CHAPTER SIX
HYPERMEDIA INFORMATION SYSTEM

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6.0 INTRODUCTION

The aviation industry manages large quantities of documentation for purposes including training, research, maintenance, and safety inspection. Paper or microfiche documents include fault isolation manuals, maintenance manuals, federal aviation regulations, and research reports. Timely and convenient access to these documents is important, but currently document access can be quite cumbersome. For example, safety inspectors and aviation maintenance technicians must carry literally stacks of documents to the flightline when they inspect or work on an aircraft. Finding the desired information in cumbersome documents is not always easy; therefore, the results are not always accurate. Improvements in the way aviation personnel access information will lead to more reliable and more cost-effective aircraft maintenance.

Toward this end, the Federal Aviation Administration (FAA) Office of Aviation Medicine (AAM) Human Factors in Aviation Maintenance research program is studying the challenges associated with creating, accessing, and maintaining digital documentation using a Hypermedia Information System (HIS). This paper discusses the current state of the HIS, including the interface features, integration into a job aiding system, and future plans.

6.1 THE HYPERMEDIA INFORMATION SYSTEM FEATURES

The goal of the AAM Hypermedia Information System research program is to use hypermedia technology to improve access to aviation information. Hypermedia technology makes it possible to establish links between a document and other documents, graphics, animation, video, and audio. This makes a hypermedia document far more powerful and meaningful than a digital document that is strictly text. With hypermedia technology, information can be stored, searched, and retrieved by referential links for fast and intuitive access. This reduces the time spent looking for information and allows a more thorough, meaningful search. Hypermedia technology allows users to make faster and more intelligent decisions. Naturally, the technology offers other benefits such as reduced costs for inspecting and maintaining aircraft. For more information on hypermedia, see Howell, 1992, and FAA/AAM & GSC, 1993b.

Initial research program efforts concentrated on demonstrating the feasibility of a hypermedia system for aviation personnel. Team members designed a digital library system and implemented rudimentary tools for storing the information. The bulk of the implementation effort was focused on information retrieval tools and the hypermedia reader interface. Federal Aviation Administration research reports were used as a testbed for creating the digital library. This proof-of-concept hypermedia viewer (FAA/AAM & GSC, 1993b) proved to be a flexible, powerful way for researchers to view hypermedia documents. The HIS can be used solely as a tool to access information, as well as integrated with training and job-aiding systems (Johnson and Norton, 1992).

Both the viewer and the library were distributed on compact disc, read-only memory (CD-ROM) to the aviation maintenance community in early 1993. As with many proof-of-concept systems, this one was geared toward a specific application area. The viewer interface was tailored to the FAA research reports, making its broad-scale applicability limited. Over the last year, research has continued to make the tools more generic and enhance their functionality. The digital library containing FAA research reports was expanded to include new reports. Additionally, two new libraries were created: one contains the Federal Aviation Regulations; the other, the Inspector's Airworthiness Handbook. The work described in this chapter will be produced and distributed on CD-ROM in early 1994.

The HIS reader interface maintains a book paradigm and consists a navigation component and a viewing component. The navigation component combines the familiarity of traditional book navigation, e.g., a table of contents, with the power of hypermedia searching. The viewing component allows the reader[1] to read, print, and manipulate the various media that make up the library.

6.1.1 Navigation

A traditional paper book provides several navigation methods, including a table of contents, an index, and simple page turning. Likewise, the HIS supports a variety of access paths into and within a document. Some readers seek specific topics of interest and appreciate a powerful method to browse through a complex document. These readers find the hierarchical Outline Viewer and powerful searching capabilities useful. Other readers may seek quick references to standard information. Hot Links and Bookmarks provide mechanisms for these readers to quickly access frequently referenced places in a document.

6.1.1.1 The Bookshelf

The first HIS component the reader encounters is the Bookshelf (Figure 6.1). The Bookshelf graphically depicts libraries available to the reader. The reader selects book icon to choose a library. To change libraries, the reader returns to the Bookshelf and selects another book icon. Bookshelf icons can be customized to fit a specific application.

