

# The Drexel Disk: Hypertext-based instructional software as a tool for the exploration of a constrained knowledge space

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In this paper, an example of multi-functional, transportable instructional software is described. The software provides the user with a constrained knowledge space and the necessary tool to explore it. Relying heavily on graphics and hypertext linkages, the software is easy to use; it is distributed throughout the university as part of a solution to the problems of training and supporting microcomputer users.

Recently, Hewett (1986b) proposed that the emphasis in developing software for instructional computing should be on the creation of multifunctional, transportable tools that students can use in discovering or creating knowledge. Illustrative examples have been described by several authors (e.g., Anderson & Lane, 1987; Bharucha, Meike, & Baird, 1987; Chute, 1986; Perkey, 1986). In a later paper, Hewett (1987) also emphasized that instructional computing involves activities other than the use of courseware. Not only can various applications programs be utilized as instructional tools by the classroom teacher (Hewett, 1985), but students can themselves directly utilize a variety of microcomputer applications software (e.g., word processors, graphics packages, spreadsheets, etc.). Such programs can serve as tools to aid in the easy, rapid accomplishment of a task (Butler, 1988; Gibson, 1987; Jensen, 1987; Lehman, 1987). Applications programs can also be used as tools that allow students to directly instantiate their learning and knowledge or to develop an understanding of psychological principles through practice (Hewett, 1987). One advantage of utilizing generic applications packages is that they are usually flexible enough so that they can be applied in several areas of endeavor or to several knowledge domains (see Hewett, 1985, for an example in which an electronic spreadsheet is used in a nonobvious way).

Increasingly, as microcomputers become a more common part of the instructional environment, there will be pressure for development of multifunctional, transportable software that also simultaneously provides the user

with access to a constrained knowledge space and acts as a tool for the exploration of it. More importantly, because of simple economics, there will also be increased pressure for the development of software tools that can be used in the exploration of several knowledge spaces. One line of development for such tools is to create programs that can range over several domains of knowledge. Another line of development is to create shell-like tool structures into which information from different knowledge domains can be inserted, almost like a plug-in module.

One purpose of this paper is to provide an example of a primitive version of the latter category of such software. The program to be described has been available to students at Drexel University for several years. Called the Drexel Disk (Hewett, Perkey, & Boardway, 1988), the program is distributed to all entering freshmen when they receive their computers, and it is a part of the university's infrastructure of training and support services. In addition, the structure of this program has provided a useful model that has been emulated both on and off campus, and which, when properly customized, can be used to allow exploration of knowledge in a domain other than the one for which it was originally created. While this particular program is still somewhat limited in the degree to which it can be customized to range over a new information space without programming support, the nature and generic structure of the program forecast things to come.

Another pressure will increase as microcomputers become a more important part of the instructional environment: the pressure to develop software and courseware that take advantage of the unique capabilities of the computer. One such capability is the creation and use of hypertext linkages between various pieces of information. A hypertext linkage is basically a "hot spot" on the screen that, when activated, allows the user to directly reference information not currently on the screen. Such linkages can, without requiring intervening steps, produce the effect of either bringing the information to the user or taking the user directly to the information. A second major

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Development of the first version of the Drexel Disk was made possible by a grant to Drexel University from the Pew Memorial Trust. The figures in this paper are taken from screen displays for the Drexel Disk ©1988; they are used by permission. Development of the Co-op disk was made possible by a grant to the Drexel University Center for Co-operative Education from the U.S. Department of Education Supplemental Funds Program for Co-operative Education. Correspondence may be addressed to Thomas T. Hewett, Department of Psychology, Sociology and Anthropology, Drexel University, Philadelphia, PA 19104.

purpose of this paper is to illustrate some ways in which hypertext linkages can be used in structuring information and in providing the user with increased ease of access to specific, useful pieces of it. Linkages that bring the information to the user and linkages that take the user to the information are both part of the Drexel Disk.

