Manual on Finding Lost Aircraft

by

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July 2012
Version 12

We are very sorry you are having to read this words, for this likely means that you have lost a loved one or a friend in a light plane disappearance at some time in the past. If so, we can only offer you our hope that your search is successful, and we can offer some knowledge in helping you find the plane. We cannot promise to help directly, for our group has limited resources, we are self-funded, and have only a few (but talented) members. But we have built up information which we are happy to share,[1] as follows.

The things you likely need to do, in priority and chronological order, are the following:

- Form a Search Analysis Group (SAG) and Create a Shared Worksite for the SAG
- Develop a Short Description of the Disappearance
- Obtain Radar Data
- Obtain the NTSB Docket
- Obtain Cell Phone Data
- Obtain Pilot's Logbook and Related Items
- Research the Aircraft
- Interview Relevant Persons
- Develop Data on Weather and Other Conditions
- Obtain Police Data
- Review ELT Data
- Research News and Magazine Sources
- Analyze Fire Reports
- Undertake Other Research
- Develop Scenarios for the Disappearance
- Undertake Proportional Consensus Voting on the Scenarios
- Organize a Search.

These topics are discussed below.

I should note that this manual is intended mainly for use by families, friends and colleagues who are taking on a missing General Aviation aircraft "cold case," after the official search is over. This official search (in the US) will generally last about one to four weeks, and will be coordinated by the US Air Force Rescue Coordination Center (AFRCC), with the Civil Air Patrol (an auxiliary volunteer arm of the US Air Force) taking the lead in aerial searching, if the plane is likely to be on land. While this manual is focused on cold cases, reading it during the official search may allow you to ask more

[1] Note that this manual is based primarily on my experience with a limited number of major missing aircraft cases, some in cooperation with law enforcement/SAR teams, and some independent, private searches. Most of these were "cold" cases but there were a few "hot" recent cases. In addition, this manual draws on the combined experience of a group of SAR professionals and airplane archaeologists who together have hundreds of SAR cases and numerous airplane searches to their credit. This manual may thus be revised as more experience is added. Searching for "cold case" missing airplanes is a fairly new field, and I felt that it was in the public interest to create such a manual now. I certainly welcome suggestions and comments on this manual.

knowledgeable (but polite!) questions of the searchers, and will allow you to start gathering data now, in the doubly unfortunate case that you need to take on the search effort after the official search is called off.[2]

Form a Search Analysis Group (SAG) and Create a Shared Worksite for the SAG

The SAG can include family, friends and associates of the disappeared pilot, crew and passengers. You should also try to recruit persons with the following specialized skills:

- Group leadership
- Search and rescue (SAR) analysis (recruit someone with SAR analysis training and experience from your local volunteer SAR group, Civil Air Patrol or Sheriff's office)
- PowerPoint briefing development and website construction
- Photographic interpretation, analysis and enhancement
- Writing; acting as group secretary
- Interviewing and documentation
- Google Earth (or other geographic information system) manipulation
- Pilots, aeronautical engineers, navigators, para-glider instructors, soaring enthusiasts and instructors, even radio-controlled model airplane builders and flyers, etc. Many pilots are fascinated with missing airplane cases, and may be keen to assist
- Cell phone records and technical expertise
- Radar analysis
- Meteorology (weather forecasting and analysis)
- Private investigation, legal, paralegal or intelligence officer background
- Expedition and ground search management.

Your SAG will likely be geographically dispersed, so you will need to set up a shared secure website (such as those offered on Yahoo Groups) to facilitate collaboration. Such sites are often free, and allow you the following functionalities:

- Send and receive group emails
- Post digital documents, maps, photos, stories, files, interviews, etc.
- Notify all group members when new items are posted

[2] Note that this manual does not address what should be done in the first few weeks after a disappearance; rather this document is focused on "cold cases." However, we can briefly say here that immediately after the disappearance, every effort should be made by the family and friends of the victims to publicize the case, to use all available means to reach the public, especially hikers, climbers, pilots, forest rangers, hunters and other outdoorsmen, to set up a missing person website, to interview persons who were in contact with the pilot and passengers, to obtain radar and cell phone data, and to try to maximize the data collection as described in this manual under a cold case. Trying to do all this work some years later will certainly make the case much more difficult to solve. **A key item to focus on immediately** is to see whether or not the plane had a SPOT, Spidertracks, or other "breadcrumb" flight following device that leaves an electronic trail every few minutes, and could thus quickly lead searchers to the general crash area. See www.findmespot.com and www.spidertracks.com.

- Invite new members, and using password protection, exclude any undesired persons.

Most important, the shared site allows all your members and experts the chance to review all the data available, and share thoughts, review contradictions, make connections, and gain a common understanding of the problem. This is vital, since it is quite possible that the crucial clue is already somewhere in your group, you just haven't realized it yet. (For example, on the famous Steve Fossett search, at least two vital clues –a radar track that was inadequately analyzed, and Fossett's own autobiography – were both available, but were apparently not fully utilized by the initial search teams.)

We have found Yahoo Groups to be very useful for our team's collaboration. You can form one by going to http://groups.yahoo.com/ and follow the directions under "start your group today." Of course, if you find another groups type site with the same functionalities or better, please do so, and let us know about it.[3]

The designated group site administrator (you, or whoever else sets up the site) will have the authority to invite people to join, and to make available information such as the names and emails of all members, if desired.

Once you have a group website, create and begin to fill useful "buckets" of information on the site. We have found the following categories of information to be the most useful:

- Data obtained through the formal US Freedom of Information Act (FOIA), and/or your equivalent state, local (or foreign) process
- Radar data
- Cell phone data
- Google Earth overlays (kml files)
- Lists of persons to be interviewed, and completed, documented interviews
- Maps
- Group meeting minutes, tasks volunteered for, and related
- Records (aircraft maintenance records, fueling receipts, pilot logbook, police notes, interviews, clue logs, etc.)
- Reports (government, private, ELT, other, including documentation on previous searches undertaken)
- Training materials
- News stories
- Scenario analysis and scenario voting records
- Logistical search info for searches you may undertake
- Formal search plan.

Use the "folders" functionality to create these "buckets."

[3] We understand that the following sites may be suitable substitutes: groups.google.com, may have some difficulties with the moderator functionality; www.zoho.com; or http://basecamphq.com/signup. Facebook and www.orkut.com are more for networking, while we like the privacy focus of Yahoo Groups.

Develop a Short Description of the Disappearance

Develop a short one page, but detailed, description of the disappearance that can be posted on the shared web site. This should be a sort of "Missing Person" or "Wanted" poster, with high density (300 dpi or higher) pictures of the plane (the actual plane, not just a similar one), recent pictures of the persons on board, information about them, specifics on when and where they took off, destination, the Last Known Point (LKP)[4], searches undertaken, weather conditions, etc. You can use this for recruitment, to circulate to the media, to hand out and post at local airports and visitors centers, to give to pilots' clubs, park rangers, etc.

Obtain Radar Data

Radar tracking of the accident aircraft has proven to be very reliable in finding missing planes. That is why this data source is listed first here. Most light airplane flights in the continental US will likely generate some kind of radar track during at least some portion of the flight; it is your task to obtain the data and identify the right track. However, it is very difficult to obtain radar data from government sources, which often consider such data to be classified as "For Official Use Only" ("FOUO") and not releasable to private parties. In the US, it may be possible to get around this classification, and secure these data by sending a Federal Freedom of Information Act (FOIA) request to the following:

- **US Air Force Rescue Coordination Center** (AFRCC), Tyndall Air Force Base, Florida (http://www.tyndall.af.mil/library/foia.asp). The AFRCC coordinates air searches, and is credited with over 13,900 "saves."
- **Federal Aviation Administration** (http://www.faa.gov/foia/foia_request/). The FAA operates radars, often through contractors, and operates the air traffic control and other aviation related systems.
- **84th Radar Evaluation Squadron (RADES)**, US Air Force, Hill Air Force Base, Utah (or other RADES unit that was involved in the case) (for Hill: http://www.hill.af.mil/library/foia.asp). This type of squadron is often called on by the AFRCC to analyze the millions of radar hits available on the accident date, and distill them down into radar tracks that are likely the subject airplane.
- **Colorado Wing, Civil Air Patrol**. This CAP wing has specialist(s) who often perform the same analysis function as the RADES units listed above. Try: http://www.coloradowingcap.org/ColoradoWingCAP/MediaAndPublicInformation/tabid/58/Default.aspx
- **National Transportation Safety Board** (NTSB). This agency does not do search or rescue, but rather analyzes the crash after it is found, to determine the cause. However, the NTSB does often have data on the crash (see its publicly

[4] Note: you may have to use careful judgment in specifying the LKP. Be certain that you really have a totally reliable source in specifying this. DO NOT rely on a single eye-witness to specify the LKP; eye-witnesses are notoriously unreliable. You may have to specify the departure airport as the LKP.

accessible data bases at http://www.ntsb.gov/ntsb/query.asp), and may possibly have retained radar data. The following link gives information on FOIA: http://www.ntsb.gov/info/foia.htm. See the next section on obtaining the NTSB docket on the case.

In any FOIA or other request to officials, it is generally best if the family (or the family's attorney) request the data, since they are likely to be given a greater volume of data, and data that have fewer "redactions" or deletions.

If you are in the special situation of being less than 40 days since a disappearance in the United States or area where FAA radars are present, **IMMEDIATELY** send a letter from the family or family's attorney to the FAA FOIA office by registered, return receipt requested overnight mail, requesting that the radar data for the day of the disappearance be preserved, for the area in question. This is because the FAA (and its radar contractors) have a policy and practice of destroying radar data after 40 days, unless directed to preserve it, or unless they receive an "accident package" that tells them officially that an accident occurred. (They may well destroy data even if they are informally aware of the disappearance.) Furthermore, the FAA has stated that FAA radar contractors "are not required to provide records under the FOIA," since they are private firms; and they may destroy the data anyway. Hence you may need to quickly involve your attorney, the press, or your Congressman or Senator.[5]

Two private firms which are contractors to the FAA and which may have radar data of use to you are:

- Serco, Inc., Federal Contract Towers, 633 East Vine St., Murfreesport, TN 37130; 615-217-2700

- Lockheed-Martin, Federal Contract Towers, 400 Virginia Ave., SW, Suite 400, Washington, DC 20024; 202-646-5344

You will need to include a "promise to pay" statement with your FOIA FAA request, in which you agree to pay a minimum of $25 for research, copying and delivery of the requested items. According to the FAA, you are not charged for the first two hours of search time, any review time, and the first 100 pages of photocopies. Radar data requests can cost $99 to $275 per hour of time it takes to extract the data. Certified voice recording fees are $30 per hour. The FAA will not provide military radar data.

If your case occurred overseas in a well-to-do country, try to determine the equivalent agencies to those listed above. If your case occurred in a developing country, you may need to hire a prominent, well-connected attorney with an in-house private investigator who can try to obtain any available data on your behalf. Also, enlist the support of your

[5] The NTSB manual on accident investigation states that these data may be destroyed within 15 days. Our interviews indicate that 40 days is more likely. An email from the FAA indicated "15 or 45 days." A letter to the Administrator of the FAA asking about this and other related radar points was never answered by the FAA.

US embassy and/or consulate. If you encounter any resistance from these offices, contact the senior US Senator from the state where the pilot or passengers maintained US residences, and get them to help with the case.

