THE BRAIN PREFERS THREE DIMENSIONS

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A resumé of methods than can be used to depict three dimensional cave data on two dimensional media. Emphasis is placed on those techniques not requiring special aids, those that are suitable for use by active cavers and those that are good for public display.

The holographic method of display is put forward as a technique that should be considered for cave records keeping not just a novel method of display.

Cavers have something in common with people. Both are sight orientated and see their world as a visual three dimensional space. However, unlike ash-tray collectors, we have this code of ethics that prevents us from carrying home what we find in our temporary places of abode. Besides, most of us would prefer to take home all of the cave and so far that has proved impractical. We make do with visual triggers to jog our memory; data to create 'mental' caves for others; and that good old loophole - "I'm taking this home for science".

Because our brain prefers 3D images, cavers often resort to the use of symbolic art, sometimes known as cave maps. We tend to forget that plans and sections with all their lines, dots and crosses are arbitrary representations of three dimensional entities. This is why everyone draws their own interpretation of the same cave. You can always tell who the creator of a map was by the style in which it was done, even though we all use the same set of symbols. It takes training and use to be able to readily re-create a cave from maps.

Similar practice is needed to read contour maps. It's just that these are thrust at us from a wider variety of people, and hence we are more used to translating contours into 3D objects. Why are contours used? Because it is easy to draw them, they can be done in black and white which is good for copying cheaply, but very importantly because everyone is expected to have trained themselves to read contours: the authors do not have to train their readers. Of course I should remind you that many contour maps are used as a method of converting overpowering spatially-related-data lists into quickly perceivable visual images. Everyday, TV thrusts barometric charts at us with their highs and lows instead of say heavy and light - a typical double conversion to enable our brains to use our excellent visual processing systems. Maybe we should use the same techniques for caves and present contours of say passage height or floor elevation as well as trying to produce a pseudo-picture.

An interesting possibility is to get the brain to convert visual images into body sensations. For instance, a cave map showing temperature as blue for cold and red for hot with all the in-betweens can, with training, be converted into real temperature feelings. Cave maps were initially just wall outlines which then progressed to imitating photographs with sketches of internal features. Our present symbols are usually pictographs. The brain can easily convert these pseudo pictures into 3D images by calling upon the reader's caving experience. A non-caver finds the task much more difficult if not impossible without having seen cave photographs.

Cave maps, diagrams etcetera are used to create a picture of caves that cannot physically be viewed from a vantage point. These methods have been devised to circumvent mere physical limitations. Possibly isometric views - of which the block diagram is a primitive form - are best, because (unlike plans) they give the perspective which the brain expects for 3D objects even if what is solid is shown as void and vice versa.

The next step up the ladder of realism is the cutaway views which keep the solids solid. These are a specialized version of the sketch.

But even if we use photographs or movies, we are relying on the brain to use pictorial cues to convert 2D to 3D. Many of these cues are unavailable, contrived or misleading when dealing with cave pictures. Some of these cues that I am talking about are; shadows to determine up, concave/convex and near/far properties (the sun is up but not necessarily the flash gun!); shadows from reflected or side light to enable the brain to determine relative distances and which is front/rear; and expected sizes - any "usual" object such as a person has a "known" height from which the brain will scale off the rest of what it sees.

If, like me, you feel I should give my brain a rest, then the use of stereo-pairs is in order. There are two major display categories of stereo-pairs - the non-overlapping and interwoven types. The former are the common twin pictures each looked at by a different eye - a good way to examine things at different scales without losing all 3D.