6.1.1.2 The Outline Viewer

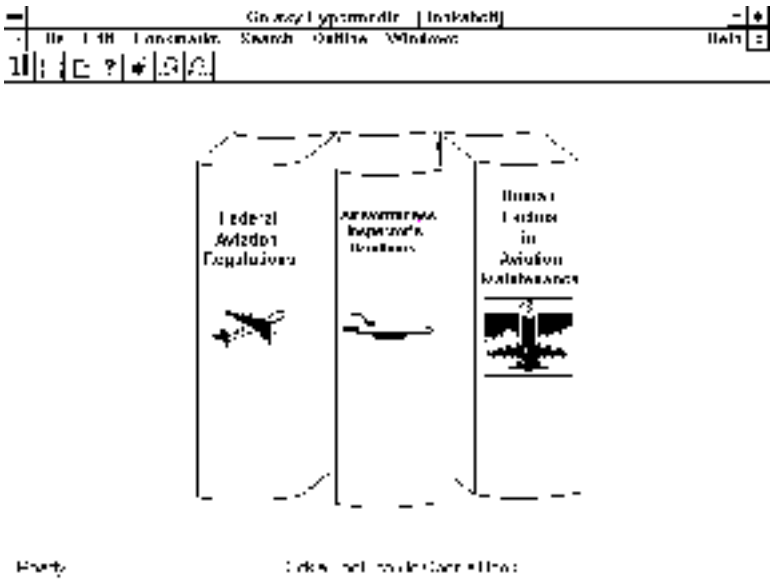

Figure 6.1 The HIS Bookshelf

Once a reader chooses a library from the Bookshelf, the Outline Viewer appears to display the complete outline for the library. The outline is similar to a Table of Contents and contains the Topics defined for the library's documents. A hypermedia author2 specifies Topics within the original digital documents and assigns a hierarchical order to them. By using the HIS Outline Viewer, a reader is able to browse the outline of all documents in the library and to expand and collapse the Topics (Figure 6.2). Once a reader finds and selects a Topic of interest, the part of the document associated with the Topic appears (Figure 6.3).

6.1.1.3 Hot Links

The HIS supports a variety of Hot Links a reader can use to navigate through the library. The Hot Links include both inter- and intra-document links to text, as well as links to graphics, animation, video, audio, definitions, and other executable programs. Hot Links are denoted by a rectangular box surrounding red text (Figure 6.3)