Radar data can be obtained even though the target plane is far away from the radar site, perhaps up to 60 miles or more, depending on terrain and the altitude of the plane. Most aircraft employ transponders that emit a signal each time the plane is interrogated (or "painted") by FAA radar. General Aviation (GA) planes' transponders squawk a common "1200" code when flying under Visual Flight Rules, making it difficult or impossible to identify the plane tracked by the radar. (In other words, the radar track is present, but it is not possible to be sure which plane is making the track.) GA flights conducted in communication with Air Traffic Control will be assigned a unique 4-digit squawk that links their registration number ("N-Number") to the radar track, vastly simplifying the identification problem.

Still another way to identify a radar track is by a "Mode S" squawk, which certain model transponders will respond with if interrogated by special Mode S radars[6] It is important to know the type of flight rules under which the aircraft was flown, and what transponder was installed on the plane. This information can help identify a radar track from among the hundreds of candidate radar tracks often provided by the FAA (or other agency) in response to a FOIA request.

Even if the plane is not "squawking" 1200 or on Mode S, the radar data you obtain by FOIA may show some "primary" radar hits, meaning a small return of radar energy was observed, but no "squawk" was received.   Such returns can be generated by birds, mountain peaks, antennas and even clouds. However, if you find a series of such returns in a line, you can analyze the time between the returns to see if it matches the likely speed of your light plane. Thus you may be able to identify a useful radar track without any transponder squawks at all. Or a track may switch from secondary (transponder) hits to primary or vice versa, or go back and forth.

If the target plane was operating in a remote area, try to obtain the location (latitude and longitude, name of the authority controlling the radar, and Point of Contact) of all (military, civilian, etc.) radars that might have painted the plane. This information may be sensitive or FOUO. If the radar site appears to be close to the possible flight path of the accident airplane, try contacting the agency directly that operates the radar, to obtain the data for the date in question.

With radar requests, it is usually best to specify a reasonable time period that would encompass the flight; a reasonable area (such as "for 150 nautical miles around the XYZ airport at latitude A and longitude B"); and a maximum altitude (such as "below 15,000 feet above sea level" for a plane with that operating ceiling).

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[6] Mode S radars are currently located in a few places in the US, but they are becoming more prevalent. It is important to check with the local FAA representative to determine if the accident aircraft was operating in a Mode S radar environment.

For all FOIA requests, ask for the radar data and "all other data of all types related to or collected re the disappearance or crash of plane with registration number XXXX."

If you obtain "raw" radar data, it will come in the form of a massive spreadsheet (probably over 200,000 lines) with hundreds of thousands of numbers, each indicating items such as the time of the hit, and the direction, bearing, and altitude of the hit. Analyzing these hits and converting them into usable visual radar track requires expensive software. This will require recruiting a specialist with the requisite skills and software. (These files will often exceed the ability of Excel or other Microsoft software to open them, since Excel has a limit of about 66,000 lines of data, and a radar file may have hundreds of thousands.)

Information on where radar has no coverage can be valuable. If a plane enters a radar "hole" and apparently doesn't exit that area, there are three possibilities: the plane crashed in that area, the plane landed in that area, or the plane exited the area at such a low level that it was not detected by radar. If you can rule out the latter two possibilities, or you can reasonably assign them a very low probability, then you have learned something valuable.

Thus it may become necessary to determine the size and extent of radar coverage. Unfortunately, these data, like much radar information in the US, are often classified as FOUO, and may not be obtainable by the general public. Try FOIA requests to the organizations listed earlier in this section. Also get your relevant US Senator involved, explaining why you need the data, and having the Senator request the data from the responsible agencies.

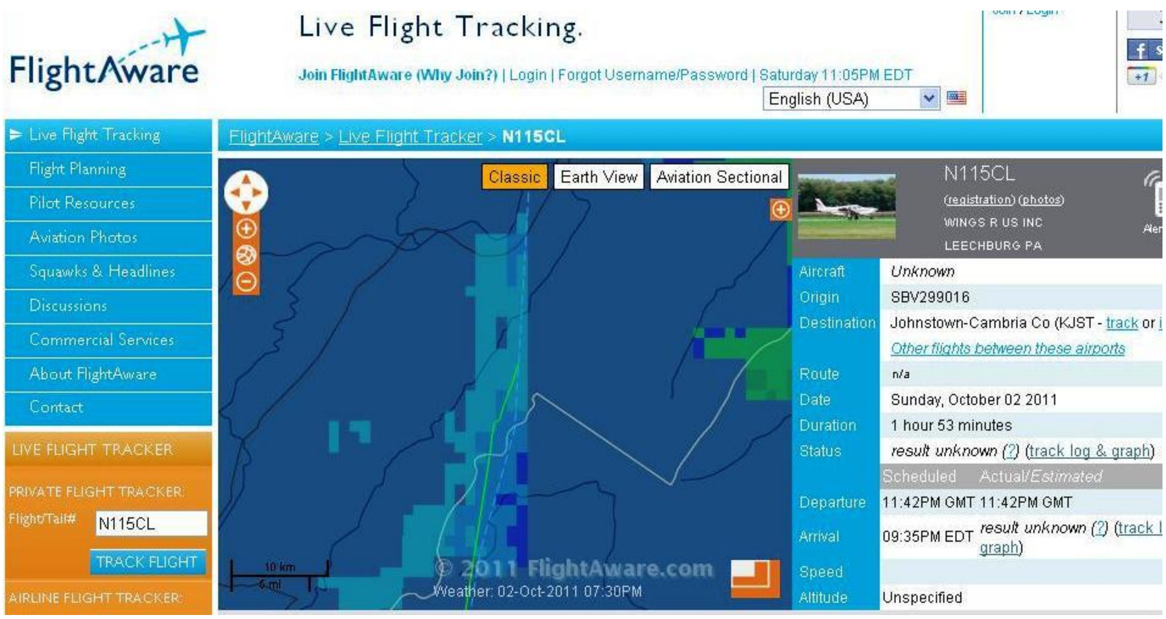
If those approaches fail, do not despair. A good radar analyst can locate or estimate the location of all civilian and military (and sometimes other) radars, plot the radar coverage of each radar against the local terrain, and then derive a radar coverage map that shows the estimated radar coverage and the "holes" in question. These calculations are computer-intensive and they require an estimate of what the altitude at which the plane would have been flying.

Post all radar data obtained on the shared web site, and study the data within your group. Some of the data obtained will likely be in the form of visual Powerpoint slides or jpeg images of "radar tracks." These will be the tracks which the radar analysts during the initial search thought were the most likely to be the target plane. Study these tracks carefully, but be aware that the right track might have been missed. An example of an actual radar track from the Steve Fossett case is presented below. (This track mesmerized searchers for a year after the disappearance, until members of the Search for Steve Fossett Expedition, including me, tracked down and interviewed the pilot who made the track, and determined that Fossett had not made this track.)

In asking via FOIA for radar tracks, be sure to ask for "stills, jpegs, slides, Google Earth kml overlays and other fixed or non-fixed images of radar tracks, spreadsheets giving the

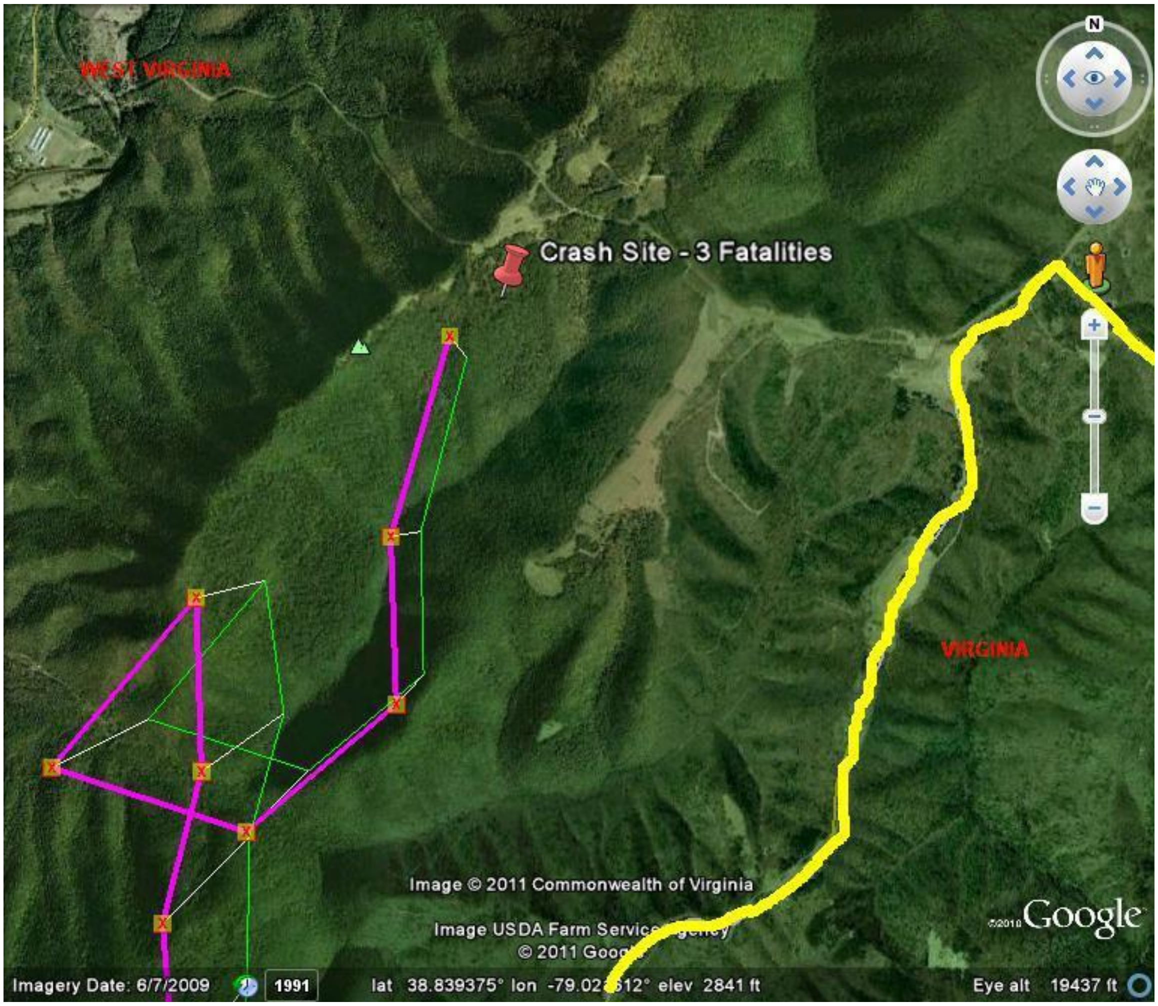
raw radar data, and all other radar and other data related to this case of registration number XXXXX."
Before you get the radar data, or if it is not obtainable, check the website www.flightaware.com. This site provides flight tracking information for commercial and certain general aviation aircraft; plots the scheduled and actual flight path on a classic, aviation sectional and earth view; and provides information on the altitude and duration of the flight. Go to "live flight tracking" and enter the tail number of the subject plane, to see if the flight was tracked. The site may also provide information on the owner of the plane, the type, other recent flights, and a picture of the aircraft.

