

MEIMS

Maintenance Error Information Management System

Aviation Maintenance Incident Database



Naval Safety Center
School of Aviation Safety



Table of Contents

<u>Section</u>	<u>Page</u>
Introduction	3
HFACS–ME Error Categories and Abbreviations	4
Start/Exit MEIMS	5
The Query Menu	6
Single Field Queries (by Model, Location, etc.)	6
Multi-Field Queries	8
Multiple Criteria	9
HFACS-ME Elements	10
HFACS-ME Summary	12
The Graph Menu	15
The Reports Menu	18
Cross-Tabbed Reports	19
Chronological Reports	20
Add a New Mishap	21
Initiate an Investigation	22
Conclusion	23

Maintenance Error Information Management System

An Introductory Student Guide



Welcome to this introductory student guide on the Maintenance Error Information Management System (MEIMS). This powerful maintenance incident management tool provides the safety professional with the means to not only record accidents, but to prevent them as well!

All databases are created to store information. Many even have multiple methods to search or categorize the information. This program, however, incorporates an additional feature. It is fully integrated with HFACS-ME, the Human Factors Analysis and Classification System-Maintenance Extension. With HFACS-ME, the safety professional can move beyond the HOW and WHEN statistics of accidents to determine WHY the maintenance accidents happened and then prevent their recurrence. The creation of this powerful tool as a Microsoft Access 2000 program file also provides the software commonality to be used effectively by any organization with a minimal amount of training and no additional program costs.

The user of this database program must, however, be familiar with the HFACS-ME concepts and its error categories. Training is available in a series presentations to guide students through the concepts, definitions, and case study applications of HFACS-ME.

HFACS-ME Error Categories

The Human Factors Analysis and Classification System-Maintenance Extension (HFACS-ME) Framework (Table 1) was developed by the U.S. Navy to reduce the number of maintenance related accidents in Naval Aviation. Due to its success, it has now been adapted for commercial aviation use and has been incorporated into this Aviation Maintenance Accident Database.

The HFACS-ME Framework error categories are the reasons WHY a particular aviation maintenance accident occurred. There is never a single or primary cause factor of an accident. Instead, all factors are assumed to be contributing “system” failures that combine at some point in time to complete the accident’s chain of events. If any factors were removed, the accident would not have happened.

One concept that is critical to the use of this tool is the philosophy of “necessitarianism”. Accidents are not inevitable, they have specific causes that are both discoverable and individually preventable. And because all causal factors are preventable, the entire accident can also be prevented. The HFACS-ME Framework provides you with the means to systematically discover and eliminate those hazards and prevent future accidents that might otherwise occur under similar circumstances.

Table 1

Error Categories of HFACS Framework				
First	Second	Third Order		
Management Conditions	Organizational	- Inadequate Processes - Inadequate Resources	- Inadequate Documentation	- Inadequate Design
	Supervisory	- Inadequate Supervision - Supervisory Misconduct	- Inappropriate Operations	- Uncorrected Problem
Maintainer Conditions	Medical	- Mental State	- Physical State	- Limitation
	Crew Coordination	- Communication	- Assertiveness	- Adaptability/Flexibility
	Readiness	- Training/Preparation	- Certification/Qualification	- Infringement
Working Conditions	Environment	- Lighting/Light	- Weather/Exposure	- Environmental Hazards
	Equipment	- Damaged/Unserviced	- Unavailable/Inappropriate	- Dated/Uncertified
	Workspace	- Confining	- Obstructed	- Inaccessible
Maintainer Acts	Error	- Attention/Memory - Skill/Technique	- Judgment/Decision-Making	- Knowledge/Rule Based
	Violation	- Routine - Flagrant	- Infraction	- Exceptional

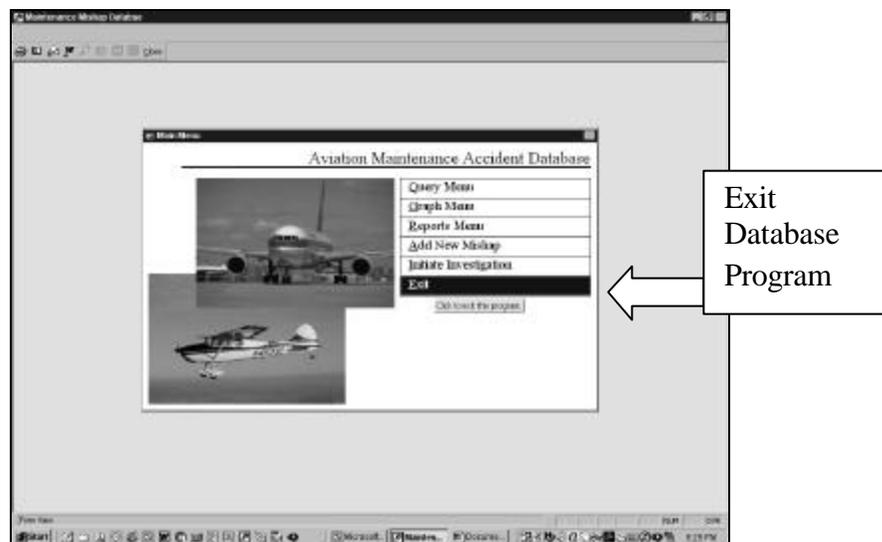
Start/Exit MEIMS

To load and operate MEIMS and access the database, clicking twice on its icon/filename under programs in the Start Menu.

The opening screen (Figure 1) will appear with direct access options to its powerful features. The major features include the Query Menu, a Graph Menu, a Reports Menu, an Add New Mishap option, and an Initiate Investigation option.

To Exit MEIMS simply click on the Exit option of the opening screen Main Menu. A cautionary note will ask if you are sure that you want to exit to Windows. Click yes to exit and close the program. This is the only method of closing the program because the normal Window's "X" boxes in the upper right corners of the Main Menu Window, and the Maintenance Mishap Database background window, are inoperative on the opening screen.

Figure 1



Let us now review each of the main features in greater detail, beginning with the Query Menu.

The Query Menu

The Query Menu provides several methods to search and analyze your accident database. To open the Query Menu, place the mouse cursor over the Query Menu option of the opening screen Main Menu (Figure 1) and it will be highlighted in blue. Click the highlighted area once to activate the feature.

The Database Query Menu (Figure 2) will then open to provide the user with various options to conduct Single-Field Queries and Multi-Field Queries.