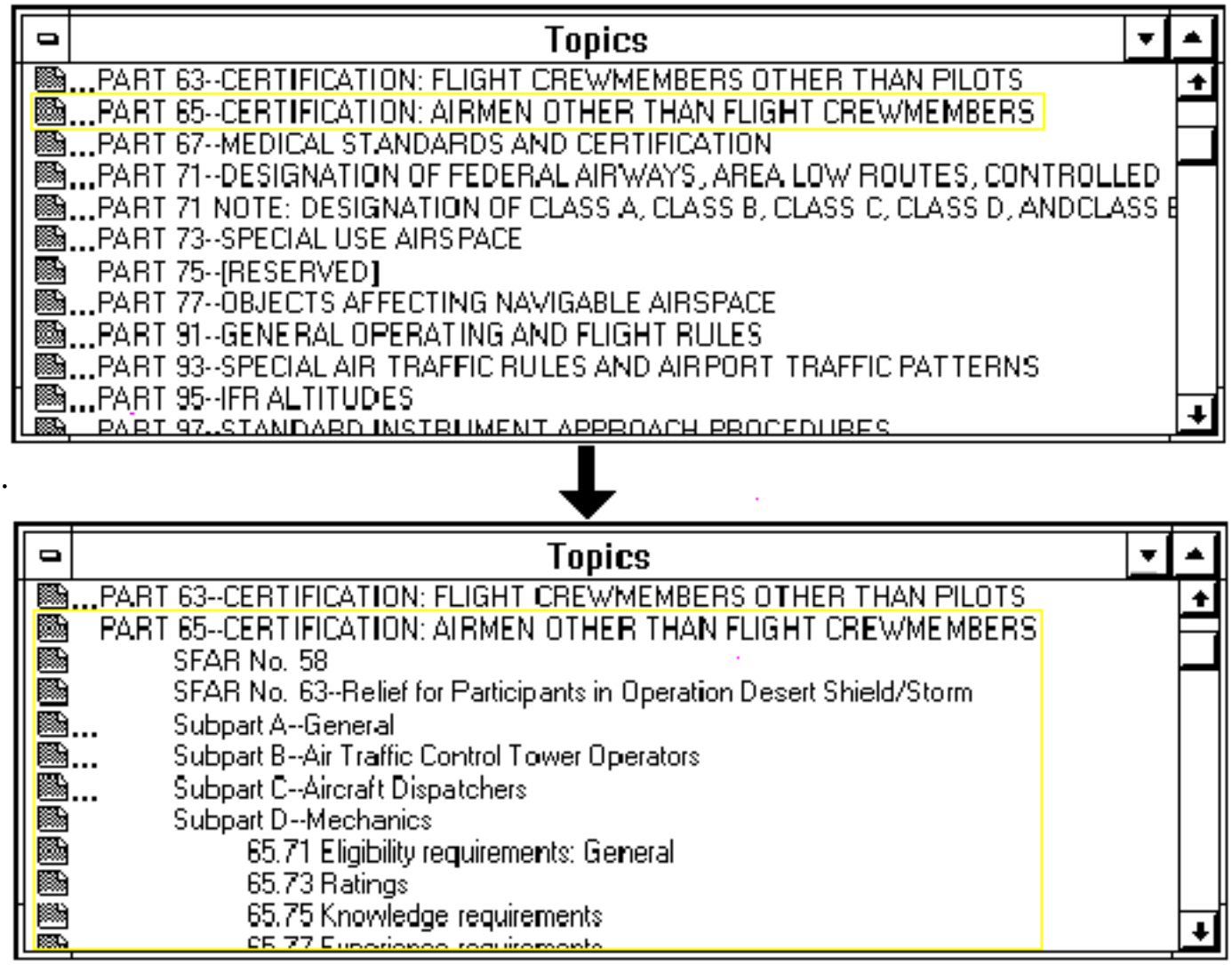

Figure 6.2 Collapsed and Expanded Topics

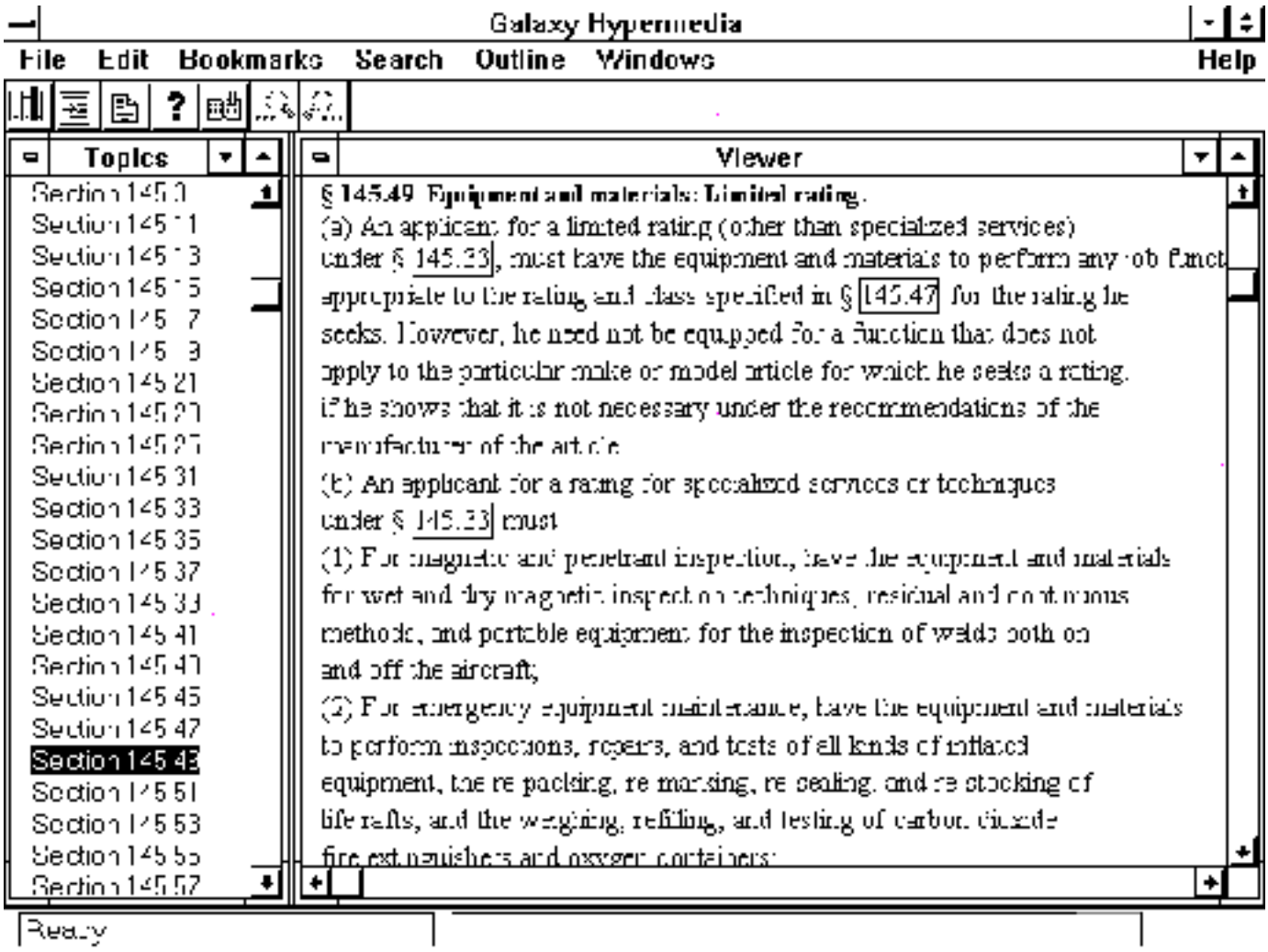

Figure 6.3 The Outline and Document Viewers

6.1.1.4 Searching

One of the most powerful features of a hypermedia system is its ability to quickly locate specific information in large amounts of text without forcing the reader to scan each line. A reader searches by typing a query, as shown in Figure 6.4. The HIS then rapidly searches all documents in the library. The HIS then displays a list of Topics satisfying the query, also shown in Figure 6.4. The reader can select one of the Topics to view. When the selected Topic's text is loaded, the search hits are highlighted, as shown in Figure 6.5. To see other search hits, the reader can either scroll through the text or use the magnifying glass icons in the icon bar (Figure 6.5) to go to the previous or next occurrence.

The HIS supports four types of searching: term, wildcard, phrase, and Boolean. A term search is a search for a specific word such as aviation that is not a stopword. A stopword is a word occurring so frequently in the document that it is not important, such as *the* or *and*. Every Topic containing the search term is listed in the Search Query Dialogue Box.