For a general aviation plane (N115CL) that went missing in West Virginia in October 2011, flightaware.com provided information on the planned and actual flight path, as shown below. Although the crashed plane was actually found by a SAR helicopter, this flight tracker information might have proved useful to ground searchers if the helicopter and fixed wing search failed, and if the detailed radar data was destroyed by the FAA or was not made available to private searchers.



In the screen shot above, the subject aircraft (N115CL) is flying north across the Virginia/West Virginia border. The border line is in light blue, the planned track of the plane is shown in a blue dashed line, and the actual track is shown by a light green line. By shifting to the "aviation sectional" view and zooming in, the site where the plane dropped off radar (the LKP or last known point) can be pinpointed to within about 1-2 square miles or less.

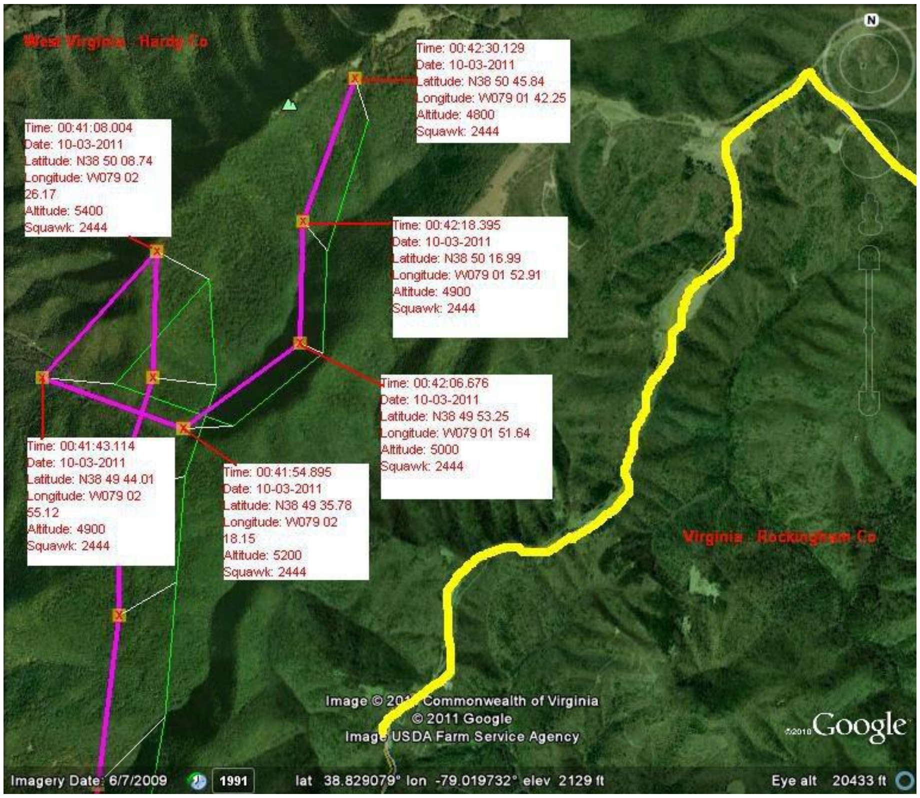
For the same case, below is a slide showing the last few radar hits on the aircraft. This slide is an overlay of information put onto Google Earth. The lavender line is the track of the plane; the yellow line is the Virginia/West Virginia state line. Each "X" is a radar hit. The slide shows that the plane came up from the south, headed north, made a mysterious 360 degree circle to the left, headed north again, then crashed just 0.27 miles north of the last radar hit.



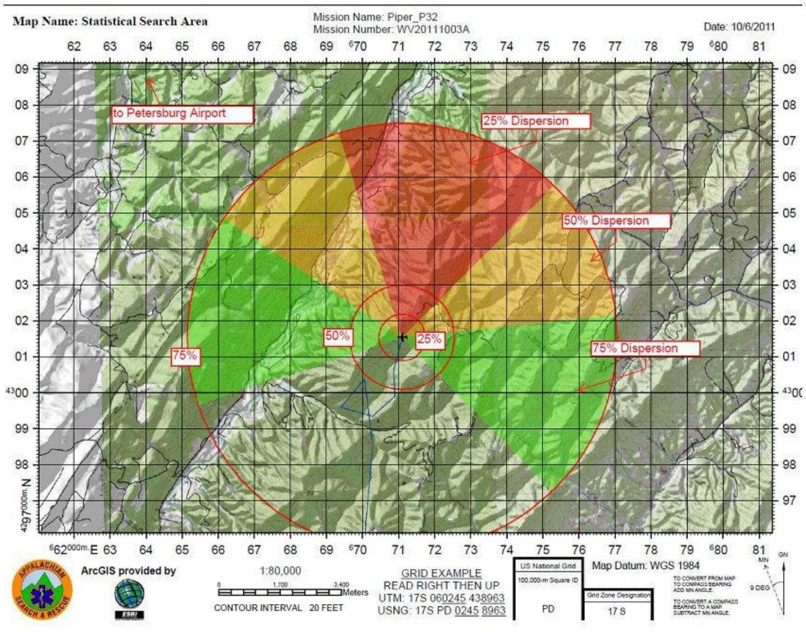
The slide below of the same case provides even more information. Here we see that each radar hit is labeled with the time, date, latitude, longitude, altitude and squawk (the frequency the plane's transponder was broadcasting on when it was painted by radar).

With this detailed information, a ground search team could develop a viable search plan, focusing on the area directly in front of and to the sides of last radar hit. Research by Dr. Robert Koester, a SAR expert, has shown that statistically, crashes are most likely in a tear-drop shaped area in front of the last radar hit.

Note that here the actual radar hits and crash site show that the plane ended up just south of the latitude of the northern-most point or "kink" in the Virginia/West Virginia state line (on the right of the slide). However, the FlightAware data presented earlier shows the actual flight path terminating north of the latitude of the kink. Therefore, a team relying only on the FlightAware data might end up searching too far north, and thus miss the crash site.



The slide below shows such a statistical analysis for this same case. Here the most likely area for the crash is shown in red. The plane was found in this area.



Note that while these are the types of slides and information a private search team should try to obtain from government sources, these are not the truly detailed radar data that were described earlier. These slides were derived by radar analysts from the raw data. The raw data for this case would have been a massive spreadsheet showing all the radar hits in the area for all the planes, birds, clouds, etc. The radar analysts would have filtered out all the unrelated hits, and identified and presented only those hits that were likely the subject plane. Here the track of the plane was almost certain because it was generally following the filed flight plan, and it was squawking on a frequency (2444) that was identifiable as this plane, not a general light plane frequency. In a case in which it is not clear which radar track is the missing plane, your private search group should try to obtain the raw radar data so a re-analysis can be done, as well as the slides and reports showing the radar analysis done at the time.

Utilize Google Earth

A useful tool to help in gaining a common understanding of geographic information such as radar tracks is Google Earth (GE). You will want to plot key radar tracks onto Google

This slide is an overlay on Google Earth, and shows a plane coming in from the west (left) over mountains, and being hit ("painted") 11 times by radar, and making 11 "squawks" via transponder (the green balls at the top of the "pins." Then there is a gap, then several hits/squawks heading south, then another gap, then some hits headed north, then a long gap, followed by the final hit, which is labeled with the time, date, latitude and longitude, altitude and the "squawk" (of 1200). This was thought to be the Steve Fossett plane, and was presented to searchers as probably the Fossett plane. But in fact this was a faster plane lining up to land at Hawthorne, Nevada, northwest of the last hit.

Earth and then examine the terrain, extend the tracks and see where the plane might have gone, and use GE to find the latitude and longitude of nearby attractive sights from the air, likely landing strips, etc.

You can use Google Earth for the following functions:

- Mapping radar tracks using kml or other files
- Looking for and marking the addresses of eyewitnesses or "earwitnesses" who heard a crash
- Looking for small landing strips your pilot may have used
- Marking off areas to be searched by helicopter or ground teams
- Identifying visual markers (such as high mountains, ridge lines, towers, rivers, highways, etc. that your pilot may have used as visual clues to navigate toward his destination
- Zooming in and identifying unmarked seaplane bases or light aircraft bases in fields
- Getting an idea of the underwater sea floor configuration for underwater searches
- Determining whether Federal or state authorities have jurisdiction over your search area
- Looking for logistical support for the search operations phase (e.g. campgrounds, hotels, motels, etc.)
- Marking off areas to be searched, or that were already searched by previous teams
- Plotting the exact GPS tracks of your search teams, so that you can later analyze any gaps.

You can freeze or capture a GE image (or any screen shot of any item on a computer with Microsoft software) as a jpeg (picture) image for sharing, by using the following procedure:

- Manipulate your computer screen so that it shows exactly what you want reproduced
- Simultaneously hit the keys for Alt, Control, and Print Scrn. This will copy the screen shot and put it into system memory
- Go to Start, to Accessories, and then to Paint. Open the Paint program
- In Paint, hit the Control and V keys simultaneously. This will take the screen shot out of system memory and put it into Paint
- In Paint, go to the File tab, then to Save As. Save the Paint image as a jpeg, bitmap or other image in the desired file folder (specify this), with a name of your choosing
- Check in that file that everything worked. The resulting jpeg should be about 150 kb
- Use the Microsoft Office Picture Manager program to manipulate the image as desired. For example, you can use the Picture – Crop function to remove unwanted borders and material. Use Picture—Autocorrect to make the picture more visible and pleasing to the eye.

Now you can post the GE (or other screen shot) image with all of its useful notations, radar tracks, labels, pins, etc. to the shared group website, for others to study.

Obtain the NTSB Docket

The official NTSB docket on the case is likely held by a government contractor:

General Microfilm, Inc.
632 Files Cross Road
Martinsburg, WV 25404
http://www.general-microfilm.com/
304-267-5830 (tel); 304-264-0862 (fax)
Email: genmicrofm@aol.com <genmicrofm@aol.com>

This firm will supply the public with the docket, for a fee. You will need at least the tail number of the plane and the date of the accident, and preferably the NTSB case number, in order to obtain the docket. A typical general aviation (GA) file on a plane which had not yet been found contained 88 pages and 2 color photos, and cost $70 for the pages and $12 for the photos, plus shipping, for non-“Blue Ribbon” copies. Blue Ribbon copies are used in court proceedings by lawyers. Copies can be supplied as hard paper copies or as CDs. Documents on the latter are presented in pdf format.

The docket will hold whatever the lead investigator thinks is relevant, not too personal, and not duplicative. Hence there may be other items, such as field notes and photos, which are present in the investigator’s files which are not present in the official docket. Theses may be destroyed after one year. They may be requested via FOIA, see above.

Dockets on cases for large aircraft with many fatalities, and on aircraft which have been found, will likely be much larger and could run to hundreds or thousands of pages and photos. Insurance companies, lawyers and families often request these from the docket and from the investigator’s files, since the investigator will only place a small portion of the photos in the official docket.

Note that the NTSB docket information is generally only available for crashes during and after 1978, when the NTSB was formed. Prior accident reports under the Civil Aviation Authority (CAA) are “spotty” at best at GMI. However, some of these older records may be available from the National Archives II facility in Greenbelt, Maryland.

It may be well worthwhile to speak to the NTSB lead investigator on the case, to get his or her views, and see what kinds of data are held beyond what is in the docket. The lead investigator’s name should be shown on the NTSB on-line report. The investigator will likely be located in one of the NTSB’s regional offices. For a list of these and their phone numbers, see:

http://www.ntsb.gov/about/contact.html

Accidents which are still in the "preliminary" investigation phase will likely not be accessible via FOIA to the NTSB. In this instance, you may need to informally approach the lead accident investigator directly.

