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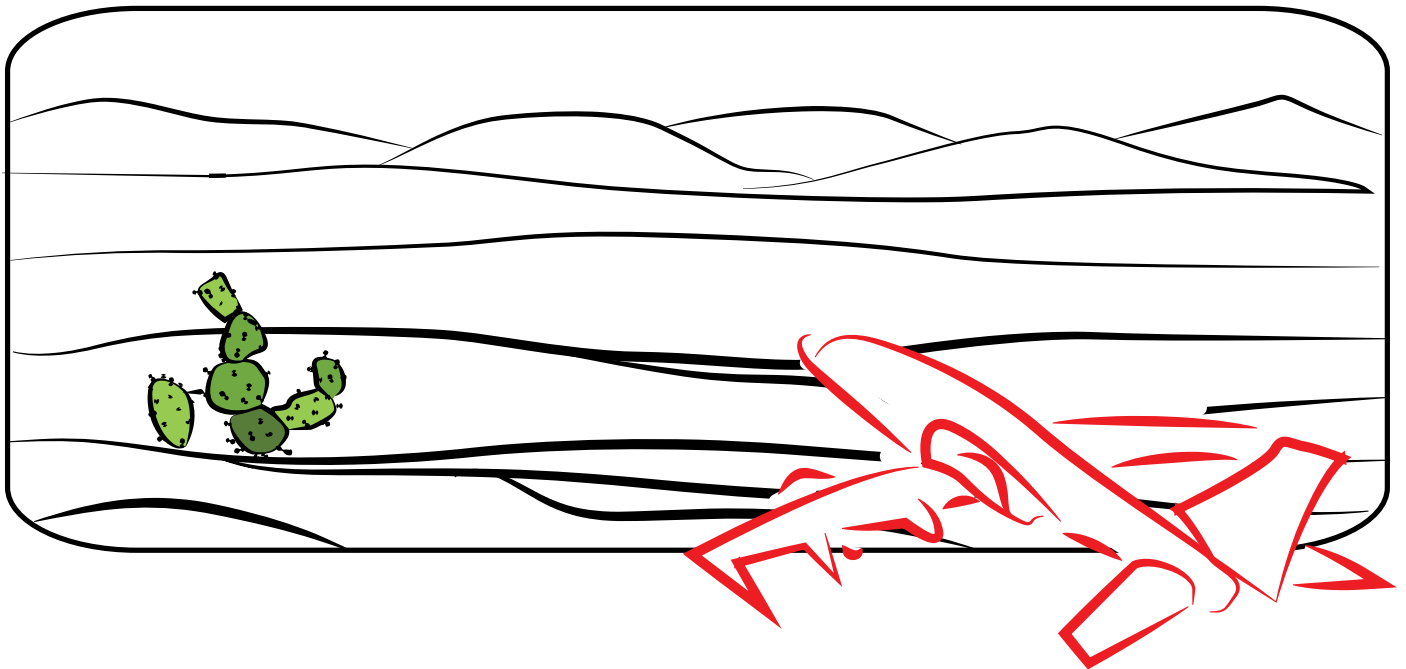
Forest Service

National Technology &
Development Program

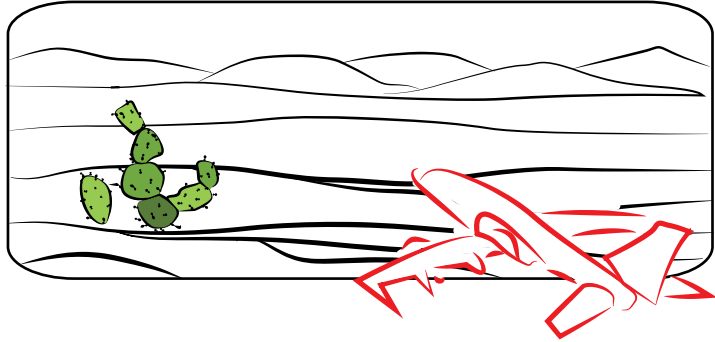
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Improving Low-Altitude Aerial Hazard Mapping and Flight Planning Using FalconView



Improving Low-Altitude Aerial Hazard Mapping and Flight Planning Using FalconView



