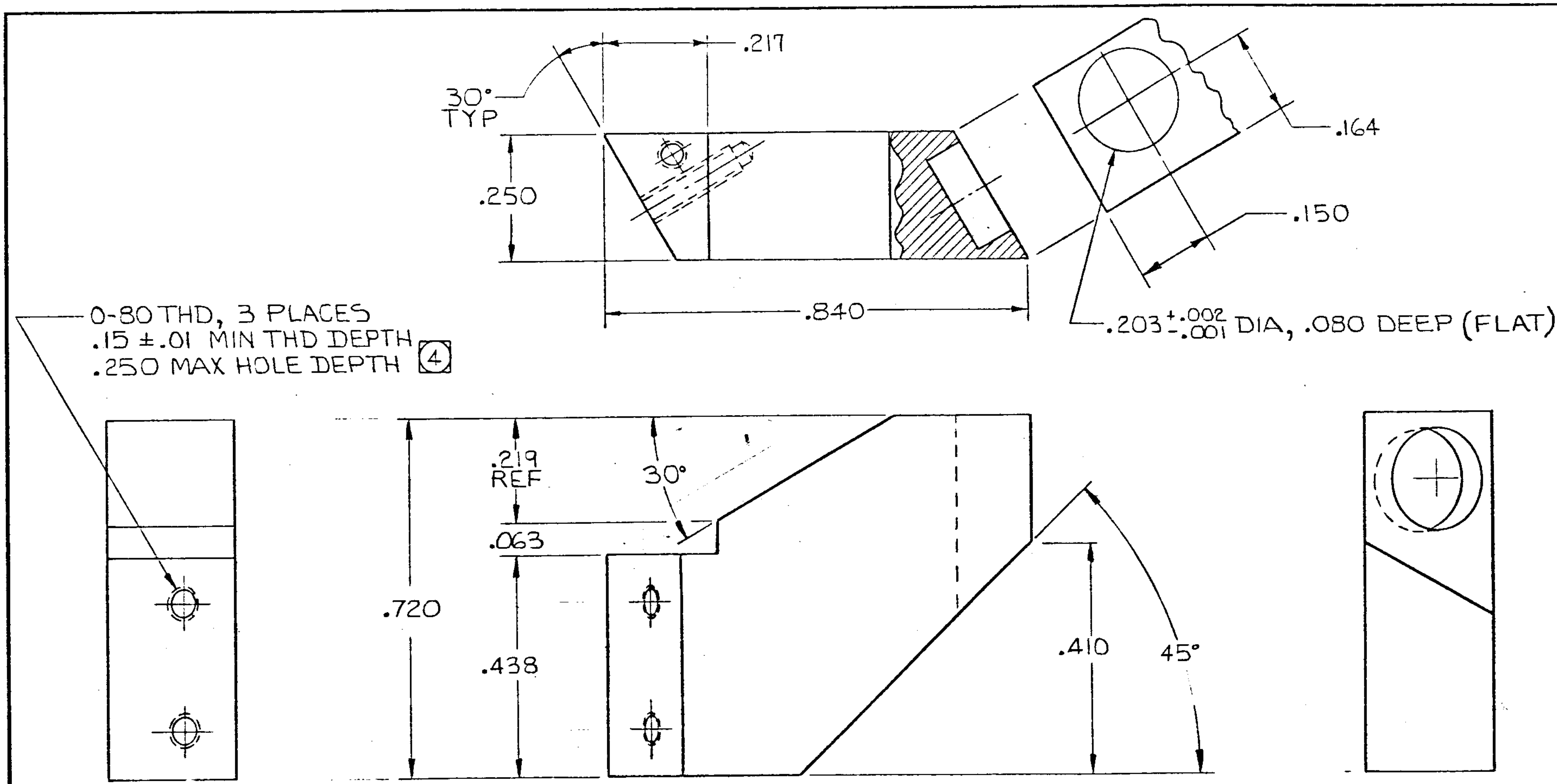

5 RIGHT SIDE SHOWN, LEFT SIDE IS MIRROR IMAGE
4 MATCH DRILL WITH ITEM 001
3. DIMENSIONS TO SHAR CORNERS
2. DIMENSIONS IN INCHES; TOLERANCES ±.005, UNLESS NOTED
1. MATERIAL: ALUMINUM, TYPE 6061-T6

NOTES

ANGLED BLOCK		
SCALE: 5x1	APPROVED BY:	DRAWN BY L. BROD
DATE: 15 SEPT 89		REVISED
SUUNTO MODIFICATION		
FIGURE 4		DRAWING NUMBER 002

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BOOK REVIEW
by Bob Hoke
of
An Introduction to Cave Surveying
by Bryan Ellis

Are you are looking for the definitive treatise on cave surveying; the one that discusses all aspects of the subject and provides guidance for all the arcane mapping situations you will encounter in a lifetime of mapping? Well, if so, this is not the book for you. However, if you want a readable, reasonably complete introduction to the concepts and techniques of cave surveying, then this 40 page booklet published by the British Cave Research Association (BCRA) may be your cup of tea.

When I first saw the book I was prepared to not like it because of its small size (about 6 x 8 inches), small type face, and lack of technical trivia. However, the introduction clearly states that "the purpose of this booklet is to provide a starting point for the person who wishes to make his own survey" and the ensuing chapters do a rather good job of introducing the reader to all aspects of surveying, including equipment, survey accuracy, in-cave techniques, note taking and sketching, map production, and publication.

All of the topics are intentionally treated briefly and only commonly used mapping situations and techniques are discussed. The writer wanted to expose his reader to the major aspects of surveying without too many digressions, and generally he did this.

The book has a rather British flavor but any clever reader will be able to convert Their English into Our English without difficulty. Some of the topics discussed are primarily of interest in Britain, especially their sacred system of survey grading. Several pages are devoted to discussing the requirements for achieving the various grades assigned to survey data and sketches. This material seems rather irrelevant in this introductory text and takes up a couple of pages that could be better spent on other topics. An example of irrelevant material presented is the fact that a grade 6 survey is "a magnetic survey that is more accurate than grade 5." Does this fact really help the novice surveyor?

There are a few omissions that seem significant. One is that only the Suunto (and similar) instruments are discussed and Bruntons are never mentioned. The days of the Brunton being the "premier" survey instrument may be over, but it deserves at least a couple sentences. Another omission, which I consider inexcusable, is the book's failure to emphasize the need to take backsights whenever possible. There is a lot of discussion of survey accuracy and potential errors but backsights are only mentioned one time and their importance is not emphasized. Of course, many venerable (but unenlightened) U. S. cavers have also managed to remain blissfully ignorant of the value of backsights.

Although Ellis made no attempt to address every surveying problem, he has some interesting suggestions. One is that the lead base of an electric bulb can be used as an emergency pencil for taking notes. Another is that passage widths should normally be measured at the height of the caver's eye, whether he be walking or crawling. He also suggests that the final plan map should only contain "the passage width at eye level, major obstacles such as pitches, and active streams and pools; other general floor details should be included if the scale is large enough." This concept would probably be quite alien to the entrants in the NSS Map Salon, who tend to draw every rock and mud clod.

Overall, the book is a good introductory text on how to survey a cave. It covers most of the important major topics that a beginning surveyor needs (and a few he does not really need) and it is quite readable despite the small type size. The book is available from Speleobooks (P. O. Box 10, Schoharie, NY 12157) for $3.00, which is lot easier than trying to get a copy from England.

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