Figure 2



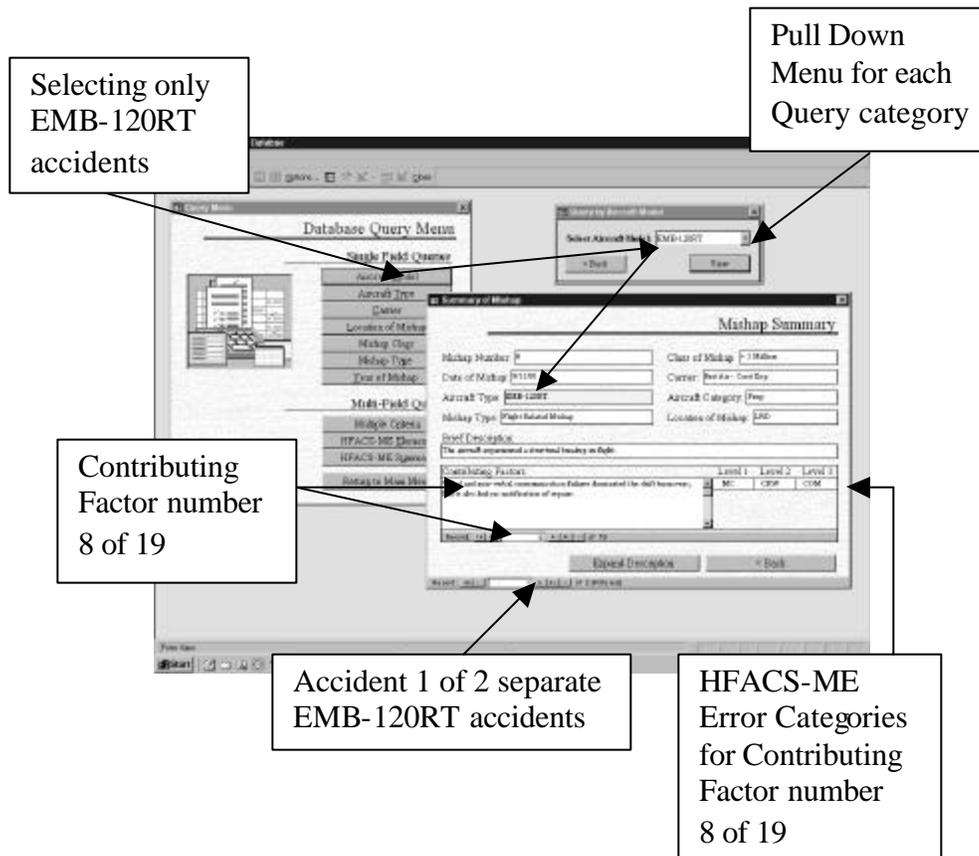
Single Field Queries

The Single-Field Queries offer the user the ability to search through all records of that query type. Reports can be queried by Aircraft model (B737, DC-10, EMB-120), by Aircraft Type (jet, prop, helo), Carrier (individual commercial airlines), Location of Mishap (airport three-letter identifier), Mishap Class (incident, > million dollars damage), Mishap Type (flight, ground), and of course, by the Year of Mishap.

Each query function has a pull-down menu box associated with it to retrieve information quickly. The pull-down menus are also used elsewhere throughout the database to ensure that data entry and retrieval will result in standardized and accurate statistics.

For example, if there were 15 accidents in our database and we were only interested in reviewing those that involved EMB-120RT aircraft, we could limit the search criteria to show only the Mishap Summaries that involve that aircraft (Figure 3).

Figure 3



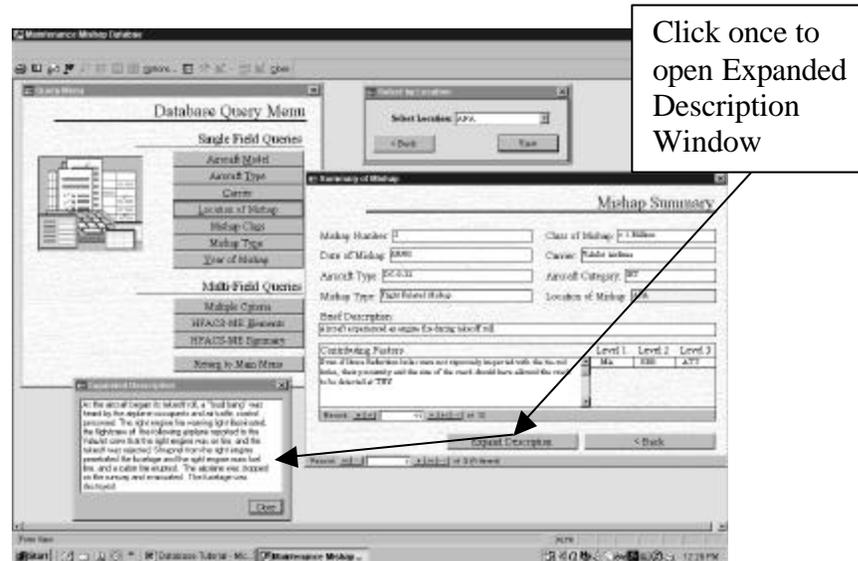
This is accomplished by first choosing the Aircraft Model Query, which opens the pull down menu so we can select the EMB-120RT, and then the Mishap Summary window opens. The upper portion of the Mishap Summary window (Figure 3) has eight data field boxes that correspond to the Single Field Query options. Note that the EMB-120RT data field is highlighted in blue within the Mishap Summary Window to identify our selection criteria. If we chose a different query type, or several query types from the Multi-Field Queries option, their corresponding data fields would be highlighted on the Mishap Summary.

