DESIGN AND OPERATION OF A MOBILE FORENSIC UAP EVENT RECONSTRUCTION MODULE (ERM)

Haines Richard F.[1]

[1]Ph.D. Chief Scientist National Aviation Reporting Center on Anomalous Phenomena, Oak Harbor, Washington, USA, mailto:narcap6@gmail.com

ПРОЕКТУВАННЯ ТА ЕКСПЛУАТАЦІЯ МОБІЛЬНОГО НАУКОВО-ДОСЛІДНОГО МОДУЛЯ РЕКОНСТРУКЦІЇ ПОДІЙ СПОСТЕРЕЖЕННЯ ААЯ (ПРМ)

Хейнс Ричард Ф.[1]

[1]Ph.D. Головний науковець Національного Авіаційного Центру збору повідомлень щодо аномальних явищ, Оук Харбор, Вашингтон, США.

Abstract: Human narratives based on memory continue to provide most of the data of anomalous aerial phenomena (UAP). This is in spite of the acknowledged need for instrumented scientific data collection. Faced with this dilemma human observers still can provide useful and reasonably reliable sighting information if it is collected and analyzed in the right way. Known psychological and perceptual principles must be considered, however. This paper presents a design for a digitally based, forensically oriented module called ERM to accurately capture perceptual details from pilots and ground witnesses after they have seen something they could not identify in order to help improve the overall reliability and clarity of their report. Such digitally reconstructed data can also support scientific investigations of UAP making it possible to statistically compare reports from multiple witnesses of the same event and produce video recreations. Procedures and equipment are described that involve real time virtual imagery that is produced by the simultaneous and carefully controlled interaction between witness, investigator and computer.

Анотація: Людські розповіді, основані на спогадах продовжують бути основним джерелом даних стосовно аномальних аерокосмічних явищ (ААЯ). Це, незважаючи на визнану необхідність в інструментальному зборі наукових даних. Однак, спостерігачі все ще можуть надати корисну і досить достовірну інформацію якщо вона накопичується і аналізується правильним шляхом, враховуючи особливості психології сприйняття. Ця стаття являє собою конструкцію для цифрової основи, криміналістично-орієнтованого модуля ПРМ, для точного моделювання сприйняття деталей льотчиків і інших очевидців, щоби поліпшити загальну надійність і чіткість їх доповіді. Такі дані дають можливість в цифровому режимі реконструювати події в відео. Технологія та обладнання описують в режимі реального часу віртуальні образи, що отримані шляхом одночасної і ретельно-контрольованої взаємодії між свідком, слідчим та комп'ютером.

Introduction. Humans are not very accurate reproducers of visual objects they have seen [1]. This is the basic problem that is addressed here; it has to do with how human memory operates and is interfered with. Researchers have found that recognition is more accurate than simple reconstruction, i.e., if one is given a carefully planned starting point for recall one can usually remember whether that starting point was similar to or different from one's original experience. But requiring someone to «pull» the original experience out of nothing is fraught with many errors that can contaminate the whole process and lead to altered memories; the original memory of the experience can be forever changed to conform to the later contaminated

version. The digital graphics methodology presented here was developed to avoid this kind of contamination while improving the reliability of the witness's memory.

Main part. As the author [2, 3] and others have shown, use of visual recognition techniques similar to those employed by police departments to help eyewitnesses identify suspects using artistic and photographic matching, can also be applied effectively to the study of UAP. The Event Reconstruction Module (ERM) presented here is founded on this idea plus the active involvement of the witness in helping to recreate a final, validated, graphic image of what was seen. It is a long established fact that humans can recognize objects more accurately than they can reproduce them in drawings.