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INTRODUCTION

Each year the Forest Service, U.S. Department of Agriculture, and other natural resource agencies operate thousands of flights at low altitude. Many segments of those flights are below 200 feet above ground level (AGL). To assure safe flight operations, flight crews must know the existing low-level flight hazards. Map systems from the U.S. Department of Transportation, Federal Aviation Administration (FAA), and commercial vendors only show aerial navigation hazards that are 200 feet AGL or higher, and as such do not meet the needs of the Forest Service. Locally, field units have implemented various methods to collect and display the low-level hazards not presented on FAA or commercial mapping systems.

The National Technology and Development Aviation Program at San Dimas Technology and Development Center (SDTDC) was asked to investigate FalconView as a nationwide tool for hazard mapping. FalconView is the mapping component of the portable flight planning software program that was developed by Georgia Tech Research Institute for use on the U.S. Air Force F-16 Fighting Falcon. Since its introduction, FalconView has been integrated into most U.S. Air Force aircraft. The program is available to all Federal agencies without charge.

INVESTIGATION APPROACH

FalconView is one of many mapping and flight planning programs available for the development and alteration of maps that SDTDC staff evaluated along with other software options found during the market search. SDTDC staff developed an investigation plan to determine the best solution to the problem of hazard mapping. The plan included:

- Overview of the FalconView program.
- Initiate a market search.
 - ▲ What mapping program does the Forest Service currently use?
 - ▲ What products are available?
- Conduct a field investigation.
 - ▲ What are the needs.
 - ▲ What is being done.
- Review the Forest Service corporate geographic information system (GIS) program.

DISCUSSION

FalconView Overview

FalconView is mapping application for Windows® that was developed for the U.S. Air Force. The Air Force uses the program as part of a portable two-part flight planning system. The first part is mission planning and the second part is flying the mission. During mission planning, the flight crew uses integral maps, weather forecasts, and other information to plan the departure, in-route way points/stops, and final destination. Flying the mission uses a computerized moving map display with the planned route, self-aircraft, and other data. With GIS information, the program can be used to fly the mission using terrain-following contours. The program uses maps ranging in scale from world maps to 1:250,000. Tools are built into the software that allows the user to place icons on the maps. Users also can turn on and off overlays of different features, such as basic geographical information, military training routes, towers greater than 200 feet AGL, and so forth.

FalconView does not make or develop maps. It uses available GIS map data for flight planning and navigation. The program does allow modification/addition of attributes to maps through overlays or GIS layers. These attributes can be saved with the mapping data. The program allows the user to display or print maps with the overlays included or not. Forest Service field personnel could use this feature to add low-level flight hazards to their selected map system. Additionally, the electronic chart updating manual (ECHUM) program used by the Air Force for dissemination of newly identified threats or hazards could be used to have the Forest Service low-level features added to the Air Force mapping data.

When a field user identifies a new local hazard, the FalconView program can place an icon at the geographical location using a map overlay. FalconView tools easily update maps. The new hazard (data) can be sent to the FalconView maintenance unit who examines the information for inclusion into the standard data set. If the maintenance unit determines the hazard data is appropriate, the data is confirmed and validated, and incorporated into the next ECHUM update.

The ECHUM process results in map maintenance by the developer, the U.S. Air Force and eliminates the Forest Service from having to maintain a separate data set (GIS layer) for visiting fire resources. The Forest Service data would have been integrated into the Air Force mapping data. On a monthly basis the National Geospatial Intelligence Agency provides supplemental updates for two databases, the digital aeronautical flight information file (DAFIF) and ECHUM. Digital terrain maps also are available.

FalconView is supported by the U.S. Air Force, which pays for software maintenance and program modifications. The program is easy to learn and use. A user with basic computer and map skills can begin using this program with little to no training. The functions are intuitive and the user can quickly become proficient.