The Mishap Summary Window is actually an Individual Mishap Summary Window within a Query Database Window of All Mishaps that meet our selected search criteria. The bottom section of the window includes an Accident Record bar that shows that you are viewing 1 of 2 different accidents that involve your search criteria of an EMB-120RT aircraft. Just above the Accident Record bar is the Contributing Factor record bar for the particular accident you chose. In this case, the first of two EMB-120RT accidents has 19 contributing factors. As you click the triangle shaped controls to advance to the next factor, the Contributing Factor window above it will change to provide a summary of that factor. To the right of the Contributing Factor summary is the HFACS-ME Error Category display. In our example, the eighth contributing factor on this accident has an

Here is another example of a Single Field Query (Figure 4). The Location of Mishap was chosen for this search, and after choosing AFA, we can see that there are 3 accidents that occurred at AFA with the first accident involving a ValuJet DC-9. Note that the Mishap Summary Window now has the Location of Mishap highlighted in blue to identify our search criteria. This ValuJet accident has 12 contributing factors with the 11th describing the failure to discover cracks during an inspection

The Mishap Summary Window has a few other features, as well. The Brief Description field in the center of the Mishap Summary Window contains a one-sentence summary of the Mishap. Below the Contributing Factors area is the Expand Description button, which opens the Expanded Description Box to provide a paragraph summary of the mishap (see arrow on Figure 4). The “<Back” buttons, “Close” buttons, “Return to Main Menu” buttons, and Windows “X” boxes will all close out these individual windows to bring you back to the opening screen.

Figure 4



All Single Field Query choices will open windows identical to those just discussed (Figures 3 and 4). The Aviation Maintenance Accident Database offers even more powerful tools in the Multi-Field Queries.

Multi-Field Queries

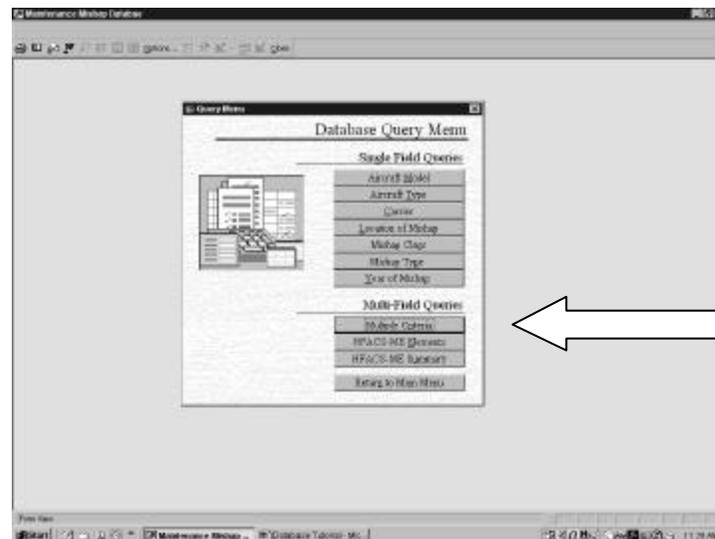
The Aviation Maintenance Accident Database’s Multi-Field Queries offer three unique choices. The Multiple Criteria option offers expanded search capabilities in the same format as the Single-Field displays. The HFACS-ME Elements and the HFACS-ME Summary options have integrated HFACS Framework “trees” to allow the user the powerful option of searching accident databases by HFACS Error Categories. The HFACS-ME Elements option queries accident records by HFACS 1st and 2nd Level Categories, whereas the HFACS-ME Summary provides statistical percentages based

upon any combination of the Multi-Field Query Categories as well as HFACS 1st, 2nd, or even 3rd levels!

Multiple Criteria

The Multiple Criteria box is the first of three options within the Multi-Field Queries of the Database Query Menu (Figure 5).

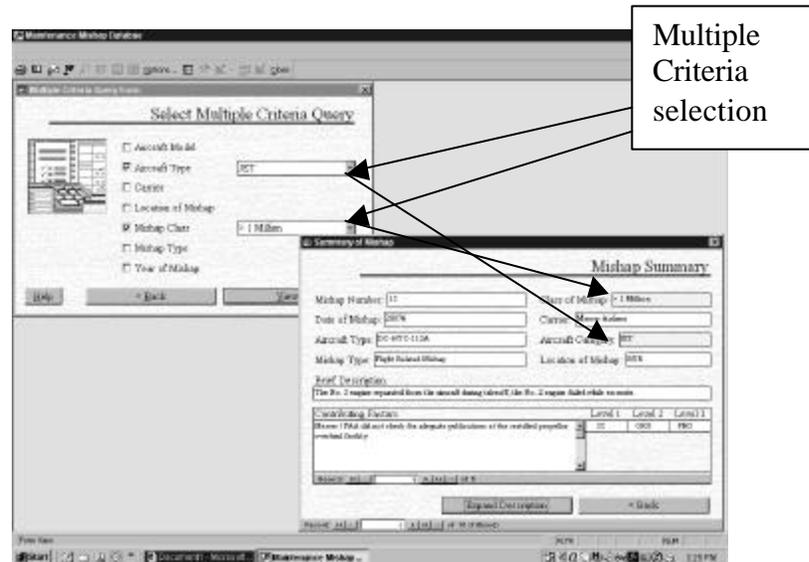
Figure 5



Upon selecting this option, the Select Multiple Criteria Query Window (Figure 6) is opened, allowing the user to choose any combination of the previously discussed Single Field Criteria. In this example, we selected two criteria. Under Aircraft Type, we chose Jet, and under Mishap Class, we chose "> Million" dollars in damage. The Mishap Summary chart is identical in its format compared to the Mishap Summary chart from the Single Field Query discussion. The only differences are that both criteria are highlighted in blue to show our multiple selections and the ten available accident reports individually met the requirements for both the Jet and the "> Million" criteria.

The Multiple Criteria Query allows you to find similarities between accidents, but more importantly, when reviewed by their contributing factors, trends may be more accurately identified for improved prevention strategy development.