The main goal of this paper is to describe a useful and currently achieveable solution to this human cognitive problem. A diagram of the basic steps of the ERM is shown in Figure 1 assuming (here) that there were three witnesses each of whom can be interviewed. The 3D computer-aided design (CAD) program(s) used in ERM should be configured with detailed drop-down menus, paint-tool browsers and with an interface (perhaps) similar to those used in police sketch software (e.g., Identi-Kit 2000, FACES, E-FIT, PortraitPad, www.flashface.ctapt.de, etc.).
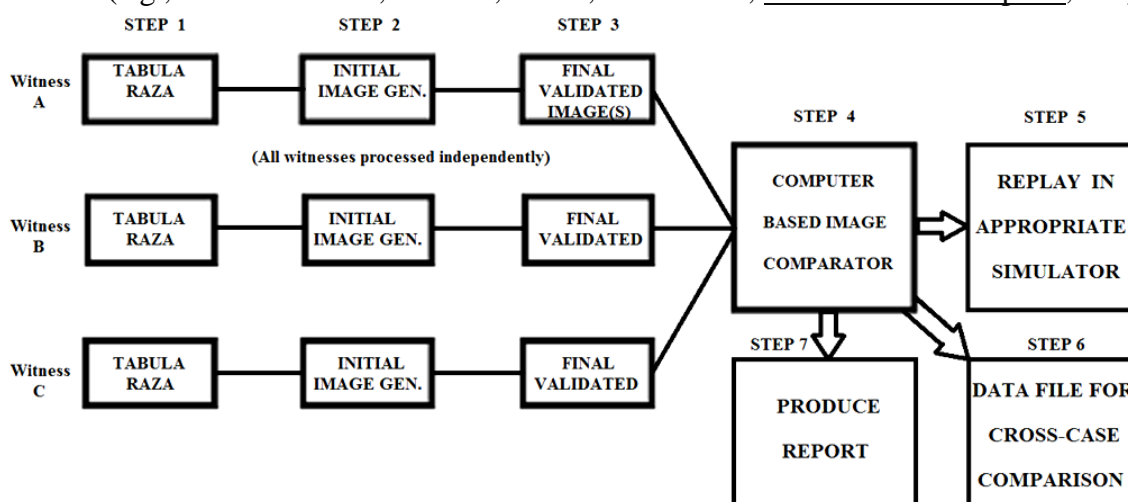

Fig.1. Block diagram of the ERM methodology

Consider witness A. Step 1 consists of allowing him or her to describe the entire sighting experience as fully as possible *without asking any questions at all* nor showing any illustrations, photos, or other potentially biasing material. This is called the Tabula Raza step; all witness comments should be video (or otherwise) recorded for later study. This leads to Step 2 which builds upon Step 1. It consists of an extensive interchange between the investigator and witness seeking to generate important graphic (and other sensory) details of the original sighting. This is done with both people sitting side by side in front of the computer screen. Following a prepared list of focused questions derived from Step 1, the computer operator systematically builds up a computer generated image (CGI) of the object, feature-by-feature with the ongoing aid of the witness. Some of these features are listed in Figure 2. When all elements of this step have been completed an *Initial Image* will have been generated on the computer screen in front of the witness. The witness is encouraged to suggest all necessary modifications to the image(s) being made by the computer specialist who is using computer image rendering software tools (discussed below). Before we proceed to Step 3 let us consider in more detail some of the various visual features of the phenomenon seen.

Referring to Figure 2, clarifying the features listed within each box should begin with the left-hand box. This is recommended because they represent visual features ordered from larger and more prominent to smaller and possibly even ambiguous. If there is more than one object involved in the sighting the witness should indicate which one he or she wishes to begin with and to concentrate on it until it is fully rendered. We will call this the "object" (also phenomenon).

In the first box of Figure 2 we find basic object shape, angular size, orientation to gravity, visual contrast relative to the background, and colors of the object. Angular size becomes a very important feature because if the object is small and far away the observer will be less able to discriminate fine details. The computer operator must help the witness to understand the idea of visual angle that is subtended both by the length of the object as well as its thickness. This is done by having the witness hold a ruler or scale in one hand, extend the ruler at arm's length away from his eye (keeping one eye closed), and then indicate how many units on the scale the object would have been equivalent to at that moment of the sighting. The same thing is then done at 90° to its long axis to obtain the object's angular width. The investigator should also take distance measurements between the eye and ruler for later trigonometric calculations. If the object moved (or changed its orientation) relative to the witness's line of sight during the sighting these details also must be documented. But always begin with a static CGI rendering. The computer operator should slowly build up a virtual image of the basic object (Step 2) and then add various other details on the computer screen *for the witness to see and evaluate in real time*. By repeating this procedure eventually the witness will come to a point where he or she can agree that what is seen on the computer screen is similar to what was seen during the original event (Step 3). These steps must be repeated exactly the same for all witnesses.
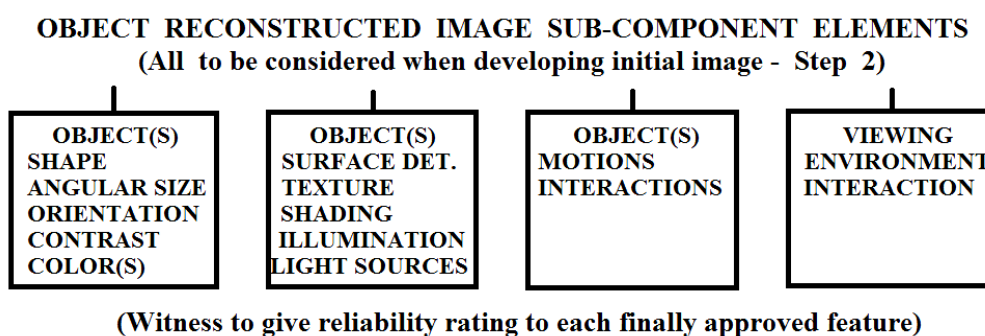
OBJECT RECONSTRUCTED IMAGE SUB-COMPONENT ELEMENTS
(All to be considered when developing initial image - Step 2)