### CONTENT AND STRUCTURE OF THE DREXEL DISK

Intended for novice or relatively inexperienced users during their first few months of experience with computers, the Drexel Disk begins with an automated introductory sequence. After the initial "Welcome to the Macintosh" screen that accompanies a successful startup of the Macintosh, a dragon—the student mascot—waddles across the screen, turns, and breathes smoke and fire. The screen dissolves into blackness, which is then wiped away to show a student-drawn picture of a central campus building. Soon, an information box appears on the screen; it contains a copyright notice and a caution that the user is assumed to know how to "mouse around." For users who may not know how to control the Macintosh interface, instructions explain how to "Quit." Clicking the mouse button while the cursor is on a "Continue" button in the information box will take the user to the master menu screen. From this point on, the user is in complete control of the flow of interaction with the program, being able, ad lib, to traverse any of a wide variety of pathways to access virtually any information on the Disk in very few steps (for experienced users of the program, a command allows one to bypass the opening sequence).

### Main Menu Screen

The main menu screen (Figure 1) offers the user six choice boxes, each one with a label and picture. The first box, which contains a picture of a Macintosh, is labeled "Drexel University Micro Facilities." The second choice box, containing a picture of the "Shift," "Option," and "Command" keys on the Macintosh keyboard, is labeled "Short Cuts & Tips." A third box contains a picture of a microdisk, a skull and crossbones, and the label "Rights & Responsibilities." The fourth box, labeled "Miscellaneous," contains a picture of a circuit diagram. The fifth box, containing a picture of the Drexel Disk, is labeled "INDEX." The final choice box, labeled "Something Else," contains the formula for the definite integral, musical notes, and some overlapping rectangles symbolizing graphics. The user activates a choice box either by putting the cursor on it and double-clicking the mouse button or by putting the cursor on the box, clicking the mouse button once to select the box, and then using "Open" from the pull-down "File" menu.

### "Micro Facilities"

After the user activates "Micro Facilities," the display changes to show another menu screen (Figure 2). This screen contains eight choice boxes with labels and pictures that represent the various types of microcomputer facilities on campus—printers, micro classrooms, repair, hotline, access clusters, consulting, database searching, and the comptroller. Each choice box represents a major component of the university's infrastructure of support services. For example, if the user activates "Printers," the display changes to show a campus map (Figure 3).

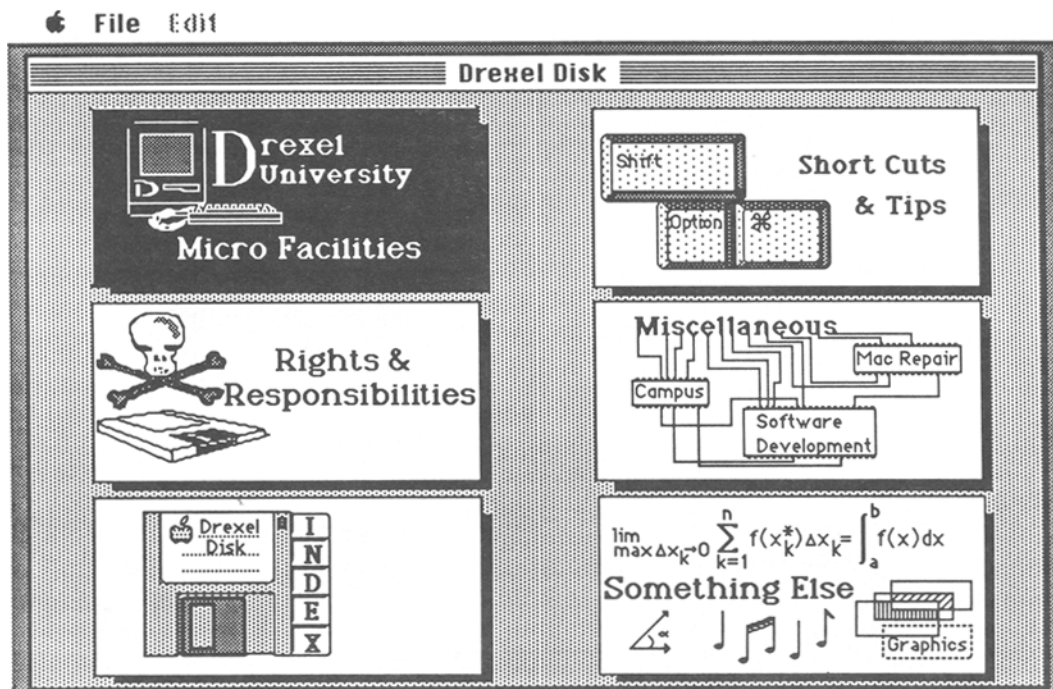


Figure 1. Drexel Disk main menu screen.