Figure 6

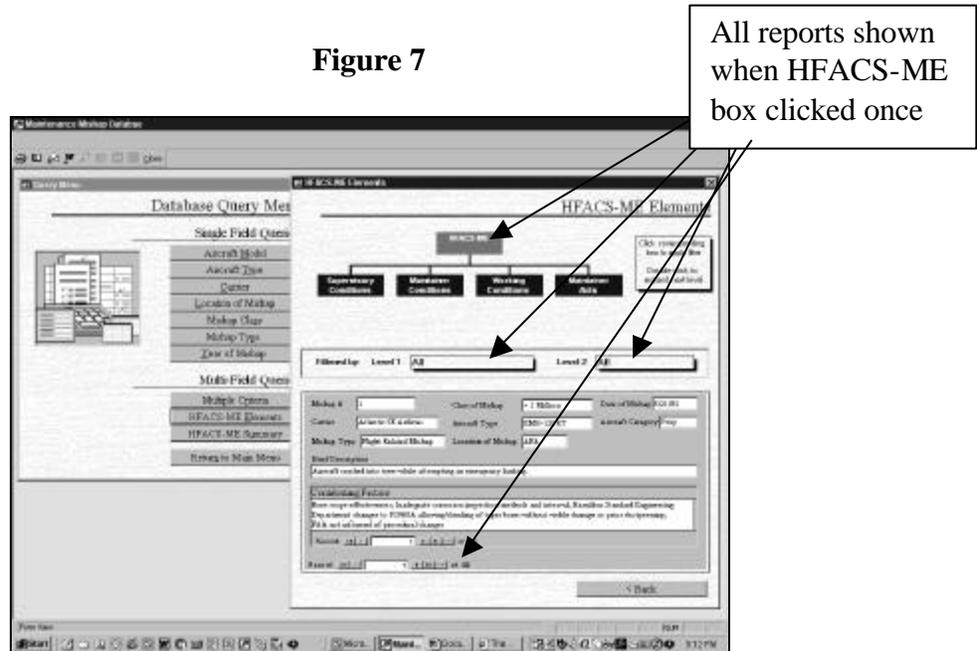


HFACS-ME Elements

The HFACS-ME Elements Window has a very different format from the previously discussed database features. When we conducted the previous queries, we discovered how many accidents happened with the same physical or time features (aircraft model, date, location, etc.) and then had the option to search through their contributing factors to see if they had similar causal factors. A faster and more reliable method of searching for similar factors is to actually query the accident reports by the factors themselves. This is one of the greatest strengths of the MEIMS Incident Maintenance Accident Database.

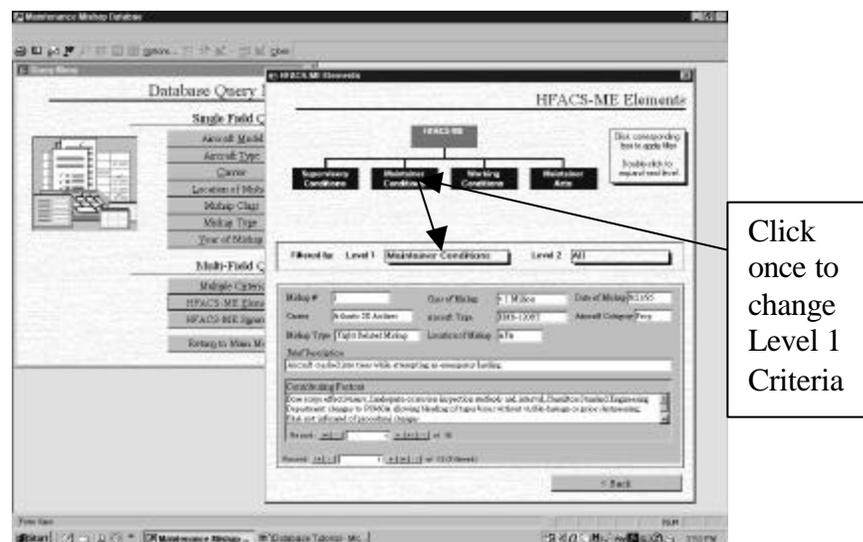
When we select HFACS-ME Elements within the Multi-Field Query Window (Figure 7) the HFACS-ME Element window opens to reveal an inverted HFACS-ME Taxonomy tree with a mishap summary, its included data fields, and the now familiar Contributing Factors and Accident Report record bars at the bottom of the window. You will notice that in this example (Figure 7) the two “Filtered by” boxes shown in the middle of the window, labeled Level 1 and Level 2, both have the words ALL displayed. This is the normal appearance when the HFACS-ME Element Window first opens. It opens with the top HFACS-ME box on the tree as the selected Filter, so of course, all accidents are shown because all accidents have at least one HFACS-ME classified causal factor.

Figure 7



If we now click once on any one of the Level 1 HFACS-ME categories, the mishap summary information and numbers of matching accident reports will change to meet the new criteria. For example, when we click once on the Maintainer Conditions box, the number of available reports decreased from 49 to 12 (Figure 8) and the Filtered by-Level 1 box states the selection criteria as Maintainer Condition. Note that the Level 2 filter box still has the word ALL in it. This is because the 12 available reports have any category of Maintainer Condition included.

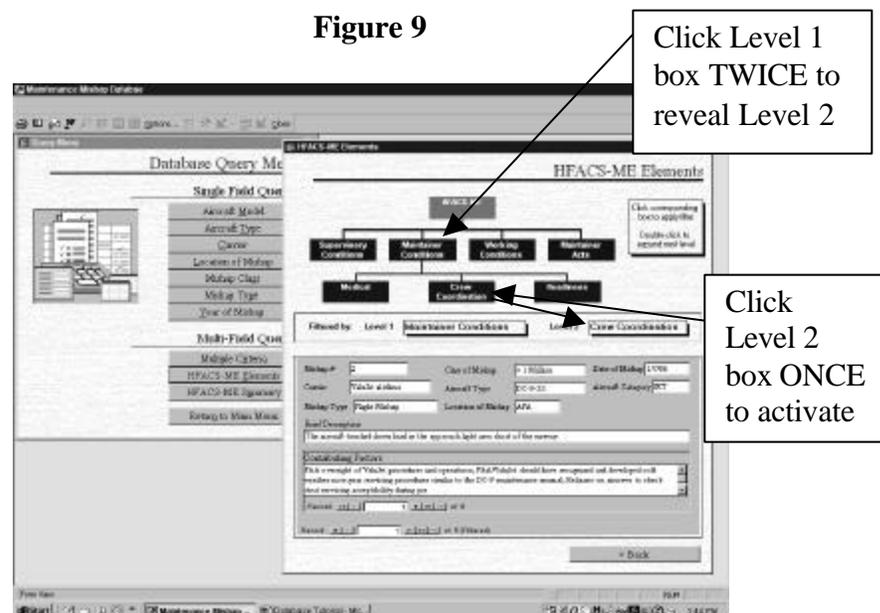
Figure 8



This particular search has just allowed us to isolate ALL Maintainer Conditions accidents from ALL accidents in the database, for ALL types of aircraft, location, date, etc. But we can further refine our search by limiting the accidents queried to only those of a certain Level 2 HFACS-ME Error Category.