Market Search

While performing a market search of available mapping programs and tools, SDTDC staff (we) found a web-based compilation of products by the U.S. Army Corp of Engineers. The Corp compiled 847 software applications that involved terrain visualization software. We used this list as the basis of our market search. The entry point URL for the Corp Web site is: <http://www.agc.army.mil/research/software/survey/index.html>

We found that terrain visualization software included many products that are not appropriate to the hazard mapping needs of the Forest Service. Next we screened out programs that were not aviation related. Many programs were not compatible with or used a mapping system that was not an aviation map (FAA sectional or similar). Some of the remaining programs were computer games, such as Microsoft® Flight Simulator; others were integrated hardware and software solutions for navigation similar to TomTom® GPS; some were eliminated because they were not easy to use or required a significant amount of training and effort to keep current; and others did not allow user additions (hazards) to the mapping system.

The remaining programs were somewhat comparable to FalconView and:

- Allowed the addition of user identified nomenclature and location.
- Provided mapping of the entire United States.
- Provided periodic GIS updates.
- Required maintenance fees.

FIELD INVESTIGATION

The field investigation identified:

- No directives and requirements for the maps.
- No standards for maps or symbols.
- No standard map-maintenance program.

What are the needs and what is being done?

The Interagency Airtanker Base Operations Guide, Interagency Helicopter Operations Guide, the Forest Service Manual and Handbook, and directives require aviation units to maintain annually updated local area hazard maps. A 2009 safety publication reminds us that this continues to be an issue. (Interagency Aviation Accident Prevention Bulletin, Hazard Map Preparation, No. IA 09-04 May 15, 2009.) This article discusses the need for annotating the hazard maps with new hazards to aviation. http://www.fs.fed.us/fire/av_safety/promotion/accident_prevention_bulletins/IA%20APB%2009-04%20Hazard%20Maps.pdf

In low-altitude flights, knowing where structures are that may interfere with a safe flight is part of a safe working environment. Aviation hazard maps are the best way to communicate that information. Hazard maps are required to be posted and are certified annually. Pilots are required to familiarize themselves with the posted hazard maps.

We began our field investigation with an Internet search of hazard maps and their requirements. This was followed by a request for aviation hazard maps, and finally we interviewed personnel from the aviation program.

We received a good response to our request for hazard maps. A survey of the available hazard maps found that they varied from base to base and their contents ranged from simple to complex. Some maps showed little more than the forest it covered and others represented an entire State.

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Icons representing the hazards varied from map to map; no standardization appears to exist among the hazard maps we reviewed.

Aviation hazard maps typically are located at the tanker base and are signed and dated by the base manager. Hazard map requirements are verified during the annual regional audit conducted at the tanker base. Posted hazard maps supplement the information contained on an FAA sectional map. These maps are mounted on the wall and range in size from a large poster to floor-to-ceiling height. Many of the maps are available on the Internet. However, due to the size and detail these maps can be very large file sizes and may be difficult to download over a modem. Portable tanker bases and remote helicopter bases may not have access to high speed Internet communication.

Tanker base managers, fixed wing pilots, and helicopter pilots were interviewed on this subject. Some of their issues included, maps are not updated, information is not shared, and additional hazards exist for helicopter flights. For example, a hazard map was signed as current, although the date of issue was several years before and it had not been updated with new hazards. One base experienced a problem getting updated maps due to reduction in manpower in their local GIS department. During a discussion with the pilots they said they were aware that new hazards existed. In the 21st century, adding a pin to the base hazard map does not appear to be a convenient method to share this information. We also found that hazards for fixed wing pilots are different from hazards for helicopter pilot; for example, mining operations could affect a helicopter transporting equipment low to the ground.

Low-altitude hazards are not fully documented. There is no set requirement for who, what, where, when, and how to collect data representing hazards. We also discovered that when new information is found, such as a cell tower installation, there is no sharing of information from the cell tower licensing entity to local aviation units.

The Forest Service needs a system to document newly identified hazards to aviation. This system should include a user friendly system that allows field personnel to report new hazards to the aviation community. There needs to be a single point of contact that is responsible for coordinating the information documenting the hazard.

In the normal scope of work, whenever agency personnel becomes aware of a new structure that may be a potential hazard during any aviation operation, or any structure over a certain height it should be documented and recorded electronically. This information should be uploaded to a centralized point for entry into the local database and then forwarded to the National Geospatial Intelligence Agency (NGA) for future inclusion into the digital vertical obstruction database.