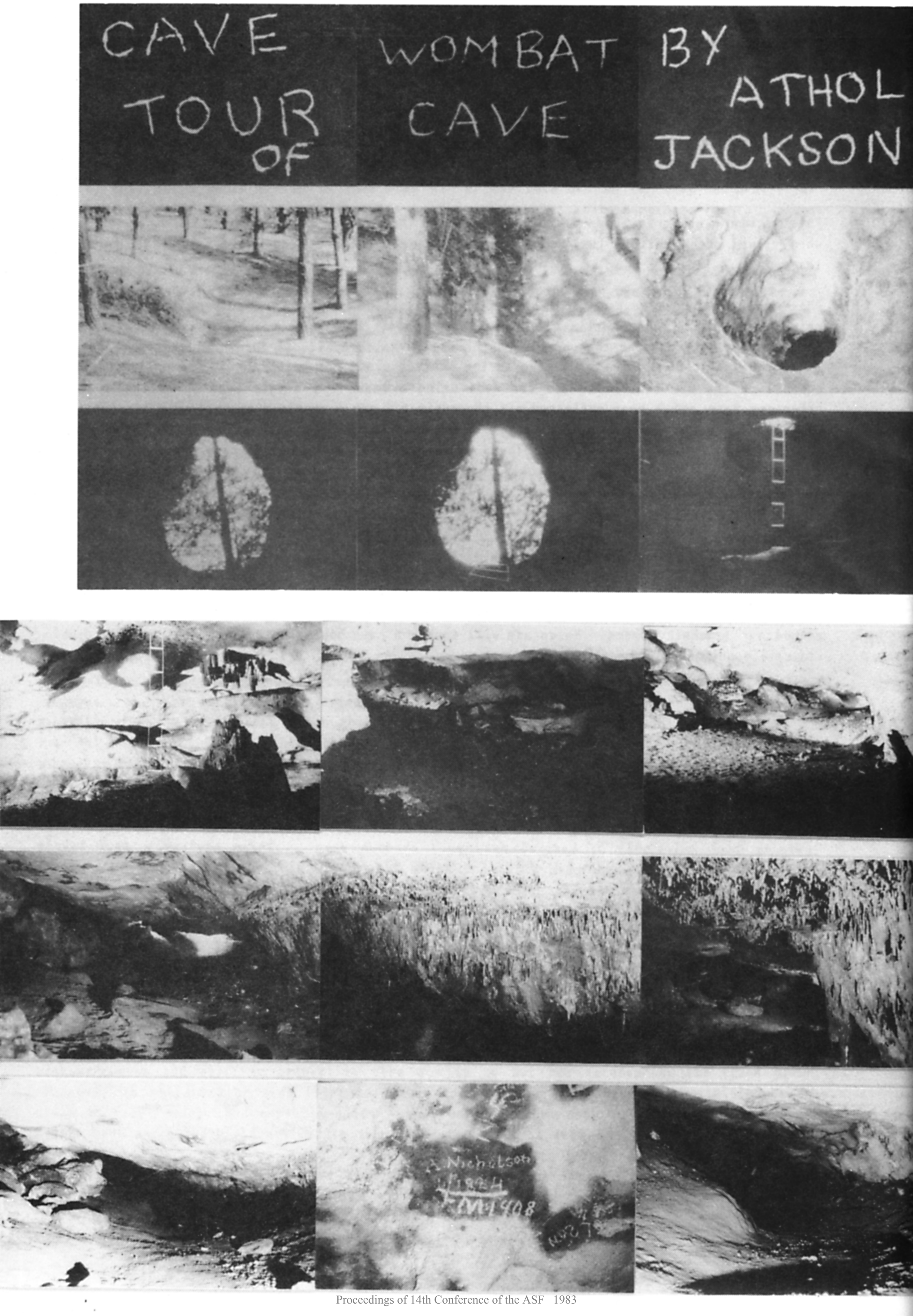
The second method of display relies on each eye picking out only the view appropriate to it when both pictures are actually visible. Many are familiar with the coloured glasses or polarized lenses techniques but another method uses a prismatic screen that makes a different picture dominate each eye with the brain rejecting the interfering strips by insisting on having a sensible 3D image.

I've talked enough about trying to fool the brain into reconstructing 3D from 2D. What exactly is 3D as the eye sees it? Why does a picture as taken by a camera (a man-made eye) not look like the real thing? The answer is that light reaching our eyes has both intensity, as recorded on film, and phase. We lose all phase information.

This is where holograms come into the picture. They record both features of the light and so when viewed are identical (well almost!) to the real thing as you would see it if you'd been there.

They have another advantage too - if you move position, so do the apparent positions of the objects on show. True parallax is there. Why aren't cavers using holography? What is wrong with the cave environment that precludes the use of holography? It turns out that what is wrong is that no caver is doing it. A cave is the perfect place for holography. The criterium needed because of the way that holograms are made using a laser - a single beam split into a direct reference beam and a beam reflected off the subject - are a stable atmosphere for minutes (this mainly means a homogeneous temperature), no stray light and no vibration of the laser system, subjects nor photographic emulsion. These features normally describe a cave. The usual subjects that we wish to encapsulate are highly reflective crystals which give a good light return for the images. However, care must be taken to avoid overexposure at the critical angles of reflection. The method of strip exposure of holograms enables a continuous time or distance picture to be taken including the creation of spherical photographs. A real record of what can be seen in a cave is extractable. Decoration can be recorded in full 3D form for prosperity. In fact, broken pieces can be "repaired" by placing a hologram at the spot!

A whole cave could be recorded by holograms enabling a cave to be set up anywhere, especially around our armchair cavers. Holograms will enable a cave poor country like Australia to double its cave count overnight.


CAVE TOUR OF
WOMBAT CAVE
BY ATHOL JACKSON
A. Nicholson
1908