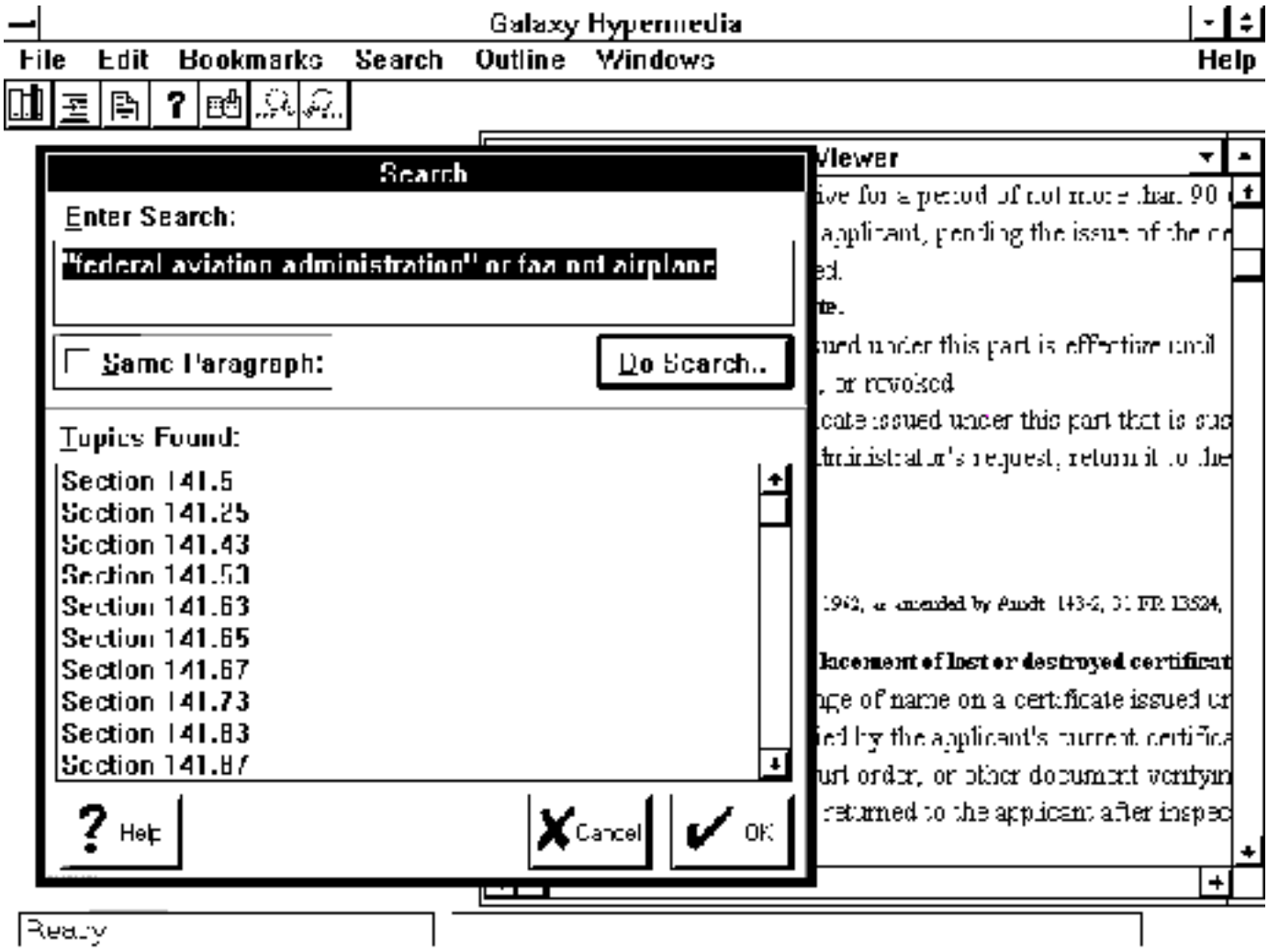

Figure 6.4 Search Query Dialogue Box

A wildcard search allows the reader to look for variations of a term such as administrate, administration, administer. The reader can append a term or partial term with either an asterisk (*) wildcard or a question mark (?) wildcard. The asterisk represents zero or more characters, and the question mark represents zero or one character.

A phrase searching enables the reader to specify the order and adjacency of multiple search terms. For example, phrase searching for "federal aviation administration" only displays places where that exact phrase appears. The reader specifies a phrase search by placing quotes around the target phrase.

A Boolean search combines any/all of the above types with Boolean operators (AND, OR, NOT), as in "federal aviation administration" or faa not airplane. In this example, the search would return a list of all Topics containing either *federal aviation administration* or *faa*, but not containing *airplane*.