By clicking TWICE on the Maintainer Condition box (or any Level 1 box), the HFACS-ME tree expands to the 2nd Level categories (Figure 9). The user can then select the Medical, Crew Coordination, or Readiness Error Categories of the Maintainer Conditions to limit the search. You only need to click the 2nd Level box ONCE to activate it. In this example, we have selected the Crew Coordination option, which resulted in 5 (of 49 total) accident reports that had Maintainer Conditions-Crew Coordination factors involved.

As you can easily see, this provides immediate examples for safety reports and discussions concerning accidents that happened with a similar factor. By clicking on the various level boxes, one can also quickly notice which factors reveal the most reports. This provides an elementary example of trend analysis in that several reports with the same or similar causal factors mean that the problem is more prevalent and may be more likely to occur again.



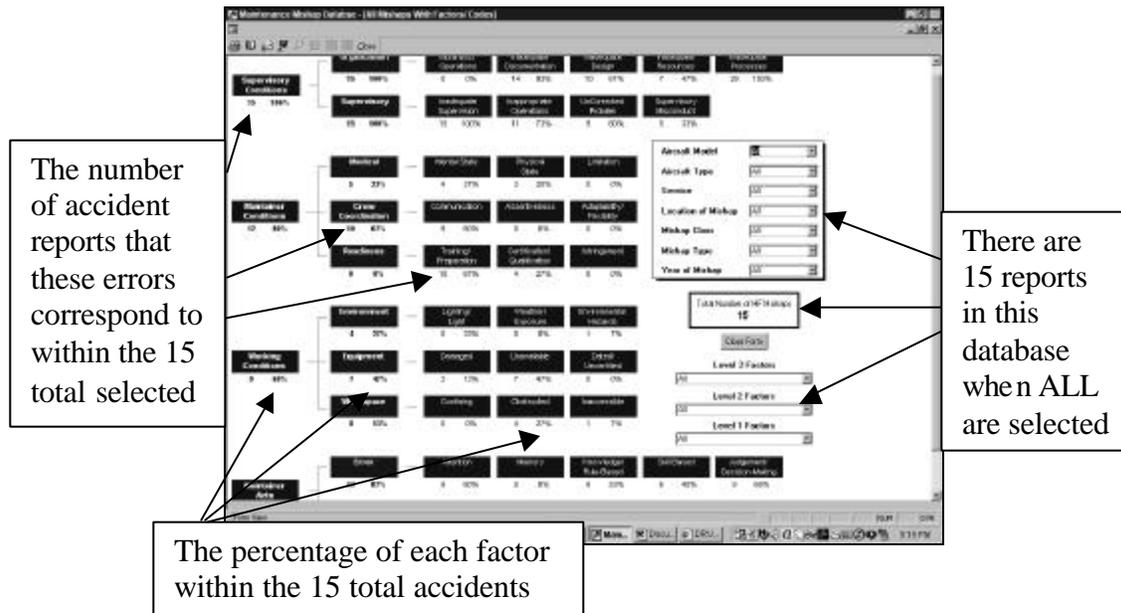
Now that the subject of trend analysis has been raised, we can actually perform it much easier and more effectively with the last Multi-Field Query option... the HFACS-ME Summary.

HFACS-ME Summary

The HFACS-ME Summary (Figure 10) is the most unique feature in the Aviation Maintenance Accident Database. It provides the user with the percentages of ALL

HFACS-ME error categories within the group of selected accidents. The selection categories still include the same options from the Single and Multi-Field Query Options, as well as, the first two levels of the HFACS-ME Error Categories. However, for the first time, the HFACS-ME 3rd Level Error Categories can also be searched!

Figure 10



The 3rd Level HFACS-ME categories allow the user to search the database at a level that no other program can offer. For example, the user can identify which accidents involved a Maintainer Act-Violation-Infraction or a Management Condition-Supervisory-Supervisory Misconduct causal factor. The HFACS-ME Tree also presents the percentages of ALL of the other HFACS-ME Error Categories within that small group of accidents. Users can better identify contributing factors with this system because the corresponding percentages of the other Error Categories are clearly visible on one screen.

As another example, users may notice that many Maintainer Acts-Errors-Knowledge/Rule Based errors occur within a certain organization or at a certain location where there is a lack of up-to-date maintenance publications. This would be clearly visible because of the higher percentages in the related area of Management Conditions-Organizational-Inadequate Documentation. The possibilities are nearly endless. All that is required is to analyze new or previous accidents using the HFACS-ME taxonomy and then utilize the features of this Aviation Maintenance Accident Database to discern similar characteristics and trends.

Let us look at a couple of cases to illustrate how the HFACS-ME Summary chart appears and operates. The first example (Figure 10) has "ALL" selected in every category. The screen normally defaults to this setting when initially opened. This sample database has 15 total accident reports (see arrow) and the corresponding percentages in each of the HFACS-ME categories are based on that selection of 15 reports. Below each box is a

number and a percentage. The number represents the number of accidents that the particular error category appears in. In this case, Supervisory Conditions are in all 15, with Maintainer Conditions in 12, and so on. As we move down the Error Category Levels the numbers will change. Note that the Supervisory 2nd Levels are both still in all 15 reports, but the 3rd Levels range from 0 to 15 occurrences. The percentages are based on the total of 15, so 0 is 0%, 10 is 67%, and 15 is 100%. Study the remaining categories to note which factors are most prevalent.

Now we will choose a more restrictive search criteria and note how each of the boxes accident report numbers and percentages change. We will choose ALL in the upper Multi-Field selection boxes, but change the Level 1 Factor to Maintainer Conditions (Figure 11). The entire chart immediately changes and reveals that only 12 of the 15 total accidents have some type of Maintainer Condition identified. All of the other HFACS category boxes have different numbers and percentages that correspond to their contribution within the same 12 accidents that the Maintainer Conditions exist.

The reason that all of the other error categories are not zero is because multiple factors cause accidents. You will never find an accident with only one type of cause factor, so this chart is very beneficial in noting the significant relationship of those other factors.

This chart also perfectly illustrates why designating primary factors is not useful. A primary factor would get all of the attention and corrective action, while the others would hardly be addressed. Notice that no single factor has an overwhelming percentage while all of the others are at or near zero percent. This is because no single or primary factor, they were caused by a combination of causal factors.