Military crash records prior to World War II are available from the US Archives; while crash records for Air Force crashes during and after WW II, up through the present, are held by the USAF Historical Research Agency at Maxwell Air Force Base in Alabama. Information on the latter's FOIA process is available at:

http://www.afhra.af.mil/foiareadingroom.asp

Military crashes for the US Navy and US Marine Corps, for the period of the 1920s through 1979, are available from:

Naval History and Heritage Command (NCCH)
NHHC Archives-Aviation
805 Kidder Breese SE
Washington Navy Yard
Washington, D.C. 20374-5060

Navy and Marine records for the post-December 1979 period are held by:

Commander
Naval Safety Center
Attn: Code 71, 375A Street
Norfolk,VA 23511-4399

The Navy has a policy of "redacting" (withholding) any witness reports in their accident reports. This naturally decreases the usefulness of what is obtainable. According to the in-house NHHC expert, these witness report will "never" be released, regardless of how much time passes.

Obtain the docket from the NTSB or other agency, study it, and post any items that have any relevance on the common website for group analysis.

Searches for crashes in US national parks may controlled by the National Park Service. Hence it may be necessary to send a FOIA to the relevant park, to obtain data on the search that NPS staff conducted, their search area, theories, interviews, etc. The NPS will almost certainly have coordinated with the AFRCC, so do not omit sending a FOIA to this organization, also.

Obtain Cell Phone Data

Cell phone data can be almost as useful as radar data, since they may be able to provide location information on the user. Cell phone data can also be used to verify radar tracks that you suspect may be the subject plane. Try to determine if the pilot or passengers had cell phones, and if so, what cell phone providers they used, and whether they were they in the habit of leaving them on in the plane and/or making calls from the plane. (Cell phones should not in fact be used or turned on in planes, but this often happens.)

This is important because cell phones that are turned on have a "handshake" or "registration" function. That is, when they enter a new cell, exit a cell, or turn on or off, they usually exchange brief signals with the nearest cell tower, so that they are ready to process calls, text messages or other data. This happens without the user's knowledge or intervention. Thus a cell phone in a plane can be tracked from cell to cell, and these records should be obtainable from the local cell phone company. In the US, law enforcement agencies can obtain these data, usually with a subpoena and expert assistance from the cell phone company. The family may also be able to request (or perhaps do a civil subpoena to get) the data from the cell company. Overseas, a similar procedure may work.

With even more analysis, the cell phone company may be able to tell you which general direction the plane was located from the cell tower at the time of the "handshake," since cell towers are usually divided into three different directions.

Cell phone information may have more of a range than you think. In an Arizona case, a questionable radar track of the subject plane in flight was identified as a track made by the accident plane, by a cell phone tower handshake. This handshake took place as the plane entered the edge of the cell, about 30 miles from the cell tower itself.

Thus with the approximate width of the cell and the approximate direction of registration, it may be possible to get an approximate "fix" for the plane, at the exact time of that handshake/registration. Of course, any such fix is invaluable in helping to narrow down your search, and the fix might corroborate questionable radar track data.

In addition to the cell phone handshake records, the more usual cell phone calling (detailed billing) records for all the passengers, crew and pilot should also be obtained. (The family of the victims should be able to obtain these data from the phone company.) Get as much detail as possible, with every single call shown, and the phone number, duration, cell site that processed the call, time of initiation, time of termination, calling number and called number. With these records you can see who these persons were talking to before (and perhaps during) the flight. Work backwards in time, call **all** the numbers, and interview the persons who were in touch with the victims. Keep careful notes. These "callees" and callers may have valuable information on where the victims were planning to go, their state of mind, and other activities and intentions.

Post all cell records and related interviews on the shared web site.

Obtain Pilot's Logbook and Related Items

Obtain the pilot's logbook, which is a personal record of flights made, their duration, and additional details used to document experience and currency. The logbook may be located in the airplane hanger or victim's home or car, or the local police may have impounded this as evidence for their missing persons case. Try to get the original back or at least get a copy that clearly shows every page.

If the pilot's logbook was not found during the initial search, it may be in electronic form on the pilot's laptop or home computer. Search these for an "electronic pilot's logbook" or similar.

Some pilots keep their (physical) logbooks with them at all times, often in an airplane "go bag" containing their logbook, glasses, earphones, pens, cell phone and other small items. This will likely be separate from any "red bag" which contains more bulky survival gear.

If the pilot keeps his logbook in the plane or in a go bag in the plane, then of course you will not be able to find the logbook. But many pilots leave their logbooks in their hanger, car, motorcycle or at home.

The logbook or other similar data should show the pilot's total time (in hours) in the air, a good measure of experience. An inexperienced pilot is one with just a few hundred hours or less. Medium experience -- which can sometimes lead to over-confidence -- is around 300 to 900 hours. More than 1500 hours in the air is considered a high level of experience, while a career commercial pilot might have 25,000 hours of flight time, an exceptionally high number.

Examine the logbook to determine how many flight hours this pilot had in this exact aircraft or other identical aircraft. For example, a pilot with 5000 hours in military jets who only has a few flight hours in a low powered, propeller-driven "tail-dragger" (a plane with two main wheels forward and a small tail wheel in the rear) may be much more at risk in the latter, since he is not familiar with this type of plane, and they fly quite differently.

See what ratings, endorsements, and certifications and medical restrictions this pilot had. This may be in the logbook or may be obtainable from his/her flight instructors or from the publicly accessible FAA database:

https://amsrvs.registry.faa.gov/airmeninquiry/

This database usually lists the pilot's address, full name, medical endorsements (such as "must have glasses available for near vision") and ratings (such as "airline transport pilot: airplane multi-engine land" or "commercial privileges: instrument helicopter" or "private privileges: glider"). Have a pilot on your team research and explain these items, so you will have a good idea of the accident pilot's experience and interests.

The logbook (or interviews with his/her flight instructors, or the FAA database listed above) may also show whether the pilot was trained to fly under instrument flight rules (IFR) versus the more common and much simpler visual flight rules (VFR). Only about 15 percent of general aviation pilots go on to get their instrument ratings, so this is an indication of dedication and experience in flying. However, if the IFR training and rating were obtained some time ago, if recent IFR flight time is low, and if the disappearance happened under IFR conditions, these facts should be factored in to the possible accident scenarios.

See what specialized training the pilot took, if any. For example, did he take courses in mountain flying, did he achieve an FAA "Wings" (Pilot Proficiency Program) level, did he recently obtain a "tail-wheel endorsement," etc.?

Also examine the logbook to see where this pilot was in the habit of flying. The airports visited will likely be listed by their three-letter identifier. To decode these identifiers, use:

http://www.airnav.com/airports/us

This database lists hundreds of airports across the US, and provides detailed information on each location. This website has a similar listing for some foreign countries.

In addition to the pilot's logbook, it may be possible to secure valuable information from other written information created by the pilot and passengers. Such items might throw light on their intentions, habits, hobbies, sports (e.g. river rafting in particular sites, mountain climbing, etc.), lifestyle, ownership of property that they might want to "buzz" from the air, state of mind, etc. Examples of such written items could include:

- Journal/diary/appointment book
- Autobiography – published or unpublished
- Letters
- Blogs
- Emails
- Twitter statements
- Stories written for local press
- Land ownership records
- On line postings on aviation or other discussion sites
- Social media postings
- Facebook, Linked-In or similar page
- Personal website

- Etc.

Write up all findings and post them to the group website.

Research the Aircraft

You need to understand the flight characteristics and specifications of the missing aircraft. You do not need to be a pilot to understand this, but it would likely be helpful if you have a pilot on your team who can write up a summary in layman's terms. Some of the items you want to know are:

- Tail number ("registration")
- Manufacturer, make and model, and year of manufacture
- Wingspan, length, weight
- Tricycle vs. tail-dragger (tail wheel) configuration
- Operating ceiling; pressurized cabin or not
- Rate of climb at sea level, at or near operating ceiling, and in between
- Glide ratio for the approximate weight of the aircraft when it went missing
- Maximum and cruise speeds in knots (you can use these to estimate range and to rule out radar tracks that are too fast)
- Airframe Never Exceed Speed (V_{NE})
- Maximum 'g" forces the airframe can sustain
- Stall speed in level flight, and stall speeds at various angles of bank (this can help you understand what might happen in a box canyon, for example, if the pilot suddenly realizes he is trapped and tries to do a quick 180 degree turn)
- Do the plane's wings stall abruptly, or are the stall characteristics mild?
- Signs and alarms indicating an impending stall
- Horsepower, including any special "speed package"
- "Tricky" handling characteristics, if any
- Is the plane rated for aerobatics?
- Paint scheme of the missing plane (try to obtain high quality color pictures of the top, bottom, tail and sides)
- Seating arrangement (side by side, "tandem" – which means one behind the other, multi-passenger, etc.)
- Metal vs. wood and fabric construction of the plane
- Strength of the fuselage frame
- Common causes of accidents in this type of aircraft
- Accident or damage history for this exact plane
- Propensity of this type of plane to burn on crashing
- Fuel capacity in gallons, and range in nautical miles (nm)
- Location of all fuel tanks, including any tank specially designed for aerobatics, and amount of fuel in each tank upon departure
- Parts of the plane that are most likely to survive a catastrophic crash
- Did the plane have "wheel pants" and were they installed on that day? (Note: a pilot flying a plane with wheel pants is unlikely to land on an unpaved strip; a useful bit of information when building scenarios.)
- Emergency exit door and how does it work? (E.g. some planes have an emergency door release that will allow the door to fall away immediately, thus permitting the pilot to

escape quickly during an emergency ditching. This configuration might perhaps lead to the plane, pilot and door all being located in different places.)

- "Airframe parachute system" if any (this is a new system that a few planes have, which is a parachute for the entire plane)
- Parachutes for the pilot or passengers
- Instrumentation on board (GPS, either installed or handheld? SPOT or similar "breadcrumb" tracking device? TracMe device? Automatic Position Reporting System (an amateur radio-based system)? Clock? Artificial horizon? Engine monitor? Strikefinder" – a digital lightning detector that detects and analyzes thunderstorms up to 200 nm away?)
- Emergency locator transmitter (ELT), either 121.5 Mhz or 406 Mhz, installed in the plane or handheld
- FAA airworthiness directives (ADs) for this make and model of plane, and whether they were complied with at the last annual inspection
- Details of the last annual inspection of the plane, including compression check of the engine and oil analysis records, if available
- If possible, very high quality pictures of the exterior and interior of an identical plane. (These can be used to identify instruments, parts of the plane that might survive, items that you forgot to ask about, etc. Try to take these pictures with a high contrast yardstick in each frame, so that you can estimate the size of each part of the plane.)
- Unusual identifying features of the plane, if any

Previous accident and damage data for this exact plane may be obtainable from:

http://www.ntsb.gov/ntsb/query.asp#query_start

Insert the tail number ("registration") and hit "submit query."

Sources for many of the other items listed above may include the airframe and power-plant (A&P) mechanic who worked on the plane (and who may be able to supply a copy of the maintenance manual), other pilots flying similar aircraft, the airplane manufacturer, and the airplane club for that type of aircraft.

If the plane was recently listed for sale, specifications and information on the plane may be available on www.barnstormers.com or www.globalplanesearch.com.