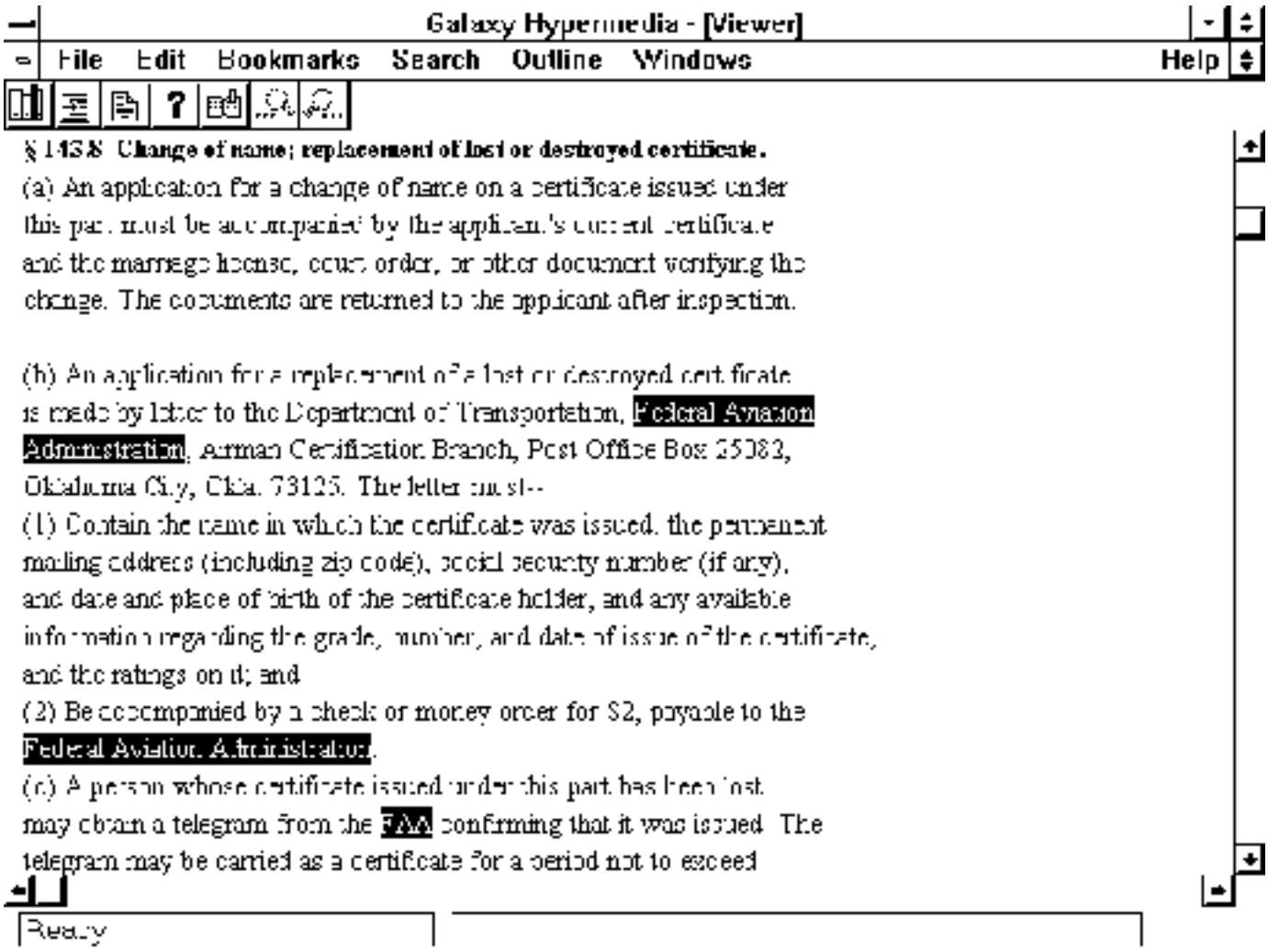

Figure 6.5 Search Hits

6.1.1.5 Bookmarks

It is sometimes desirable for a reader to mark a place in a document. The HIS provides a bookmarking capability and enables a reader to create multiple Bookmarks for a document. When creating a Bookmark, the HIS uses the current Topic as the Bookmark's target destination. To use a previously created Bookmark, the reader chooses one from the list of active Bookmarks (Figure 6.6**)**. The Topic containing the Bookmark does not have to be in the current library; the HIS automatically switches libraries, if necessary.

6.1.2 Viewing

The HIS provides three distinct tools viewing the various media comprising a hypermedia library. The Document Viewer has multiple entry mechanisms: the Outline Viewer, the Search Query Dialogue Box, Bookmarks, and Hot Links. The Graphics Viewer and the Multimedia Viewer are accessible only through Hot Links.

6.1.2.1 The Document Viewer

The Document Viewer, shown in Figures 6.3 and 6.5, allows a reader to scroll through and read a hypermedia document, as well as to investigate search hits. Text formatting such as boldface, italics, underlining, and multiple font sizes and typefaces, enables the on-line document closely to resemble the original. Any headers and footers are also displayed.

6.1.2.2 The Graphics Viewer

Readers use the Graphics Viewer to view and print graphics. It appears when a reader clicks on a hot word that links to a static graphic image. Supported graphics formats include, among others, bitmap (BMP), encapsulated postscript (EPS), graphics interchange file (GIF), target image file format (TIFF), and Joint Photographic Experts Group (JPEG). The Graphics Viewer determines the graphics file's format and displays it appropriately; it offers seamless incorporation.