The NGA has indicated that they would welcome data submitted for inclusion in the digital vertical obstruction database. NGA verifies obstruction data using stereo imaging.

Hazard maps printed or created from this process must be identified as not-for-navigation. Navigational-map requirements are specific. With addition of information by field personnel to the maps (hazard below 200 feet AGL), the map is modified and no longer meets its original standards. The Forest Service should avoid any navigation liability with this notation.

FOREST SERVICE CORPORATE GIS SOFTWARE

The Forest Service corporate GIS software is ArcView suite developed by Environmental Systems Research Institute (ESRI), Inc. ArcView, as used in this document, describes the entire suite of products, which the Forest Service obtains from ESRI (ArcView, ArcEditor, and ArcInfo). ArcView is the basic level of the software package; ArcEditor includes the functionality of ArcView with additional capability; and ArcInfo includes the functionality of ArcEditor with additional capability.

ArcView is used for visualizing, managing, creating, and analyzing geographic data. ArcView is used to author maps to allow the visual presentation of geographic data for the purpose of determining patterns and other analysis. Maps (GIS information) are created in layers, for example topography layer, mineral/soil type layer, vegetation layer, and so forth. The user can choose all or any number of layers to display or print from the GIS information file.

ArcView is a very powerful program and requires a significant investment in training, and requires frequent periodic use to maintain user proficiency.

ANALYSIS

In general, the targeted user of the hazard map software cannot devote significant time for initial training and proficiency maintenance. Therefore while the Forest Service corporate GIS package (ArcView) is capable of meeting the technical capability of hazard mapping, it does not meet the need of the user: the fire hazard map community.

The market search and review of the remaining possible commercial products found that the software packages are capable of meeting the needs for fire hazard mapping. However, they fall short when compared to FalconView for the following reasons:

- FalconView is provided free to all U.S. Government agencies. All other products must be purchased.
- FalconView provides free map updates on a 28-day cycle. Commercially available products provide map updates on periodic schedules for a year; then they require a renewal subscription.
- FalconView's software program support is free. Commercially available products provide support typically for a year; then they require a renewal subscription.
- FalconView provides ECHUM, the process where field user-defined information (low-level hazards in case of the Forest Service) is reviewed, validated, and incorporated into the basic map information. These updates appear in the 28-day map cycle. Commercially available products do not provide this capability.

FALCONVIEW INDEPTH ANALYSIS

FalconView is a mapping program currently used by military aviators and aviation support personnel to plan flight battle plans, identify hazards, and other threats. FalconView is the map component of the portable flight planning software that was developed by Georgia Tech Research Institute for the U.S. Air Force. FalconView is now used by all uniformed services. FalconView is well known for its minimal training requirements and its ease of use. Most users are able to get up and running within a half day with minimal support. The Department of Defense Usage of FalconView is available in appendix A.

FalconView has been used by the Forest Service in fire operations involving the modular airborne fire fighting system and by active reservists using the program in their military operations. They shared their experiences with aviation management: In 2004, a group was formed

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from agency personnel with experience in GIS and aviation. They attended formal training in FalconView and began to develop steps that would facilitate the use of FalconView. (Jim Morrison correspondence.) From these experiences, FalconView has been recognized as a program that could meet the requirement to aid in providing a platform to prepare flight safety maps that present hazard and other important flight information in a standardized format. A detailed scale local hazard map, showing geographical and hazard information, can be printed and provided directly to the pilot.

FalconView is a government off-the-shelf product developed by the military and is available to all government agencies free of charge. FalconView is classified as limited distribution software and can be used only on government-owned computers. This software must not be distributed freely.

FalconView's versatility is in its efficient use of maps, toolbars, overlays, and software support. Maps form the backbone of the program; toolbars allow the user to customize the maps as needed; overlays extend the sharing of information; and its continued development and maintenance ensures accurate information is available to the user. The digital aeronautical flight information file and ECHUM updates are issued every 28 days. As with any program, vigilance to maintain currency may prove to be labor intensive.

Maps

The program can use maps supplied in a variety of scales and formats including raster, shape, and GeoTiffs (photographs). Maps are available from Defense Supply Center, Richmond, VA.