Various sources on the Internet can provide some of these specification data, including:

http://www.risingup.com/planespecs/info/

Interview Relevant Persons

You have probably already interviewed many people about the case, perhaps informally. But have you really documented every interview? Very soon you will be overwhelmed with data, and it will be impossible to remember who said what, or where which fact came from. Then you will be unable to evaluate the quality of the information obtained. So **every single interview** should be completely documented, and posted on the shared website. Re-do the interviews undertaken to date, if necessary. A suggested interview form with some sample responses is attached in Appendix A.

Capturing interview data is one of the most important steps. Remember, the process you are undertaking may go on for months. It will be impossible to remember everything you have learned unless you document it now. In fact, one of the most useful things you can do at the start of every month during the investigation, is to re-read every document, file and interview collected.

The types of people to be interviewed, and the focus of each interview is listed below.

Type of Person	Focus of Interview
Witnesses up through plane take-off	Activities of pilot and others in the day or two leading up to the disappearance; persons they came in contact with (so **they** can be interviewed), statements about flight plans, meals eaten, mood, overheard conversations, remarks, what the victims were wearing, whether they were wearing a watch or carrying a cell phone, whether they were in possession of survival or other gear, the weather on day of disappearance, etc. A major goal here and in all interviews is to "try to get inside the pilot's head"
Witnesses during flight through the crash	Witnesses who heard the plane or saw it in flight; determine the location, time, direction, motions of plane, weather, smoke or fire sighted, pictures taken, remarks made, reports made, calls made etc.
Friends, family and associates, especially flying associates	Statements made by pilot and others in plane about intentions, flight plan, preferences ("he liked to fly by Indian ruins" or "he liked to re-visit his favorite rafting rivers" or similar), flying style, spontaneous vs. "checklist" personality, "bold" pilot vs. "old" pilot, routes he/she usually liked to take, etc. Medical history, history of depression, any financial, marital, legal or other problems or distractions? (These do not necessarily point to suicide or intentional disappearance, but can help you understand how the pilot might be distracted when he/she should have been concentrating on the mission.)
FAA or equivalent at departure airport(s)	Flight plan, tower radio transmissions (recorded? typed out?), time cleared for takeoff, time of takeoff and direction, weather, requests made for weather information, remarks made, other planes in vicinity at the time, wind shear or other anomalies, thunderstorms or front in the area, radars operating in the area, etc.
Flight instructors	Flying style, habits, problems of pilot. Typical causes of crashes in that region/environment. Again, get "inside the head of the pilot." Was he/she a "list-maker and list-ticker" or more casual? Was he/she an "old pilot" or a "bold pilot"? A "cowboy"? (a very pejorative word in aviation)
Airframe and Powerplant mechanic(s) that serviced the plane	Equipment on board: ELT on board, what type? GPS?, transponder (Mode S?), clock? SPOT or similar "breadcrumb" tracking device? Condition of aircraft? Possible mechanical failure? Flying style of pilot? Places he often flew before? Flight hours and calendar time since last annual inspection? Since last maintenance? History of aircraft? Previous accidents or this plane or this pilot? Etc.

Fueler	Possibility that the plane just ran out of fuel (very common); fueling records available, time, who did the actual fueling (interview him re any remarks made by pilot or passengers), problems with plane, time of takeoff, etc. Get copies of all fuel records for the day in question and ideally for 2-3 days before. Try to determine if all the fuel tanks for the plane were completely "topped off."
Initial search authorities	Which organizations (public, military, private, voluntary, other) were involved and Points of Contact for each, activities undertaken by each, documents, maps, downloadable GPS files for all ground and air searches done, clue logs recorded and disposition of clues, reports filed, "after action" reports done, field interviews recorded, fire or smoke reports received, ELT transmissions received, radar tracks generated, raw radar data obtained, procedures and technologies used in searching, and the estimated Probability of Detection (POD). These data may be difficult to obtain. "Back door" channels may be more fruitful, and a Federal FOIA is worthwhile. You will want these data to evaluate where previous searching was done and how well it was performed. Federal parks, US Forest Service, and other Federal land owning agencies may have controlled all or part of the search effort. Obtain information from them. Find out if there is a state or county equivalent of the Federal FOIA, and use it to secure the maximum amount of data. Try to interview actual searchers, not just management or Public Information Officers; you may get a different view of the search and of the estimated POD obtained. Timber companies, Indian reservations, and other large private landowners may have useful data. Be aware that key documents and clues often are generated and may reside inside many different organizations that do not necessarily communicate with each other, that have different databases, and that report data in different ways. Do not assume, for example, that because you have searched one publicly available database for fire reports published by one agency, that you have searched all fire reports for all agencies in a region, or that minor fires were always documented even in that one agency.
Any follow-on searchers (public or private)	ditto
Specialists	Weather specialists, local fixed wing, soaring, paragliding or other pilots familiar with weather and especially micro-weather conditions in the area Radar specialists Cell phone specialists Local ornithologists – ask about danger of bird strikes in this area in bringing down the plane Divers and underwater searchers – if the plane could be underwater, what searching was done, how complete, and with what estimated

	POD Airplane manufacturer—weaknesses in the plane, causes of past crashes, plane specifications as cited in the previous section Air club for owners of this type of aircraft—ditto Owners of identical planes—inspect plane, identify engine size, take photos, examine emergency equipment, ask about handling peculiarities and causes of crashes
Potential Team Members	Interview re relevant skills, especially those missing on the team
Overhead assets	Google Earth experts, www.internetSAR.org, other overhead satellites or aerial photos that could be useful. The AFRCC in its logbook may show that "national assets" were used. These are probably satellites, and it is very unlikely that you will be able to obtain data on these.
Private firms involved	Private firms are often very concerned about liability. If cooperation is not working, then you may well need to hire a lawyer or private investigator, and perhaps use civil subpoenas, obtain a court order, or bring suit to obtain the needed data or witnesses. The party served with the subpoena will generally be given time to respond and perhaps try to quash the subpoena.

In total, 30 to 50 or more interviews may well be necessary. This is a major effort that may require hundreds of hours of work. Divide up the effort.

It is of course very likely that the police, CAP and other authorities may have already interviewed some of these persons. However, in our experience, detailed re-interviews, very well documented, are always warranted, for several reasons: 1. It is unlikely that you will get the detailed interview notes from the authorities; 2. Interviews done in the haste of an actual emergency are unlikely to be well documented; 3. Very few interviewers actually manage to capture everything that a subject says.

If it becomes clear that some interview and other data are particularly sensitive, for whatever reasons, it may be necessary to have two websites for posting your team's information: one with all the information that can be viewed by the senior analysts, and one for "searchers" who are given the relevant information to allow them to search and participate in discussion, but who are not provided the sensitive or irrelevant information uncovered. Drawing the line on what information to not provide is very difficult, however, and may lead to some group dissention.

A note on interviewees, which applies during the initial official search phase and during the "cold case" phase: in almost any investigation like this, some interviewees will speculate that the pilot (and passengers) disappeared intentionally, and have voluntarily left the search area. Of course this could happen. To obtain factual evidence regarding this question, you can monitor the pre- and post-disappearance finances of the pilot (and others), ask law enforcement and the relevant bankers and insurance agents to examine the financial, insurance and credit card accounts in question, and interview anyone who makes this speculation, to see if they have any factual evidence. You should also examine what you know about the character, ethics and attachments of the disappeared person(s). If you are wholly satisfied in your mind that this person would never disappear on purpose, then you are very likely right, and you should devote your energies to data acquisition and analysis, not speculation.

Be sure to ask all relevant interviewees if they took any digital (or film) photos at the approximate time of the disappearance of the plane. Such digital photos will likely contain data on the exact time the photo was taken, and may even have GPS information embedded. (To get the time and date a photo was taken, roll your cursor slowly over the jpeg when it is listed in a group of other files and jpegs.) If they took photos at about the time they think they heard or saw the plane, and it turns out that that time is just not feasible, then you can rule out this sighting.

Develop Data on Weather and Other Conditions

Weather is critical to light plane pilots, and thus is critical to your search. As part of your focus on "getting inside the head" of the pilot, you need to understand what weather information he/she had when planning the flight, and what weather was actually encountered.

To get a gross visual idea of the weather on the day in question in the US, go to the US National Oceanographic and Atmospheric Administration (NOAA) NEXRAD National Mosaic Reflectivity Images database, at:

http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwNexrad~Images2

Select the date of the disappearance, then on the next screen, select the Zulu time you are interested in. This is also known as GMT, the mean time in Greenwich, England, or Coordinated Universal Time – UTC.

(See http://wwp.greenwichmeantime.com/info/timezone.htm for the Local to UTC time conversions.)

For example, for the famous Steve Fossett disappearance, select the accident date of 3 September 2007, then select 1700 Zulu (1000 local time in Nevada and California, a time that it is likely that Fossett was aloft). The red numbers in the middle bottom of the screen show you that you are seeing the right time and date. Examine the radar images of the weather systems developing at that time. Note that there are no major storms over the southwest portion of Nevada, where Fossett disappeared. Now hit "hourly" "animate" in the lower box on the right hand side. This brings up an animation which shows the weather hourly, after your specified time. Note that in SW Nevada there are no major cloud formations or fronts until 2200 UTC, or 1500 (3:00 pm) local time, well after Fossett should have landed.

However, remember that this is just a very gross picture from a long way away; local micro weather can quite different, and may not show up on this distant view of the US.

A US national weather map for any date since 2002 can be obtained from:

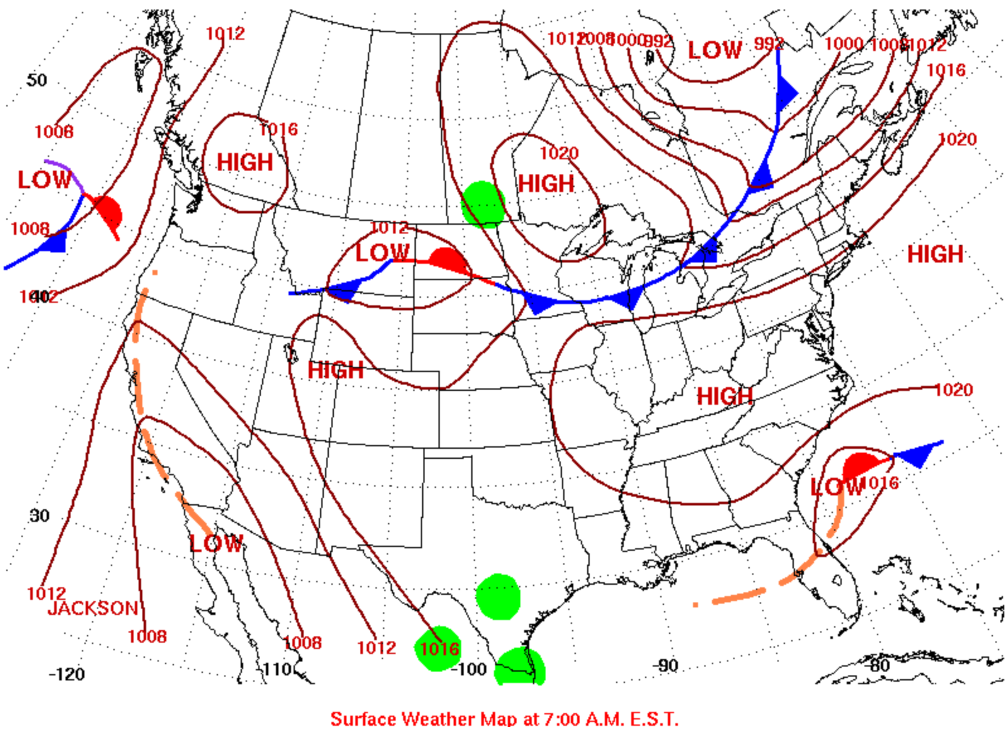
http://www.hpc.ncep.noaa.gov/dailywxmap/

One of the best sites for obtaining detailed historical weather data in the US is maintained by the University of Wyoming at:

http://www.weather.uwyo.edu/upperair/sounding.html

This web page presents raw NOAA data which are collected twice each day, usually twelve hours apart, at about 92 sites around the country (and 800 around the world), using weather balloons and radiosondes (data collection and transmitting devices) which collect weather data at various altitudes. Data at various altitudes are quite important, since weather and especially wind speed and direction can vary significantly by height above ground level (AGL).