Figure 6.6 Bookmarks

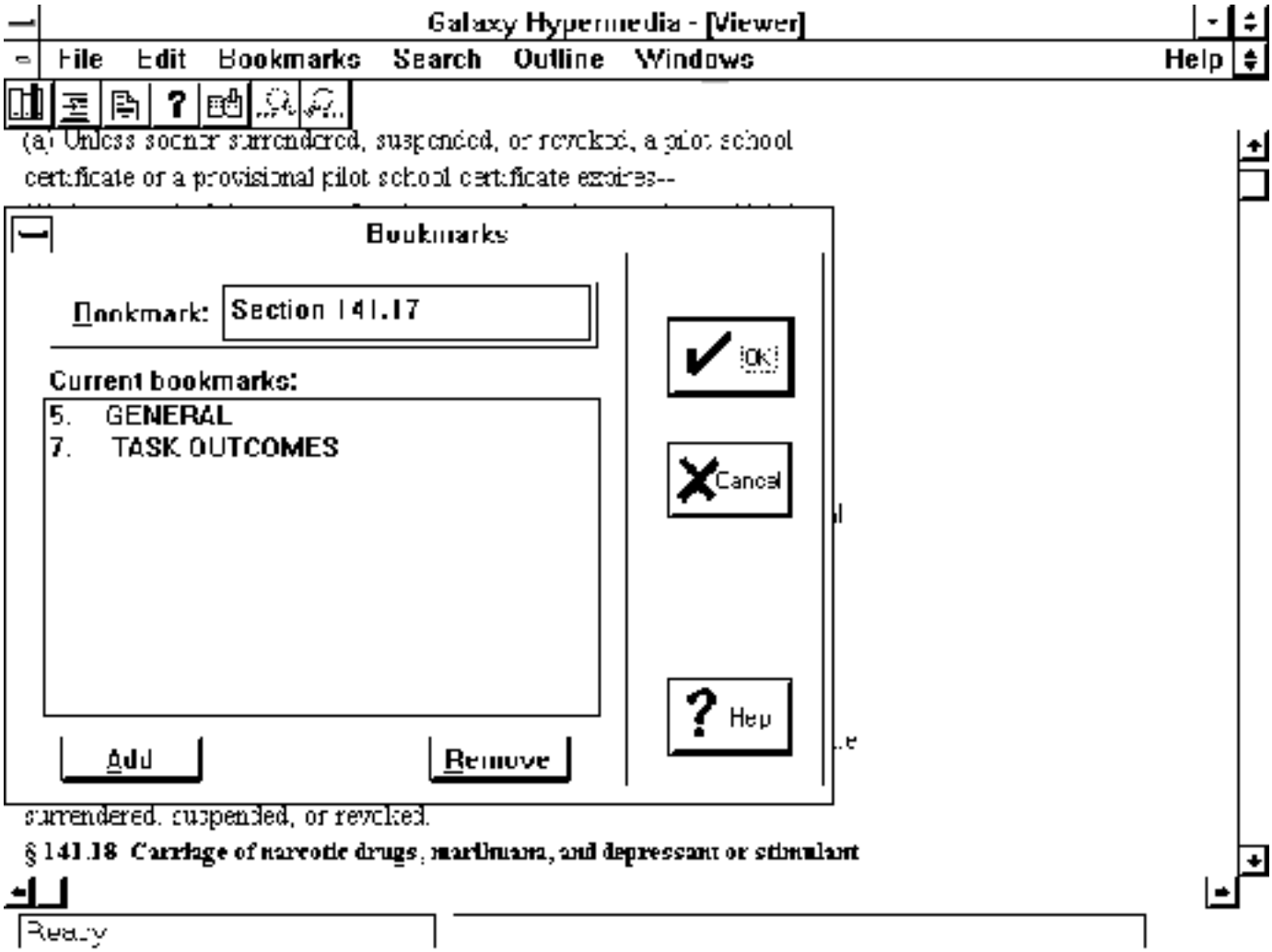

Figure 6.5 Search Hits

6.1.2.3 The Multimedia Viewer

More innovative types of media are now available for computer presentation (e.g., sound, video, animation, etc.). The Multimedia Viewer is provided for such media. The Multimedia Viewer is also seamless, determining the type of media when the reader selects a Hot Link to a media source and playing it appropriately. The HIS currently supports all MCI-supported media, including animation, video, cd-audio, and audio-video interleave.

6.2 HYPERMEDIA DOCUMENT CREATION

Because a hypermedia document is more than just a digital version of a paper document, it is necessary to transform a document from its original form into a form containing information for the HIS. This information runs the gamut from basic text format such as which font to use to links to other documents, graphics, animation, or other software programs. The HIS currently provides support for the following document types: WordPerfect, Standard Generalized Markup Language (SGML) that conforms to the Air Transport Association (ATA) Specification 100, and ANSI. The transformation process for each type is described briefly below.

For document types such as WordPerfect, the transformation process is partially automated. It is possible to include WordPerfect formatting such as boldface, italics, fonts, headers, etc., with an in-house filter that converts inherent WordPerfect commands into commands that the HIS understands. A similar filter could be created for other word processor formats such as Microsoft Word and would behave similarly. The hypermedia author then adds hypermedia-specific information such as Topics and Hot Links.

The transformation process for SGML documents that conform to ATA Spec 100, such as the Boeing 757 Aircraft Maintenance Manual, is completely automated. The SGML language is used to mark up documents by inserting tags in the text. Basically, these tags describe the document's structure, such as which text is chapter titles (Topics), which is references (Hot Links), which is paragraphs, etc. The hypermedia research project has developed a translation program to convert SGML tags into their HIS counterparts. This makes documentation transformation a smooth process, with no need for intervention by an author.

An ANSI document requires the most cumbersome transformation process. Since an ANSI document is flat text with no fonts, boldface, links, etc., it is the hypermedia author's responsibility to provide these details. Fortunately, an authoring system is under development to make this task intuitive. With this authoring system, a computer novice will be able to turn a digital document into a hypermedia document easily. Once a document is displayed in the HIS, an author can put the Document Viewer into "author mode." By using the mouse to highlight text, the author can use menu options to specify the text's appearance (bold, italics, etc.) or function (link to graphics, link to text, etc.). The information the author provides is part of the hypermedia document, even after the author exits from the HIS.

6.3 REAL-WORLD HIS APPLICATION

Now that the HIS itself has been described in detail, it is beneficial to describe a situation in which it is being used. The HIS has proven its ability to support all facets of the aviation community. The previous version of the HIS on CD-ROM addressed the needs of researchers. It was also successfully integrated into several maintenance training systems. During the last year, the current HIS (described above) was incorporated into a job aid for Aviation Safety Inspectors.