OBJECT(S) SHAPE ANGULAR SIZE ORIENTATION CONTRAST COLOR(S)	OBJECT(S) SURFACE DET. TEXTURE SHADING ILLUMINATION LIGHT SOURCES	OBJECT(S) MOTIONS INTERACTIONS	VIEWING ENVIRONMENT INTERACTION

(Witness to give reliability rating to each finally approved feature)

Fig.2. Selected Image reconstruction sub-component elements

If the object was fixed in the sky, the two sides, top and bottom edges of the computer screen can be used to represent gravitational vertical and the horizontal. This should be explained to the witness while he or she helps the computer operator orient the shape correctly. Using dynamically controlled 3-D computer graphic rendering tools makes it easier to present to the witness with examples of both static and moving objects relative to the edges of the surrounding screen. Development of real-time object motions will be discussed later. But what about object luminance and contrast?

The screen's background brightness should be adjusted to approximate the sky brightness existing during the sighting. When this is done and the eyes of the witness are adapted to this brightness (as they were during the original event) the computer operator can then adjust the brightness of the object on the screen until the witness indicates a close match to the original event. This helps establish a more accurate contrast level of the object and its immediate background [2, p. 120]. Similar steps can be followed about the object's color. Today's computers are capable of presenting millions of colors; the witness only needs to point to a color pallet on the screen while the computer operator selects and inserts it onto the object outline for final acceptance, rejection or further modification by the witness.

Figure 2 also lists some of the smaller details on or related to the object such as: texture or smoothness, shading effects from sunlight or other objects nearby that might have cast shadows, illumination effects (particularly after dark when the object may emit its own luminance), and the presence of self-luminous sources of light on the object or near it, etc? These kinds of smaller details are as important as are the larger features and should not be ignored.

In the third square in Figure 2 we deal with object motion characteristics and interactions of the object with other nearby physical objects in the witness's visual field (buildings, telephone poles, trees, or other structures). The computer operator should include these kinds of spatial references in his (video) CGI for the witness to (later) indicate object motions relative to them. But what if the witness was in a moving vehicle of some kind?

Almost all vehicles today have windshields whose surrounding support frames can provide valuable spatial references particularly if the witness is not moving his/her eye position. Capturing these motion-related features of the object (in video) is very important because of secondary features that can be deduced from them. If the vehicle is an automobile or truck we are assured that the vehicle will not pitch (vertical motion) or roll as an airplane could (moving in three-dimensional space); a car can only change its heading (yaw) relative to the object and or to nearby visual details such as trees or fences etc. In this case the computer operator should draw an accurate outline of the windshield and/or side windows of the automobile or truck on the computer screen so that the witness can use these outlines as stable reference points for assessing the motion of the object. [4]. See [5] for an example which is addressed next.

In some nighttime situations the pilot may not be aware of changes in cockpit motions. The best possible situation for an accurate pilot recreation of a UAP in flight is when the airplane is under autopilot control and is flying straight and level in smooth air. This provides a stable viewing platform for the witness so that apparent motion(s) of the object(s) (at least relative to the airplane) can be assessed relative to the cockpit's window outline. During either daytime or nighttime flight when the airplane is changing attitude in roll, pitch, and/or yaw accurately depicting the apparent motion of the object becomes much more difficult. The key to obtaining accurate and valid object motion features in these dynamic situations rests upon the computer operator clearly explaining which particular visual references the witness is supposed to use (one by one) in his re-creation of the event. For example, if a pilot remembers that he did not move his head very much within the cockpit during the sighting then the cockpit window outline will be relatively stable. Or if he remembers that the airplane was in a constant rate turn during the sighting and the object remained centered in his forward windshield then the object had to be maintaining an equivalent, turning flight path as that of the airplane, etc.

Computer-based Image Comparison. Step 4 in Figure 1 is where the various renderings made from all witnesses of the same event are compared. These comparisons can range from simple (linear and angular dimensions and related object surface details) to very complex (dynamic motions, light signaling, etc.). Some comparisons may require statistical tests while others can be less formal. New UAP-related insights may be anticipated from such comparisons.