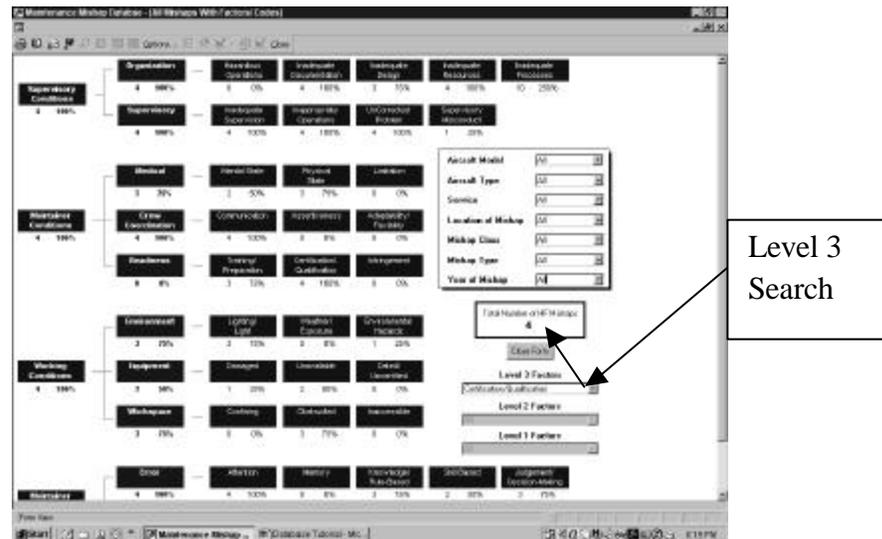
Figure 11



Here is one more example with factors selected at the 3rd HFACS Level (Figure 12). Using the Level 3 Factor pull down menu, we selected Certification/Qualification which is a Maintainer Condition-Readiness factor. Notice that only 4 accident reports had

Certification/Qualification factors. However, within those 4 reports, there were 100 percent factors in ALL of the other 1st Level categories! These Certification/Qualification errors were not simply an error at the maintainer level, they were failures of the organizations to develop, track, train, and effectively plan maintenance.

Figure 12

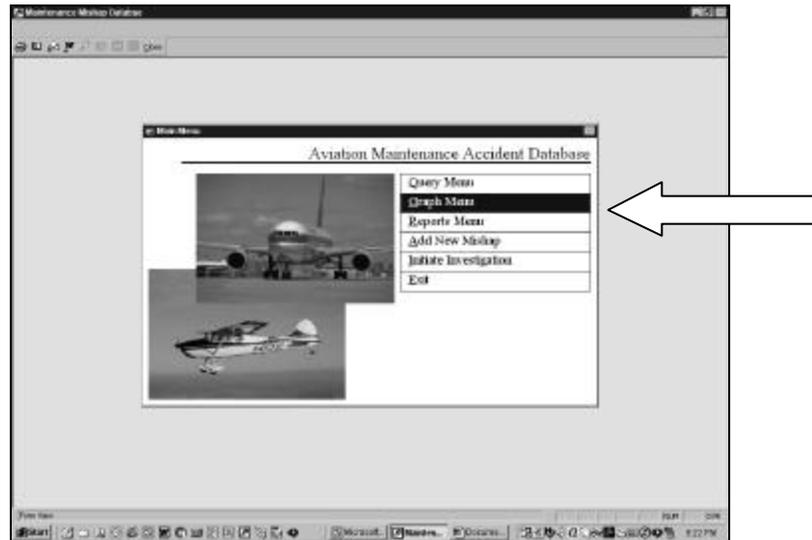


Users will find this portion of the Aviation Maintenance Accident Database program enjoyable to use and enlightening. It provides the most information per screen, it highlights the complexities of accident factor relationships, and it provides the safety professional with the means to persuade management on necessary corrective actions to prevent future accidents. Management normally requires documentation, reports, and/or short presentations to rationalize any change in procedures and expenditures. Fortunately, this program also includes the Graph Menu and the Reports Menu to facilitate that requirement.

The Graph Menu

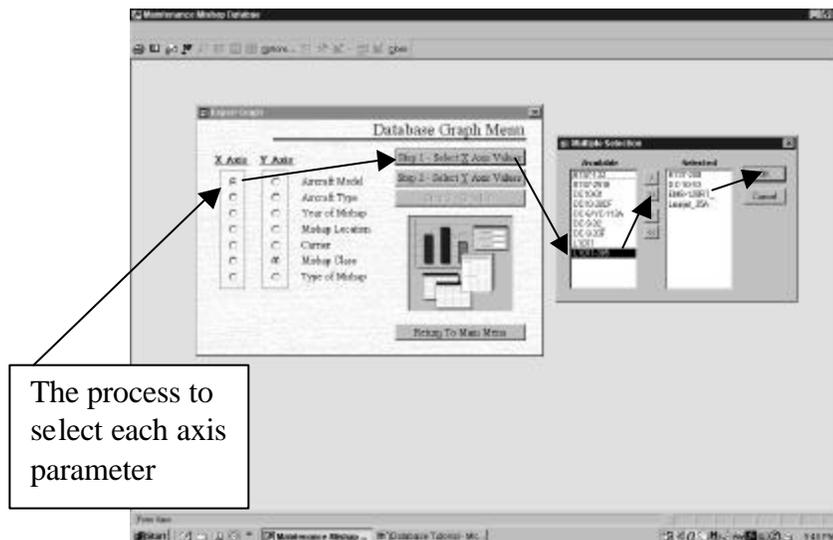
Let us now Close the Summary form and return to the opening Main Menu Screen to select the Graph Menu (Figure 13). The Graph Menu is the second option of the opening screen's Main Menu (Figure 13).

Figure 13



Click the Graph Menu option once to open the Database Graph Menu window (Figure 14). The Database Graph Menu Window contains a column for X-axis selections, another column for Y-axis selections, the Step 1 and Step 2 buttons that open their respective Multiple Selection Box, and the Step 3 Graph It button. Let us work through two examples to illustrate the functions of each.