The Performance Enhancement System (PENS) (see FAA/AAM & GSC, 1993a) applies pen computer and hypermedia technology to provide real-time job aiding and information retrieval for Aviation Safety Inspectors. Aviation Safety Inspectors must have access to large amounts of information, including Federal Aviation Regulations, Airworthiness Directives, and Advisory Circulars. The Federal Aviation Regulations and the Inspector's Airworthiness Handbook have been put into a library for inspectors' use. As the inspectors use PENS, they can directly access the HIS to reference and search for information. The initial PENS system is being distributed for use and evaluation to Aviation Safety Inspectors in nine U.S. locations. During the formal evaluation, feedback provided regarding the HIS will be used to make future PENS enhancements. Initial, informal feedback indicates that inspectors find it extremely valuable to have access to the documents through the HIS. Inspectors are looking forward to having other documents such as the Airworthiness Directives incorporated into the system.

6.4 FUTURE DIRECTIONS

As demand continues to increase, the HIS will continue to evolve. Specifically, the goals for developing the HIS further include the following:

- Complete the development of easy-to-use authoring tools
- Support a wider variety of document types
- Increase the document base to include other aviation documents
- Enhance the searching mechanism to provide "smarter" searching
- Support embedded graphics and tables.

The following sections describe plans to enhance the HIS in support of these goals.

6.4.1 Authoring Tools

Given that it is necessary for an author to transform a digital document into a hypermedia document, it is desirable to make the process for doing so as easy and intuitive as possible. As mentioned previously, development is under way to provide such an authoring system. Anything the author needs to add, such as Hot Links and Topics, will be added in a WYSIWYG ("what you see is what you get") environment. The author will be able to modify text, e.g., to correct spelling errors, and even to type a document from scratch. This powerful authoring environment will enable virtually anyone to create a hypermedia document.

6.4.2 Extended Document Types

It is also necessary to provide up-front support for existing source documents in formats other than WordPerfect, SGML, and ANSI. Another goal is to develop filters for other word processing formats and documentation standards. These other formats and standards might include Microsoft Word and Interactive Electronic Technical Manual (IETM) specifications.

6.4.3 Increased Document Base

This past year's work has already seen an increase in the supported document base for the HIS to include the Federal Aviation Regulations (FARs), the Airworthiness Inspector's Handbook, and recent research publications of the FAA/ AAM & GSC. This work is just the tip of the iceberg so far as the HIS' documentation base is concerned. Next year, the Human Factors Guide that is currently in development under the Human Factors in Aviation Maintenance research program will be transformed into an HIS-accessible hypermedia document. Also, Aviation Safety Inspectors participating in the PENS project are requesting Advisory Circulars and Airworthiness Directives.

6.4.4 Enhanced Searching

Searching is a powerful means of navigating a hypermedia document, enabling a reader to access interesting information directly. By combining terms and phrases with Boolean operators, a reader can refine a search that is too broad. However, it is still possible for a reader to end up with search hits that are irrelevant or only vaguely related to the actual topic(s) of interest. Future research will investigate several potential solutions to this problem. A relevancy measure is one way to prevent a reader from needlessly examining irrelevant hits by indicating the relative relevance of a search hit to the topic in which it is found.

A relevancy measure may not always be useful, such as in situations when multiple hits have similar relevance. A thesaurus will assist the reader to focus a search. The thesaurus can be customized by library; "plane" may have "air-plane" as a synonym in an aviation library and "shave" in a carpentry library.

6.4.5 Embedded Graphics

The HIS allows an author to present text to a reader in the Document Viewer and to provide Hot Links to graphics. Graphics are then displayed via the Graphics Viewer. The Graphics Viewer may not be desirable for some types of documents. For example, a document containing pages with numerous icons, figures, or small tables might be clumsy if it requires frequent opening and closing of graphics files via the Graphics Viewer. To accommodate this type of document, the HIS will add support for scrollable embedded graphics and tables. This also allows a reader to print text and graphics together, instead of having to print them from their separate viewers.

6.5 SUMMARY

The AAM Hypermedia Information System (HIS) research program continues to meet the challenges of improving aviation information access successfully. The HIS that has been developed allows a reader to navigate through huge amounts information quickly and easily. By supporting projects such as PENS and by creating hypermedia documents such as the FARs, the Airworthiness Inspector's Handbook, and research publications of the FAA/AAM & GSC, the HIS has proven its ability to support all facets of the aviation community. The HIS is flexible in its support of multiple document/graphic types and standards and in its ability to accommodate new types of media. With the advent of an authoring system that will enable virtually anyone to put documents into the HIS, demand for the HIS will only increase.

6.6 REFERENCES

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