Go to the University of Wyoming web site. At the top of the page, specify the region of the world you want, then a “text-list” plot, then the date of the disappearance and a time bracket in Zulu time. You can go back as far as the year 1973. On the map, pick the station closest to the missing aircraft LKP; this generates a list of data.



National weather map for 3 September 2007, the day of the Fossett disappearance.

The following are the interpretations for some of the weather abbreviations used:

HGHT: height above sea level in meters, of the weather station or the weather balloon launched by the station to collect data
DWPT: dewpoint
RELH: relative humidity
DRCT: direction of the wind in degrees (true)
SKNT: speed of the wind in knots (nautical miles per hour)
TEMP: temperature in Celcius (centigrade)
PRES: barometric pressure (in inches of mercury)

Thus if you specify, for example, 12:00 Zulu for 3 September 2007, the date of the Fossett disappearance, you can obtain data for Reno, Nevada, the closest station, at 0500 (5:00 am) local time. Examining these data, note that near ground level the wind speed is very low, about zero to three knots. But higher than 2743 meters above sea level, the wind speed jumps up to 19 to 25 knots. Thus a pilot taking off early in the morning might be deceived into thinking that winds were calm, but in fact they were fairly strong aloft. The wind direction is from the south, around 185 degrees true. Hence ridges running east to west in this area might have a moderate "rotor" or dangerous tumbling airflow on the leeward, northern side. Examine the data for 12 hours later to see if the conditions continued to be challenging, or even got worse. These conditions should be considered in developing possible accident scenarios.

The temperature on the ground for the Fossett example is a mild 20 degrees C, about 71 F, and is colder aloft. But remember, this is at 5:00 am local time. The temperature in this part of the country will probably climb much higher after the sun comes up. Temperature is important because a high temperature forces the air molecules further apart, thus the air is less dense. This affects the "density altitude" – the apparent altitude that the plane experiences as it flies. Examine another data base that gives archival temperature at ground level every hour. For example, examine the site:

http://www.wunderground.com/history/

Here you can enter the city or zip code and date, and obtain daily average and hourly weather observations at that station. If you enter Hawthorne, NV (a town close to where Fossett took off) and the date 3 September 2007, you get a wealth of data from Fallon Naval Air Station, north of Hawthorne, including hourly data which shows that the temperature by 9:56 am was already almost 83 degrees F, certainly high enough to affect the density altitude. Thus this should be factored in to the scenario analysis for that disappearance.

To examine the effect of density altitude, you can use the data obtained from the University of Wyoming (UW) website, and an on-line density altitude calculator such as:

http://wahiduddin.net/calc/calc_hp_dp_metric.htm

Here let's assume that the Fossett plane is flying a bit above 6000 feet above sea level, so you enter 2030 meters from the UW database. At that altitude, the temperature as listed on the UW site was 21.2 degrees C. Set the atmospheric pressure at a standard in hPa (mb) of 1013.2. The dew point from the UW site was 1.2. Enter these data in the upper box of the metric calculator and hit the "calculate" button. This yields a density altitude of 2734 meters, or a third more than actual altitude! And the relative horsepower is only 77 percent.

These items mean that when the plane is flying at about 6000 to 7000 feet, it feels more like 8500 to 9300 feet, and the engine feels much weaker than it does at sea level. Thus the plane cannot climb as quickly and would find it more difficult to get out of box canyons, downdrafts or other challenges. Consider these data when building your possible accident scenarios.

Returning for a moment to the weather stations which launch weather balloons, it is unfortunate that there are usually only about two such weather stations per state, and they do not always launch their weather balloons twice per day. Hence the site of your incident may be far away from the location of the available detailed data. To obtain precise micro-data for your area, try to interview pilots who were flying that day in that area, who may recall the weather because they remember hearing about the incident. Go to the local general aviation airports, interview staff and pilots, and see if there is a local volunteer who hangs around the airport and knows everyone and all the gossip. In some small towns this person may actually write a small column about airport activities in the local paper. Enlist the support of that person to try to track down weather and other information, and local pilots, mechanics, fuel technicians, and others in the flying community.

If weather appears to play a key role in the accident, you may wish to engage the services of a Certified Consulting Meteorologist, or "forensic meteorologist." You may be able to get such an expert to volunteer his services, which normally are fee based. To obtain a list of such weather experts in the area of the crash, go to:

http://www.ametsoc.org/memb/ccm/ccmhmfrm.html

This site has a pull down menu for states and countries in case you ever want to look for the services of a meteorologist elsewhere, including overseas. Write up a report summarizing your weather findings, including density altitude estimates. Include the raw data and sources in an appendix, and post these on the group website.

Another condition that may well be of interest relates to the status of the sun and moon. Many light plane pilots fly early in the morning, since weather conditions are usually better and winds minimal. So it may be useful to know the times of sunrise and twilight, and the rising and setting and phase of the moon (which can provide light). For this information, see:

http://www.sunrisesunset.com/usa/

This site gives data on three different types of twilight times (civil, nautical and astronomical); sunrise and sunset times; phase of moon; and moonrise and moonset, for every day for numerous towns in the 50 US states, for all dates since before planes started flyng!

Knowing these data may help you weigh other evidence. Suppose you have two radar tracks and are not sure which one is your target light plane, piloted by a solo, novice pilot. One departs early in the morning well before astronomical twilight (in the dark). One departs just after sunrise. All other conditions being equal, it seems likely that the second track is your target plane, since an inexperienced pilot probably would not take off until dawn. Furthermore, Sport Pilot rules state that a pilot with only a Sport Pilot license is not supposed to take off in the morning until civil twilight has begun, so if your track begins just after civil twilight, this may be your plane.

Write up your data and analysis of such conditions, and post them on the common website.

Obtain Police Data

Your case is very likely considered a "missing person" criminal case by the jurisdiction that the missing person(s) departed from. You can possibly use this fact to your advantage, by getting the police and local prosecutor on your side, to help subpoena information. This will be easier to do if you have public knowledge and sympathy on your side. In police parlance, you need your case to be a "red ball" case, deserving of high priority, lots of resources, and an in-depth investigation.

You may need that subpoena power frequently. Take a real example: you need to locate the airport employee who fueled the plane, but that person has left his job and now the only information you have is that "he is taking courses at the ABC flight school." You call the ABC school to get his phone number and address, and the personnel department tells you that they cannot release the information except under a subpoena.

After the official police investigation is over or is "suspended," the "missing persons" investigation data may be requested and obtained by the family, in some jurisdictions. Sometimes dozens of pages of investigative notes are available. The reports may be somewhat "redacted" with phone numbers or emails removed. But sometimes the relevant persons can be traced and re-interviewed, often with good results.

You will need to become skilled in tracking down people. Learn to use Google, www.whitepages.com, www.mapquest, www.facebook.com and other similar sites, and the Public Records Index database on www.ancestry.com (very helpful).

Post all the data obtained on the shared website.

Review ELT Data

An ELT is an Emergency Locator Transmitter. Most general aviation planes in the US (and elsewhere) are required by law to carry an ELT.

The US and several other major countries are currently in the controversial process of changing over from an analog 121.5 Mhz (Megahertz, a radio frequency) ELT standard to a digital 406 Mhz standard. Both types of ELT transmit a distress signal which can be received by satellite or by planes overhead, thus indicating the location of the downed aircraft which set off the signal. The distress signal can be set off manually, or is set off automatically when the ELT receives an impact shock or is submerged in water. Be aware that for both systems, well over 95 percent of all signals received are false alarms, often caused by hard landings, testing, or other reasons.

An ELT (the orange box) installed in a light plane.

After 1 February 2009, the satellite system monitoring the 121.5 ELT was no longer available (although at least one expert thinks it may be possible to "resurrect" missing data). But many if not most light planes retain their 121.5 ELTs, and thus 121.5 ELT signals may be heard by passing aircraft and may provide useful information on where your target plane is located. Also, the downed pilot may be able to transmit by voice channel over the ELT emergency frequency for some period after the crash, if the ELT survived. This may provide useful information also.

For your purposes, you need to obtain all the ELT signals information gathered by the original search effort for the date of the disappearance (and for at least a week afterwards), and see if any more information remains to be gathered. You then need to review these data to see if they shed light on the case. It is quite possible that the data obtained will be quite confusing due to: false alarms, reflections of transmissions, the difficulty in localizing the 121.5 transmissions, the possibility that the ELT or its antenna was destroyed in the crash, and hence the data you are seeing are other ELTs going off, and the reported possibility that 406 transmitters do not work very well when bobbing up and down on water.

Often ELT data will be as vague as a report in an AFRCC clue log (which you may be able to obtain via a FOIA request) that "a pilot flying in XYX county near the town of SLT on a route from ABC to DEF at about 1100 local time heard an ELT going off, circled around and tried to locate it, was unable to, notified the CAP, and proceeded on. The CAP arrived at 1500 but was unable to locate any ELT transmission." This vague clue is nevertheless a clue, and should be worked into your scenarios.

Be aware that 121.5 ELTs can continue to transmit for a number of days; depending on the state of the batteries.[7] Hence the need to collect data for some time after the crash. Of course, ELT reports on the day of the incident are a top priority for investigation and analysis.

If there are multiple ELT hits, it may be possible for a radio or ELT expert to estimate the reflections caused by local terrain, and the areas which are in ELT terrain "shadows." Thus it may be possible to narrow down the search area, even when ELTs signals are scattered and confusing.

Note that in addition to ELT information, there may be information from "breadcrumb" electronic systems that leave a trail of GPS locations that will allow you to track the plane. One of the leading suppliers of such technology is SPOT; see www.findmespot.com. SPOT is usually set to transmit every five to ten minutes, giving a signal that is received by a satellite and relayed down to a ground station, and then distributed to authorized websites and persons. Many pilots are now using SPOT, and their spouses or colleagues have access to their websites. Thus this will allow tracking of the plane to within a few minutes of the crash site, a terrific lead. SPOT has coverage of most of the land masses of the Earth.

Other similar possibilities include a TracMe device or an Automatic Position Reporting System (an amateur radio-based system).

Research News and Magazine Sources

Reporters who covered the story of the disappearance in depth can be a gold mine of information, and may reveal sources, contacts, theories, resources, documents, maps and other items. And they may help keep the story alive and bring pressure for continued searching.