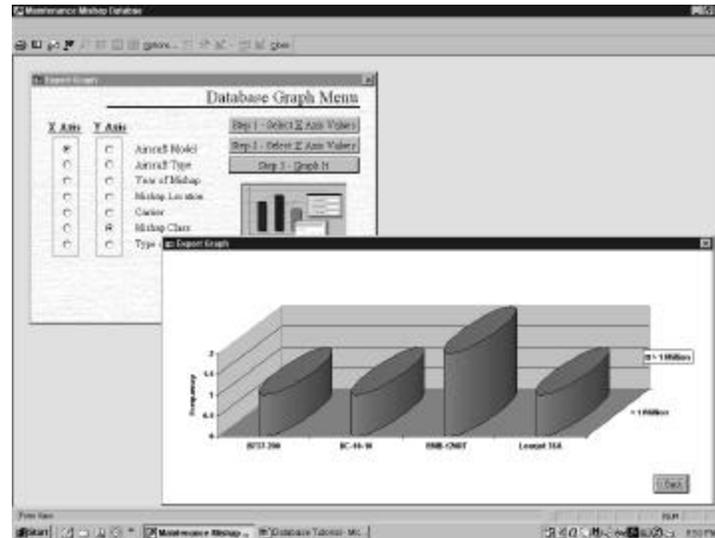
Figure 14



First click on one of the circles in each of the X and Y-axis columns to select your general graph criteria. We chose Aircraft Model in the X-axis compared to Mishap Class in the Y-axis (Figure 14). Next, click once on the Step 1- Select X-Axis Values box to open the Multiple Selection Window. The user may choose one, a selection, or all of the options in the Available column and either double-click your selection or press the >>

box to move those choices to the Selected column. When satisfied with your choices, click the OK button to lock in your X-axis selection. In our example, we chose four aircraft for the X-axis.

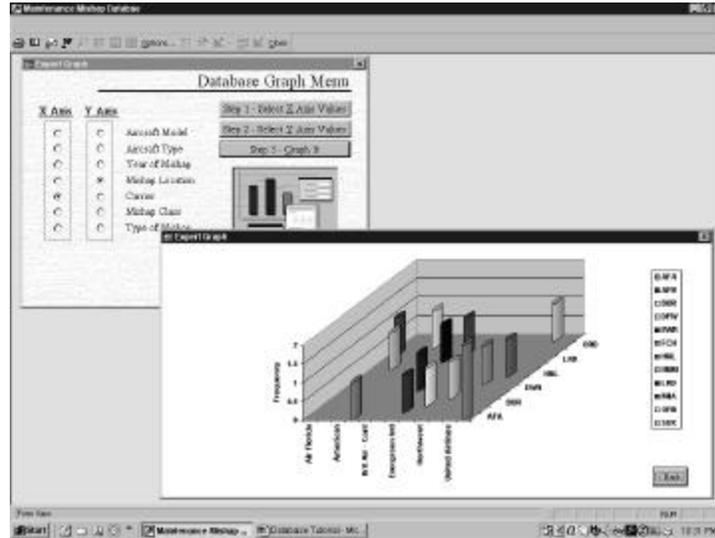
Figure 15



Using the same process, we then selected our Y-Axis Value, which was Mishap Class at > million dollars, followed by clicking the Step 3-Graph It box. The resulting chart (Figure 15) shows that three of the aircraft each had one accident > million dollars in our sample database of 15 total accidents. The remaining aircraft model (EMB-120RT) had two accidents in our database. The results may now be printed and only the chart will appear on the print out.

Here is another example with multiple criteria in both the X and Y-axis (Figure 16). This chart shows the relationship between all of the databases Air Carriers in the X-axis with the Mishap Location in the Y-Axis. The matching criteria resulted in a six-by-six graph showing on accident at each location with the exception of two accidents at AFA by United Airlines. The graphs would be much more pronounced with a larger database of accidents, but this limited sample database still emphasizes that accidents are universal problems that are not limited to one carrier or one location.

Figure 16

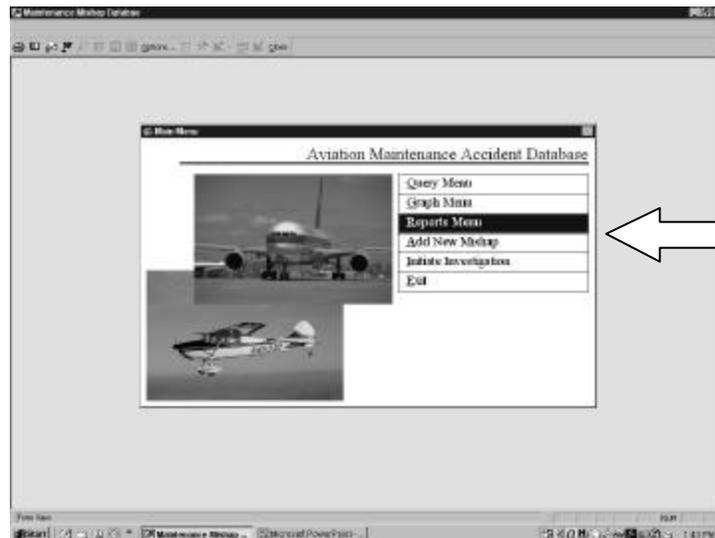


Graphs are only one type of printable report. The Aviation Maintenance Accident Database has a Report Menu with other options to meet your organization's requirements.

The Reports Menu

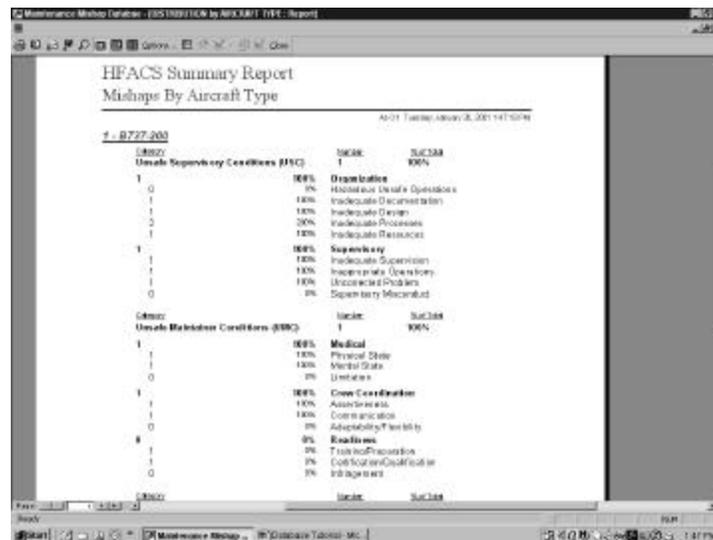
The Reports Menu can be accessed from the opening screen Main Menu (Figure 17). As with the other Menu options, clicking once on the Reports Menu will open a Database Reports Menu Window (Figure 18). The Reports Menu Window has options for both Cross-Tabbed Reports and Chronological Reports.