FalconView ships with TIROS (the big blue marble view of the earth) series of maps, which show only water and land boundaries. Another available map format is compressed ARC digitized raster graphics (CADRG). CADRG maps

have details including mountains, roads, towers, railroads, and other data. These images quickly redraw when panning the map across the monitor screen.

Raster images present the map as pixels. Raster format is an image similar to a jpeg. Pixel images have a limitation on resizing (zoom in) the map, too large a resize and the map becomes pixilated. The map can be redrawn quickly when moving from one area of the map to another or from one scale to the next.

Shape maps are vector maps. Shape images are a geographically referenced set of data; the database consists of representative lines, shapes, and colors shown on the map. A resized vector map does not become pixilated. Vector format contains detailed geographical information. Due to the amount of information a vector format display can require substantial computer memory. Increased detail may cause the map to redraw very slowly.

Drawings generated by ArcView are vector drawings and are saved as shape files. A shape file covering the entire United States (depending on the detail) will open very slowly. The user may assume the program has crashed or locked up.

FalconView can use photographic images with geographical reference points as an overlay. The user can create a GeoTiff with GeoRect, a FalconView supporting program. An image file is opened in GeoRect, places three geographically referenced points on the image. The image is saved as a GeoTiff and can be opened as an overlay in FalconView. GeoTiff maps are saved as .tif format.

Map scale and level of detail influences how quickly the user can move around in FalconView. Map information comes in many scales, such as 1:250,000. Each scale provides reference to specific details. "Simply defined, scale is the relationship between distance on the map and

distance on the ground. A map scale usually is given as a fraction or a ratio—1/10,000 or 1:10,000.” For instance, 1 inch on the map equals 10,000 inches on the ground. Reference: Map Scales, USGS Fact Sheet 015-02 (February 2002)

Toolbars

A number of toolbars are available to the user. Included among the toolbars are drawing editor, manual chum, threat editor, page layout tool, and moving maps.

When a toolbar is selected and used an overlay is generated; any changes will be saved in that overlay file. Overlays can be turned on or off. These overlay files can be saved individually. A mission file is a group of overlays packaged for electronic transfer to another computer with FalconView. A mission file can be shared with another FalconView user.

The drawing editor allows the user to draw on the maps. A variety of tools are available to create freehand lines, poly lines, individual straight lines, boxes, ellipses, pointers, and bull’s-eyes. Various line types and widths can be selected. Drawings are saved as a drawing overlay.

The manual chum toolbar is used to place elevated icons, such as towers that pose a threat to low-altitude flights onto the map. The data points are saved as overlays and can be distributed by email or a centralized distribution point, such as a server. Manual chum is saved in the chum overlay.

The threat editor is used to place a representative symbol of mobile equipment, such as a vehicle. User-created icons can be created with a third party icon-editor program and imported to the threat editor. Numerous symbols are included in FalconView to simulate various equipment and activities. Icons are dragged from a palette to the map and will lock in to position when the mouse

button is released. If dropped at the wrong spot, the icon can be moved by the user to different locations. These are saved in the threat overlay.

The moving maps toolbar is used to connect a global positioning system (GPS) to FalconView. A subprogram called handheld AWE provides an interface between GPS and FalconView. The user can download tracks showing a path or display boundary area such as a fireline. GPS can also display current location on FalconView maps providing a live view. Data collected from GPS will be saved as tracks files.

The handheld AWE is a program that is included with FalconView. Handheld AWE supports connecting GPS to FalconView. Tracks can be imported directly from the GPS database from a number of GPS devices. Trails can be displayed directly in FalconView.

The moving maps overlay can receive multiple feeds and display locations of a number of different field assets. An appropriate scale map is necessary to show sufficient detail.

Use the page layout toolbar instead of the printer icon to print maps. The toolbar allows the user to select the desired area and scale needed. Maps can be selected and printed in the desired series/scale with or without overlays. With the appropriate software, a map can be saved as an adobe acrobat file (.pdf).