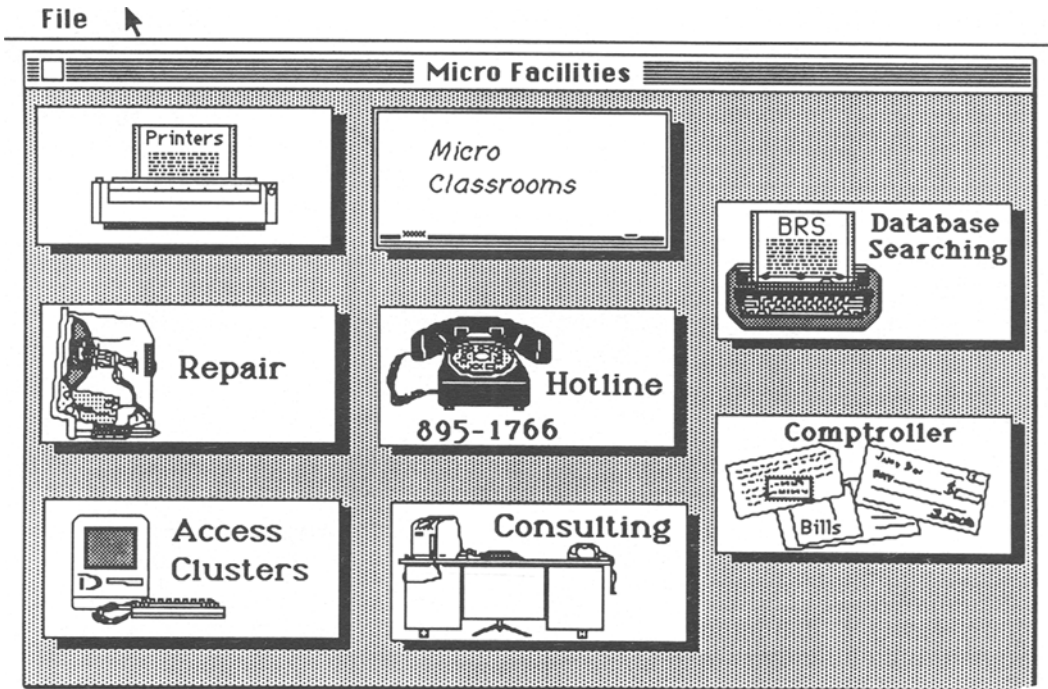


Figure 2. "Micro Facilities" menu.

On the map, each building is numbered, and the buildings that contain printer stations are highlighted. Text in an information box across the bottom of the screen explains that clicking on a highlighted building will result in further information. Each building represented on the

map is a hot spot on the screen. Clicking on the highlighted building activates a new information box that provides the user with such information as the name of the building, location of the print facility, hours of operation, kind of staff on duty, etc. Double clicking on any non-