Figure 17



Another example is the Mishaps by Aircraft Type (Figure 20). Please notice that the format is exactly the same. Under the title/date line, the first of many Aircraft Types are listed with their corresponding HFACS-ME Error Categories, numbers and percentages. The other two Cross-Tabbed Report options, Mishaps by Carrier and Mishaps by Location, also have the same format. Safety managers may prefer some reports to others, or they may prefer to print and review each report option on a regular basis. In any case, the Aviation Maintenance Accident Database has the features needed to assist your organization in disseminating this accident data.

Figure 20



Chronological Reports

The second Report Type is the Chronological Report. The user need only click once on the Mishap Chronological Listing button to open the Chronological Listing of All Mishaps HFACS-ME Summary Report (Figure 21). Unlike the previous report options, the Chronological Listing does not contain the HFACS-ME Error Categories. It instead focuses on the basic identification of each accident with a summary line of the accident circumstances.

The accidents are numbered, in this case 15 to 1, to signify the total number of accidents in this sample database. After each ID number, the date, aircraft type, class of mishap, and mishap types are displayed on the top line of each accident summary section. A very brief Description of Incident follows to explain the nature of each accident.

The Chronological Report was included to offer the safety team additional flexibility in report and briefing options.

Figure 21

HFACS Summary Report
Chronological Listing Of All Mishaps
As Of: Friday, January 15, 2010 8:30:07 AM

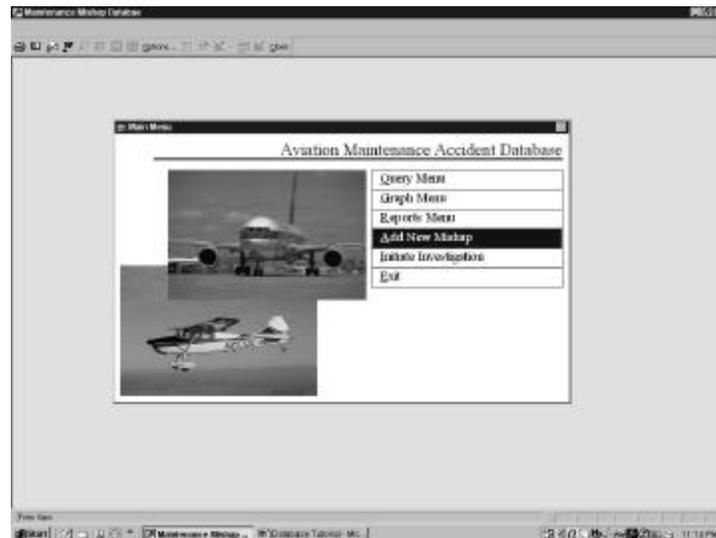
ID	DATE OF MISHAP	MISHAP TYPE	CLASS	TYPE
13	02/07/10	DC-007126	> 1 MISAP	Flight Performance
14	02/07/10	> 1 MISAP	> 1 MISAP	Flight Performance
13	02/06/10	DC-00607	MISAP	Flight Performance
12	02/05/10	L701-001	MISAP	Flight Performance
11	02/05/10	L701-001	MISAP	Flight Performance
10	02/05/10	DC-00520	> 1 MISAP	Flight Performance
9	02/04/10	DC-00410	> 1 MISAP	Flight Performance
8	02/03/10	DC-00307	> 1 MISAP	Flight Performance

We have now discussed all of the key features of the Aviation Maintenance Accident Database. The only question that should remain is how to add your own accidents to this database. Fortunately, this program offers two options that will simplify the process. Safety personnel can either choose the Add a New Mishap option or the Initiate Investigation option.

Add a New Mishap

To initially build up your database, or add onto an existing one, the Add a New Mishap feature was included in the Aviation Maintenance Accident Database. From the Main Menu on the opening screen, select the Add a New Mishap option (Figure 22).

Figure 22



The Add a Mishap Window will open (Figure 23). The form will have blank fields except for the Date field, which will automatically enter the date you begin the file. The Mishap Number field is gray to preclude any entry. It will be automatically updated when you add the Record to the database.

Each of the upper field boxes have pull down menus to simplify data entry. Plain text is used for the Brief Description and Contributing Factor fields. As each factor is entered, the user should click once on the Add Factor button to register that field with the accident record. When all entries have been completed, click once on the Add Record button to close out the accident record and have it included with the other accident reports in the database. The Add a New Mishap Window will automatically close at that time and return you to the opening screen Main Menu. Should you wish to return to the Main Menu before completing the Mishap entry, simply click the Return to Main Menu button.

Figure 23

Initiate an Investigation

The Initiate an Investigation option is identical in every way to the Add a Mishap option. Both may be accessed from the opening screen Main Menu and all of the data fields may be completed in the same way. Please refer to the previous Add a Mishap section for additional guidance.

The only differences are the title of the form window, which is now Add An Item Under Investigation (Figure 24) and the purpose of its entry. The Add a New Mishap option was created to provide a data entry person with an easy method to quickly add several accidents to the database. The Add An Item Under Investigation option was created to record data as it became available in the course of an accident investigation.

Figure 24

The screenshot displays a Windows application window titled "MEIMS Aviation Maintenance Incident Database". Inside, a sub-window titled "Add An Item Under Investigation" is open. The form contains the following fields and controls:

- Mishap #**: Text input field.
- Mishap Class**: Dropdown menu.
- Date of Mishap**: Text input field with "11/15/11" entered.
- Center**: Dropdown menu.
- Aircraft Type**: Dropdown menu.
- Category**: Dropdown menu.
- Mishap Type**: Dropdown menu.
- Location**: Dropdown menu.
- Brief Description**: Text area.
- Contributing Factors**: Text area.
- Code**: Text input field.
- Material** and **Aviation**: Radio buttons.

At the bottom of the form are three buttons: "Add Entry", "Add Failed", and "Return To Main Menu". The Windows taskbar at the bottom shows the system tray with the date and time "11/15/11 1:28 PM".

Conclusion

This concludes the student guide on the concepts and operation of the MEIMS Aviation Maintenance Incident Database program.

MEIMS, in conjunction with the HFACS-ME Framework, offers your aviation organization the tools and potential to greatly reduce its accident rate. It is our hope that this program, offered freely, will encourage the free transfer of information between organizations to reduce the human and material costs of ALL aviation accidents.

Updates to Prototype MEIMS Tool and Tutorial will be available as changes are made.