Overlays

An overlay provides an electronic method to mark up a map with additional information without affecting the base map. This is one of the features of the FalconView program: its ability to allow the user to generate an overlay populated with symbols and to create an informational map that will quickly educate the reader about hazards or look-out situations. Other overlays contain additional information, such as temporary flight restrictions, airports, and military training routes.

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The overlay information will show any additional points of interest not currently listed or relevant to the basic map. For example, highlighting a route or outlining a fire area.

FalconView uses overlays to present geographically referenced data, such as tower locations. Users can add their own geographically referenced data points, such as details for a work area and low-altitude hazards. The ability to prepare maps of low-altitude hazards is especially useful to the Forest Service.

Overlays in shape-file format may not open quickly because of their size. Shape files can become quite large, nearly a gigabyte. When opened in FalconView, large shape files will redraw the entire drawing, while only a portion is visible whenever the drawing is moved.

PROGRAM UPDATES

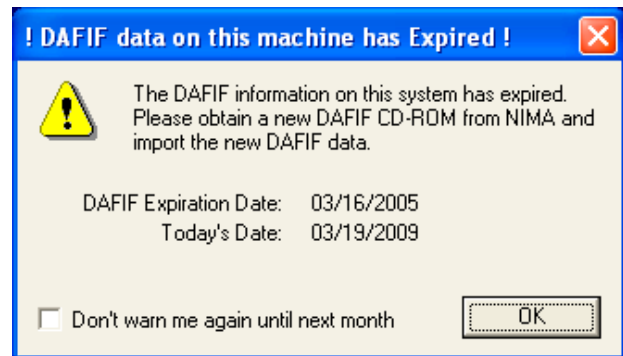
The FalconView program, maps, and certain data are updated periodically. FalconView program updates are handled by Hill Air Force. Map updates are available through the Defense Supply Center Richmond. Subscriptions are available. Data files are updated by the National Geospatial-Intelligence Agency.

FalconView software and maps are classified limited distribution and cannot be distributed to anyone outside the government.

The data files are updated every 28 days. Currently a secure form of update exists using e-authentication. The Web site to access the fire system portal is <http://www.nwportal.fs.usda.gov>. The updates are stored in the digital aviation information and are available in shape file format. They are very large, cumbersome files and contain detailed data for the entire United States. Each movement of the map requires the entire map to move even though you are moving only a small distance; computer response when these files are open can be very slow.

Program distribution and maintenance must be addressed on a national level. In order to keep FalconView portable, updates must be available in a usable format. Portable format for DAFIF and ECHUM files is a text-based database.

FalconView provides a manual check to indicate the system health and displays the currency of the maps, DAFIF and ECHUM data. FalconView informs the user if the data is current or out of date.



These files may be large and may become difficult for dial-up methods.

CONCLUSIONS

The Forest Service is involved in flights at approved low altitude. These flights include helitac, aerial firefighting, and moving equipment to and throughout the forest.

The Forest Service requires posting of current aviation hazard maps. Various hazard maps from across the United States were examined and it is apparent that no standards exist for the maps and their content. Interviews of agency personnel suggest that each unit has unique methods to provide a solution to the hazard maps.

A market search identified several potential programs to aid in producing aviation hazard maps. The U.S. Army Corp of Engineers had surveyed hundreds of programs. Many of these programs did not meet our basic requirements for

producing hazard maps. Of those programs that met the basic requirements, map updates were annual and required costly subscriptions.

The Forest Service corporate GIS software, ArcView, can meet all the needs of producing maps. However, it requires training and constant use to maintain currency.

FalconView is a powerful, user friendly, easy to learn mapping program that provides map updates every 28 days. FalconView is free and the program's developmental maintenance is ongoing. Regular map maintenance is handled by the National Geospatial Intelligence Agency.

RECOMMENDATIONS

- Form a development team to develop and issue standards for hazard maps and standardized symbols.
- Establish a centralized point of contact to coordinate the findings of the development team.
- Establish standardized method to collect information for updating maps.
- Adopt FalconView.
- Develop agreements to tailor FalconView to Agency requirements.
- Establish national and regional points of contact that would manage and facilitate the collection and dissemination of updates to the field.
- Enhance current procedures to coordinate aviation dispatches to include maps to responsible personnel.