[7] Manufacturers often cite figures of about 50 hours of operating life for an active ELT in use. However, it is possible that an ELT could function for a longer period. (One manufacturer informed me of a case in which a 121.5 ELT ejected during a catastrophic crash in a blizzard did not function initially due to the cold and being covered with snow, but during the daytime over the next several days did function, apparently as it warmed up and the snow cover melted.) Also, a handheld or manually operated ELT could last substantially longer, if the operator is able to turn it off and on. Find out exactly what make and model your missing plane's ELT was, and what the manufacturer states is the battery life. You may wish to experiment with another of the same make and model under the conditions you think the plane encountered. Just be sure to conduct any tests in such a way that you do not trigger a search!

Remember to remain upbeat and positive with these reporters. Do not reveal frustrations with the official search teams, or divisions in your own group, UNLESS you have given this matter very careful consideration and feel that such discussion is absolutely essential. Such public criticism, especially during the active official search (usually the first one to four weeks after the disappearance) may reduce your chances of getting inside information that could be very valuable later.

Be aware that there are rarely any established procedures (except for the Federal FOIA) for private groups such as yours to interact with existing SAR groups that participated in the initial search. Hence the need for careful management of the press, and of your relations with these groups. Remember that county SAR teams, the Civil Air Patrol, and most other searchers in this country are volunteers who are giving their time and energy, and sometimes risking their lives, to help you in your time of need. Be sure to thank them for their assistance!

Post the data obtained from reporters and the media on the shared website. Be sure to electronically "clip" all news stories about the incident and search from all media outlets, including specialized outlets such as SAR and CAP magazines, chat rooms and bulletin boards. Do regular Google and other electronic searches to pick up as many stories as possible; you may uncover new clues. (During the Fossett search, a likely new eye-witness was spotted because he wrote a note on the electronic bulletin board of a journalist who had written a story about the disappearance.)

In terms of letting journalists in to your team's operation, it is generally not advisable to allow reporters access to the shared website, or even tell them that it exists. The website will undoubtedly have lots of extraneous, confusing, contradictory and perhaps sensitive, negative or even scandalous information. (For example, you might find out that the pilot is having an affair outside of marriage. Do you really want this information out in the press?) If you want to get your message out, to have the public look harder for the plane, develop a short, sound-bite sized story and press release, and distribute it to as many outlets as possible. Be sure to advise the aviation press, both print and electronic (such as www.avweb.com).

If you are researching an historical case, you may well be able to find data in news stories from the period. Articles about the missing plane, pilot and passengers may be obtainable from local newspapers or libraries. Contact the local newspaper publisher, but you may have better luck in the microfilm records of the local public library. The state libraries of many states also keep microfilm records for many local papers.

In recent years many newspapers have been put on line and can be searched from your home computer. Such sources (which usually require a subscription fee or pay-per-article arrangement) include:

- www.nytimes.com (the New York Times; most other major papers now have a searchable archive or "morgue" of all their stories, not just obituaries)

- www.newspaperarchive.com; “tens of millions of newspaper pages…”

- www.ancestry.com; Historical Newspaper Collection. Note that www.ancestry.com can be very useful for tracking down the descendants of the pilot and passengers in the plane, and for locating live persons to interview (see the “Public Records database” section.

- www.genealogybank.com; very strong in the NE United States

- www.smalltownpapers.com; 250 small town papers

Searching these on-line databases can be quite difficult, since you may not be able to focus in on just one date, month or year for the disappearance, and entering a generic search term such as “plane crash” may generate thousands of irrelevant “hits.” Hence your first and best approach may be to search microfilm for the date of the disappearance and for several weeks or months after the disappearance.

When searching on-line in the newspaper archives, don’t forget to simply enter the name of the pilot and passenger(s) in the search engine, and see what you come up with. You may obtain a useful obituary, memorial notice, or articles about the people and their lives, career, family, etc.

While on-line, you should also use general search engines such as Google, www.bing.com and www.dogpile.com to search for the name of the pilot, passengers, and the tail number of the plane. You may find that others have already done some research on your case, or you may find useful primary data.

Analyze Fire Reports

One item that should be elaborated on is fire reports. Many light plane crashes result in fire. This can be either a primary fire of the plane itself, characterized by dark smoke lasting perhaps 5 to 25 minutes, and/or a secondary fire of the surrounding vegetation and trees, with light grey to white smoke lasting perhaps an hour or even becoming a major fire lasting hours or days. This latter fire will very likely cause a “burn spot” which will be much more visible than the plane or the primary fire location. Try to do your analysis and get out searching before a winter/spring cycle destroys or reduces that crucial burn spot.

People tend to report fires, especially in the West, since they are so destructive, and hence you should research fire reports carefully. Unfortunately, there is no unified historical fire database (across all agencies for wildfires) that is readily accessible by the public. Hence you will need to interview all relevant agencies in the search area, to determine what fires were recorded on the date of the disappearance. Agencies to be contacted should include:

- US Forest Service (you may have to contact each National Forest separately)

- US National Park Service (you may have to contact each National Park separately)
- US Bureau of Land Management
- State Park system
- County Park system
- Indian reservations
- Other land-owning agencies
- Private ranches
- City, fire district and county fire departments.

Note that some agencies do not record a fire in their databases, especially a small fire, unless the fire is confirmed by being observed by a fire officer. Therefore, if a fire resulting from a plane crash is out by the time the fire official flies overhead looking for it, or drives to the area, the data may not be recorded. But the initial fire report may still exist in a written form in a log book, or in electronic form on a fire department tape or separate database. It is up to you to seek out those initial reports, and correlate them to your missing aircraft.

There is a system that lists major fire incidents for the last 365 days for some states which may be useful. This is located at:

http://www.inciweb.org/

Links from that site to various regions may also prove useful.

There is reportedly a system called the National Interagency Fire Management Integrated Database, which is an Oracle database the collects fire reports from various agencies, and apparently contains more than a decade of historical information. We have not yet been able to access this system or its successor, and we invite you to research this database and advise us of your findings.

Undertake Other Research

Fill up all the “buckets” listed in the first section above, if they are not already taken care of. Post the data obtained on the shared website.

Another item that may be useful is information on the departure airport, destination airport, or other nearby airports. Data of interest can include elevation, lat/long, runway locations and construction, lighting, nearby navigational aids, average number of aircraft operations (departures and takeoffs) per day, etc. These data can be secured from:

http://www.airnav.com/airports/

Develop Scenarios for the Disappearance

Using the data collected, come up with a list of reasonable scenarios for the crash and disappearance. Identify the simplest ones that fit all the facts. Try to obtain the services of an expert in search theory to assist in this and in the next step below. Such theorists are not common, but may be obtainable through the National SAR School (in Yorktown PA; see http://www.uscg.mil/tcyorktown/Ops/SAR/Inland/default.asp), your local county SAR team, or other similar organizations. Consider joining your local SAR team to learn or at least have some familiarity with these techniques.

At a minimum, the scenarios should include the following three elements: analysis of what could have happened to the plane; the maximum containment zone; and logical areas within that zone. These are discussed below.

1. Analysis of what could have happened to the plane, given the facts and theories developed to date. Encourage all input, using a brainstorming approach. Avoid "scenario lock" where only one scenario or bit of evidence is focused on. Do not allow some team members' titles or positions, or extroverted or dominant nature, to drive the scenario development—get everyone to think and provide input. Think about the natural and man-made hazards in your area, such as buttes, canyon walls, ridges, mountains, power lines, etc. that could have played a part in the accident. Work those into the scenarios.

A typical scenario from the actual Steve Fossett case was:

> The plane was reportedly seen here, at what we think is the LKP, at about 11:15 am, and the pilot needed to be back at the Ranch, sitting at the dining table, at exactly noon, for a farewell lunch. Hence allowing for transit time, landing time, and a few minutes to clean up, we estimate that the pilot was unlikely to have flown east around the Wassuk Range, but rather would probably have flown home more directly. The most direct route home is boring and rather featureless, across a flat plain. But there is a curved route home along the pretty foothills and canyons on the west side of the Wassuk Range that is attractive, and this also resembles a route back to the Ranch that we know from interviews that soaring pilots like to take. Our pilot likes soaring (although he is in a powered plane) and is out for a sightseeing jaunt. Hence we think that the pilot could have been transiting those canyons, acting like a soaring pilot, and caught a wing, been trapped in a box canyon, or encountered a major downdraft, probably near the crest of a ridge or along the edge of a canyon. Aerial searching has already been very intense in those canyons. Thus areas in those valleys that are hard to search from the air (e.g. north facing slopes with high vegetation and poor lighting) should be a high priority for our ground search effort.

This scenario unfortunately turned out to be wrong, because it relied on an erroneous witness for determining the LKP. The plane was found 66 miles away, in another state. That scenario was very convincing, though!

A typical scenario from an actual case in Arizona was:

> According to our interviews, the pilot was interested in Indian ruins and sometimes likes to fly below the side walls of canyons. His apparent radar track heads due north toward a beautiful canyon area which includes some Indian ruins. Hence these canyons in line with the (extended) radar track, north of the LKP, should be a high priority ground search area.

This scenario turned out to be right, since the LKP was based on a feasible radar track further validated by a cell phone registration. The crashed plane was eventually found in one of the attractive canyons that apparently had drawn the pilot to that area.

Note that the two scenarios listed above are rather long and have speculative elements. The best scenarios are short and ultimately provable, e.g. "the pilot decided to go east around this major mountain range obstacle" or "the pilot decided to go over this major mountain range obstacle."

2. Draw a line around the "maximum containment zone" (MCZ). This is the area in which the plane could feasibly be located. This area may be the maximum range of the plane, flying in one direction at the most fuel efficient speed, with that range used as the radius of a circle around the takeoff location or the LKP. But such an area is likely too large to be useful. Instead, use your knowledge of the case to develop an MCZ that you feel comfortable has virtually 100 percent "probability of containment."

3. Within the MCZ, use geographic features and the scenarios you have developed to create logical areas with roughly equal probability within each area. For example, in the actual Fossett example described above, the "open, uninteresting and boring area" between the suspected LKP and the Ranch was designated as one area, with an equal (unlikely) probability in that area. The "interesting, pretty canyons" along the "curved route" from the LKP to the Ranch were designated as a separate area (with a high probability).

Note that each area does not have to correspond to a scenario, since different elements of a single scenario could possibly place the plane in different areas.

Each area does not have to have the same number of square miles, and can be any shape or size. There can be any number of areas, but more than 16 exceeds the capacity of the National SAR School software and the Search Tracker software that can be used to analyze scenarios. And of course if you only have 1 or 2 areas, you will not get much use out of the next step, voting.

Post the scenarios for consideration on the shared website. Discuss them and possibly revise them.

Undertake Proportional Consensus Voting on the Scenarios

At some point you will have a substantial amount of data, and a reasonable number of areas and scenarios. You will then want to have your group review all the information (or at least all the relevant information). If there is no clear "aha!" location, you may well want to undertake “Proportional Consensus Voting” to determine the highest priority search areas/scenarios.[8] This system tallies the secret ballots of each reviewer, with each person giving a certain number of votes to each of various possible search areas. Then the secret ballots are tallied and the group consensus announced. Surprisingly, this system does seem to do a good job of capturing the collective opinions of the group, and improving the probability of searching in the right place. There can be wisdom in groups.

The vote results in a prioritization of each of the search scenarios, assigning a collective opinion of the likelihood that each scenario’s associated area contains the missing aircraft. These priorities (and their weights) form the basis for selecting areas for future search.