Software and Computer Issues: We are fortunate today to have a wide variety of powerful software available to support the ERM method (http://cheapsoftwaredownload.net/index.html). Of course the same can be said about computers. There are two different approaches involved in employing most 3D software: Rendering and Viewing. *Rendering* is compute-intensive since it involves representing the spatial characteristics of the object being modeled. Faster processors and more computational core are needed to support rendering. *Viewing* the objects during development and in later ERM applications, however, is graphics-intensive where faster graphics cards are best.

It is useful to divide CAD programs into two basic types: (A) Free-Form 3D Modeling programs and (B) Free-Form Computer Aided Design programs.

(A) So-called Free-Form 3D Modeling programs allow one to design very complicated shapes easily however it is more difficult to design mechanical shapes to exact dimensions. These programs are often used to make models for animations or video games. Two of the many available programs are: (1) *Silo 3-D* (powerful, dynamic, and inexpensive for modelling organic shapes, with an interface that is relatively easy to learn), and (2) *Blender* (open source, free, modeling program with an interface that is more difficult to learn).

(B) <u>Free-Form Computer Aided Design</u> programs support the development of dimensionally accurate models which, for the present application, is probably not as required. Several of the large number of available programs include: (1) *Viacad 3D* (relatively inexpensive, popular, and relatively easy to learn, available for the PC and Macintosh). (2) *Moment of Inspiration* (MOL) (simple user interface, usable on pen computers or tablets, and suited to both organic and mechanical shapes), (3) *Sketchup* (simple to use, free version available, plug-ins available to allow an STL to be exported without paying for the expensive, full version), (4) *Rhino* (perhaps the most flexible and powerful CAD program available, handles both organic and mechanical shapes, but is expensive).

The most important objective of image rendering and displaying is to develop an image that most closely matches what was seen by the witness. This may require highly realistic shading and illumination effects, edge definition, small details, motions, and a host of other features. See [6] for an example. The computer operator should work closely with the witness in real time to generate this image or set of video images and, *at the conclusion of each step*, ask the witness for a final accuracy estimate (scale of 1 to 5) which should also be recorded as part of the final image's coding. What kind of computer should be used? Although having a portable, light weight computer is beneficial for applications like ERM laptop processors are much less powerful than their desktop equivalents, because they need to run cooler and therefore consume less power. For example, a high-end desktop Core i7 runs at around 130W where a more mobile (laptop) version might consume as little as 17 W and an Intel Atom only 2W. This situation may change as computer technology continues to develop. Sony's VAIO dual core i3 or i5 CPU and 64-bit operating system is capable of running many of the available programs as long as there is sufficient ROM, RAM and graphic card speed. For a truly portable ERM system the weight, set up efficiency, widescreen view ability by two people at the same time, screen gamma adjustment capability, and touch screen capability all become important design factors as is the capability to transfer the computer-based images and video to the flight simulator's visual display system.

What about an operating system? If Adobe or Unity 3-D software are to be used then dual-booting a version of Linux to run Blender software as well as Windows operating system will be suitable (e.g., 64-bit Windows 7).

Fig.3. Exterior scene of a modern flight training simulator

Memory Enhancement Using an Airplane or Automobile Simulator –Step 5 For pilots or drivers, remembered object details can be enhanced significantly by having the witness seated inside a similar perceptual environment such as an airplane or automobile simulator (if an actual cockpit is not available) [cf. 5]. Today, virtual external scene resolution is approaching photographic quality as is shown in Figure 3. If the digitally rendered object from ERM is programmed to appear upon this outside scene it is very likely that the witness will recall even more details than otherwise. I call this "total immersion simulation."

Most aircraft training simulators are expensive to operate and restricted in their access. Nevertheless, in certain UAP cases their use may be justified just as they are in many accident investigations. A simulator can add to the overall immersion into 'virtual' reality and encourages

more accurate memory of some details that otherwise might be lost. Human memory operates largely on the basis of past associations so that a fuller array of environmental details that existed during the original sighting (noises, vibration, etc.) should be included in a realistic re-creation of the event in order to evoke more accurate memory.

Step 6 makes it possible to carry out various comparisons both across witnesses of the same event and between different events. Over time, digital and statistical data banks on object shapes, color, dynamics, electro-magnetic effects, etc. will accumulate and become increasingly useful for taxonomy development and statistical testing.

In conclusion, the ERM approach can contribute to a deeper understanding of UAP that is based upon human memory.

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