Once you’ve prioritized the areas, you can examine the search effort previously applied in each of the areas, and decide if they were searched adequately, or if they still need to be canvassed. This can be done mathematically by a search theorist using software, or it can be done a little less precisely using common sense. It is here that you factor in the detailed information on the initial (and any subsequent) searches, their extent, estimated POD, duration and intensity.

Last, you need to incorporate a “density function” into the analysis. Imagine that your analysis so far has shown that you have two top priority areas out of sixteen, and the top two are equally likely and have been equally searched so far. But area A has 10 square miles and area B has 50. Therefore, you will get more “bang for the buck” by first searching area A, since the “density” of the probability is higher there. Probability analysts like to talk about the “peanut butter” analogy. In area A the peanut butter (the probability) is spread thicker over the ground, because the area (the piece of bread) is smaller than in area B, where the same amount of peanut butter is spread over a much larger piece of bread, and is thus a very thin layer.

The end result is a short, prioritized list of areas that should be searched *next*, if more searchers are available for tasking, and another list of areas that should be searched *soon,* followed by a list of low priority areas, and a list of areas to be ignored (if any). Those “next” areas are not guaranteed to contain the plane. But if you have done your analysis correctly, they should be the areas that will have the “biggest bang for the buck” – the most chance of increasing the overall probability of detection.

Post the consensus, the individual votes, and the end result of prioritized areas on the shared website. If substantially new data are obtained, you may wish to re-do your voting, and after substantial new searching is done, you will need to re-do the final “next areas” analysis.

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[8] Note: Various SAR organizations use the “Mattson voting” approach to determine the highest priority search area(s). However, various experts feel that the Mattson approach has been proved to have various scientific flaws, and will provide misleading and mathematically insupportable results. Instead, based on my research and interviews, I recommend using “proportional consensus voting” or “valid consensus-type voting.” A short version of this recommended approach is presented in Appendix C.

Organize a Search

Searching is a huge and potentially dangerous and expensive undertaking, which of course is undertaken at your own risk. To limit your liability, you may wish to get volunteer searchers to sign a waiver acknowledging that they understand the risks of searching, and that they indemnify your organization, search leaders and other participants from claims or lawsuits.

Overseas in the developing world you may be best served by hiring cheap local guides or villagers who know the area well. We generally recommend against offering rewards. Rewards may only lead to mis-information and frustration, or even fraudulent behavior and intentional deception. Instead, rely on good will and sympathy.

In the US you can try to get local SAR groups to use your case as a "training mission." They may be barred from officially looking for persons declared legally dead, or where the initial search failed and it is assumed that the victims are dead, but "training missions" may be allowed. Try to get media attention on the case; that will likely help.

Failing all that, you may wish to organize a search yourself. If you are satisfied that a reasonably complete air search was done of the highest probability area(s), but the terrain and ground cover in that area is such that a light plane might well have been missed from the air, then a ground search there may be warranted.

Aerial searching used in most missing plane cases can be very inefficient and ineffective if the area is large, if the terrain rugged, or if the target is small, crumpled, or hidden from view. The coverage and estimated POD generated by such searching is a function of a number of factors, including the speed and height of the search plane, the number, training, fatigue and motivation of the observers, the atmospheric visibility, the sun angle, the terrain and vegetative cover, the recency of the crash and whether it created a burn spot, the size and color of the target or its "debris field," the width of the "search lanes," the consistency of the pilot in maintaining his search lanes, etc.

A typical fixed wing search by the Civil Air Patrol in the US will be conducted at about 1000 feet above ground level (AGL) for safety reasons, at approximately 100 knots (115 statute miles per hour), with search lanes about ½ mile wide. At such speeds and altitudes, observers can (and have been known to) easily miss all but the most obvious crash sites. (See Appendix B for a few pictures of actual missing crashed planes.)

Light planes often burn and crumple on impact, and may not show ANY of the bright colors of the plane fabric. Furthermore, the fuselage may crumple into a mass no larger than one or two shopping carts. Fire and rust may quickly make even this look like a downed tree or bush. Thus aerial searching from fixed wing aircraft has a very low probability of detection; yet this is the main method used.

In mountainous terrain, the CAP usually flies along contour lines, which keeps the search plane at approximately the same AGL height all the time.

Unfortunately (and remarkably), the CAP does not generally record and download GPS data showing where they have searched; thus such valuable data on the initial search will likely not be available to you (or to the CAP for self-evaluation). But if you do aerial (or ground) searching, you should religiously use a GPS system to record everywhere you have searched. (Make these data, and a copy of all your analyses, available to local SAR authorities and to the CAP in a final report, if you do not find the plane and must terminate your search.)

By the way, the most common mistake in using such a GPS in searching is forgetting to turn the GPS unit on only when arriving at the start of the search grid, and forgetting to turn the GPS unit off, immediately upon stopping the search activity. Making this mistake will lead to lots of confusing and irrelevant transit tracks to and from the search area, that must be erased by the search theory analysts.

Helicopters generally make better search platforms due to their slower speeds and lower altitudes, but their very high cost per hour (often $1000 to $4000 per hour, depending on the type of "helo") often is outside the budget of private searchers.

Be aware that there are many cases where a light plane crash has not been seen, even by a helo observer hovering only a few hundred feet over the wreck.

For these reasons, a targeted ground search may be the best approach. But this method is slow and can cover only a very tiny bit of territory. So the best technique is to do very, very extensive research and data analysis before you even think of going into the field.

During that period of analysis, you should try to locate a sponsor or person with funding, who is willing to pay for the out of pocket costs of the eventual ground search. To give you an idea, a volunteer ground search run very carefully on a shoe string budget in the US, that delivered over 250 person-days of searching (including direct overhead such as search planning in the field) over the course of 19 calendar days, cost about $15,000 to $20,000 in direct, out-of-pocket expenses. If all the costs had been non-donated, and if everyone was paid their normal salaries, the cost would have been enormous -- around $500,000 to perhaps $1 million. Note that 250 person days of searching is a tremendous number of days, and likely exceeds the total ground effort delivered in many US counties or perhaps even states for any particular missing plane.

Before you go into the field, develop a formal Search Plan using Incident Command System (ICS) principles,[9] with an ICS organization chart, including a Safety Officer. Plan the search and then search using the Plan. Employ search tactics tailored to your terrain and your case. For example, you may wish to have air support for your team, but at this point it is likely that the aircraft will be used more to spot "productive" areas for

[9] See http://training.fema.gov/EMIweb/IS/IS100A.asp

searching, or to examine anomalies spotted by ground searchers using binoculars, rather than for general area searching.

Be sure to bring in experienced ground SAR experts who will keep you safe; you don't want anyone else to get hurt or go missing.

* * *

By undertaking the detailed analyses recommended in this manual, and by organizing a search for others, you have chosen to sacrifice your time, energy and treasure for a good cause. Your missing loved ones and friends thank you for your effort, whether they are in this world or the next. As you travel this difficult path, remember the motto of the Missing Aircraft Search Team:

Spes Mos Increbresco: Hope Shall Prevail

Good luck!

Acknowledgements

Many thanks to Colleen Keller and Rick Slatten for their very helpful substantive contributions and editorial corrections.   All remaining errors are mine. Thanks to the family members and friends and colleagues of Steve Fossett and Marcy Randolph and Bill Westover, and to the many other family members and friends of other missing aviators out there -- this manuscript is for you. To the other members of the Missing Aircraft Search Team, many thanks, and keep up the good work!

Appendix A

Sample Interview Form
with Some Information Filled In to Give a Flavor of What is Required

Case of the Disappearance of Tail No. XXXXX
Interview Notes—Summary

(to be used for most interviews)

Focus topic of interview: ___friendship with _YYY(a disappeared passenger) and destination on date of disappearance___________

Name of interviewee: __XXX_______________

Nature of interviewee's relationship to case subject: friend/acquaintance/co-worker for about xx years of YYY

Date interviewed ___________ Local time of day: ______
Approximate duration of interview:_ 40________(minutes)
Date interview notes typed up___________
Interviewed by phone__ mail__ in-person__ or email__
Interview conducted by: _ ____________ and ________x_____________
Interview conducted in: English ___Spanish ___ Other (describe) ____________

Contact info for this interviewee:
Landline tel:
Cell:
Email:
Address:

Bias observed in this interviewee: No: _x__ Yes ___ Possible ___
Describe bias if other than "No":

Background and qualifications of the interviewee:

Friend of YYY for about xx years

[Note: items in brackets are comments by the interviewer.]

Summary of Relevant Points in the Interview:

1. XX called me; I had left a message on his phone a couple of weeks ago and tried to reach him but no reply. XX was forthright and described his relationship with YY as KKKKKKKKKKKKK

2. XX saw YY on the day of the disappearance. They had gotten together to walk to UU and catch up. They had not seen each other in xx months. Their conversation was as follows: 10 lines redacted.
3. 10 lines redacted, re XXX frame of mind.
4. 10 lines redacted.
5. 2 lines redacted.
6. XX does not know about [the pilot's] plans, destinations that would attract him, flying style, etc., and did not hear anything about these topics after the disappearance.
7. 7 lines redacted.
8. 6 lines redacted.
9. 3 lines redacted.
10. XX stated the following about their exact movements and times on the date of the disappearance: ZZZZZZZZZZZZZZ

* * * * *

1. Conclusions or inferences drawn from this interview by interviewer:

2. Follow-up actions needed:

[NOTE: a good interview should try to capture every single statement made by the interviewee. Word for word transcription is not vital, but no details should be omitted.]

Appendix B

Actual Photos of Missing Aircraft After Being Located
Note that most of these planes were not visible from the air.

The Steve Fossett crash site,
invisible from as close as 300 feet in the air

Appendix C

Valid Consensus-style Voting

As mentioned in a footnote in the text, "Mattson" style consensus voting, in which each individual gets to "spend" 100 "pennies" on which regions he/she feels are the highest priorities for searching, has been shown to be mathematically flawed. Instead, I recommend a mathematically valid approach which is summarized below; this approach is derived from teaching and sources at the well-regarded National Search and Rescue School. This approach may seem similar to Mattson voting, but it is mathematically different. Software is available to help process the voting information; see for example the Search Tracker software developed by Lt. Rick Slatten of the St. Louis County Rescue Squad, Duluth, MN.

The following is an excerpt (with permission) from the St. Louis County *Missing Person Search Management Plan*.

> On a separate piece of paper, each Command Staff participant individually decides which region is **<u>most likely</u>** to contain the missing subject. He or she assigns this region a value of 10. The participant should carefully consider all possible scenarios that might explain the subject's loss when determining which region to assign the 10-rating.
>
> Each participant then rates all the other regions **<u>in proportion to</u>** the most likely region. For example, if the participant believes Region B is half as likely to contain the subject as the most likely region, he or she would rate it a 5; if it's a third as likely, a 3; almost as likely, a 9; and equally likely, a 10. Any number on a 0 to 10 scale is permitted, as long as it reflects proper proportion to the most likely sector. If you don't believe there is *any* chance of a region containing the subject, rate it a zero; however, this option should be very carefully considered, and even then used sparingly. Do **<u>not</u>** be concerned with staying inside some arbitrary allotment of points, such as a 100-point scale taught in the Mattson Method. If you believe that four regions are equally likely to contain the subject, rate them all the same.