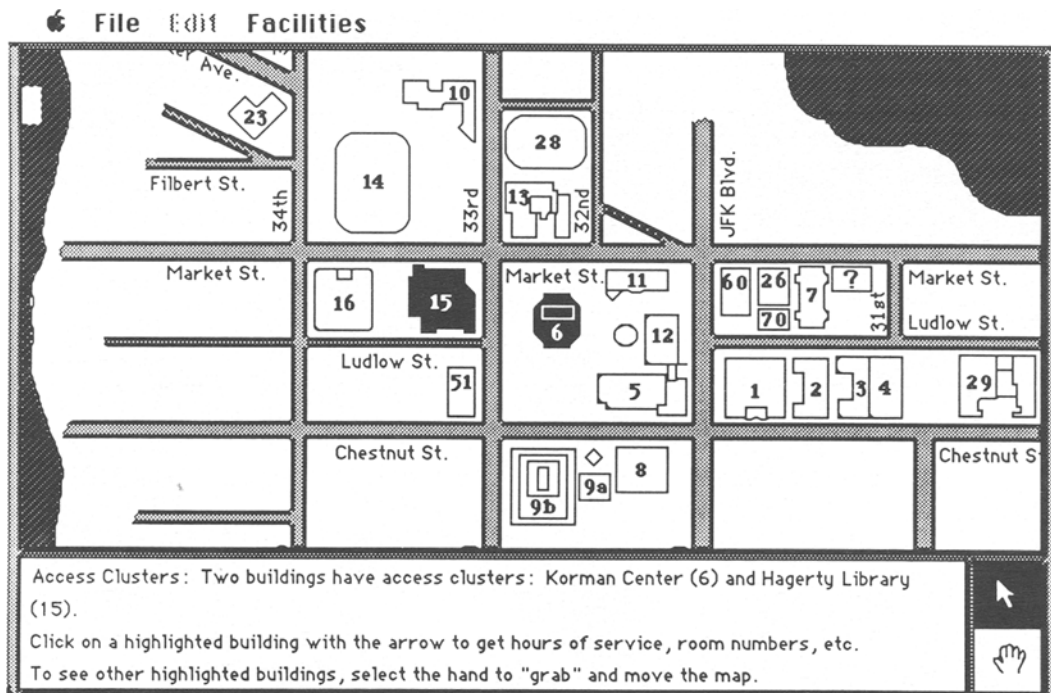


Figure 3. "Hypertextually" interactive campus map.

highlighted building also activates an information box that contains the name and number of that building.

Similarly, other choice boxes on the menu screen represent additional major facilities or user support services. Choosing "Micro Classrooms" provides the user with information about the locations of microcomputer-equipped classrooms on campus. Activating "Hotline" enables the user to discover where and how to telephone a consultant who can advise on the use of university-supported software packages, or help in diagnosing software and hardware problems. For anyone with a hardware problem, the "Repair" choice box shows the location of the campus computer-repair facility and provides information about normal operating hours, etc. The "Access Clusters" and "Consulting" choice boxes let the user find the on-campus locations either of consultants or of university-owned machines available for student and staff use. Selection of the "Database Searching" choice box displays the locations of the facilities established for users who wish to do their own on-line bibliographic database searching.

After having activated the map, the user can then use a pull-down menu to select any other category of micro facility without having to return to the "Micro Facilities" menu screen. If necessary, the program redraws the map to center the newly selected facility on the screen. From the map one can then "Exit Micro Facilities" and return to the master menu screen, or "Quit Drexel Disk." The same sequence of events is allowed for all categories of facilities.

### "Short Cuts & Tips"

When the "Short Cuts & Tips" box in the master menu screen is opened, the user sees a screen with several choice boxes that contain labels and pictures (Figure 4), each of which represents a different kind of tip—"Space & Storage," "Apple Jargon," "MacWrite," "Nifty Things," "Printing," "Hardware," "Spreadsheets," "FileMaker," and "HyperCard." These files contain helpful suggestions or reminders regarding the use of various pieces of software and hardware, or helpful hints on how to use the computer as a tool in instructional computing. The tips range from very basic information about establishing document margins or controlling the printer to explanations of various undocumented features of the Macintosh and its software.

The user can access any category of tips in either of the standard ways, by double-clicking the choice box, or selecting the picture and using "Open" from the pull-down "File" menu. Once a tip category has been opened, a tip-selection window and a tip-information window appear (Figure 5). The tip-selection window allows the user to scroll through a list of tip titles or hints in the desired category and select a tip of interest. Each tip title is intended to serve as both a hypertext hot spot and a mnemonic cue that references more detailed information in the tip-description window. Asking to be shown a selected tip results in the corresponding tip description's being automatically scrolled to the top of the tip-information window. Alternatively, the user can scroll through the full text of the active category of tip descrip-

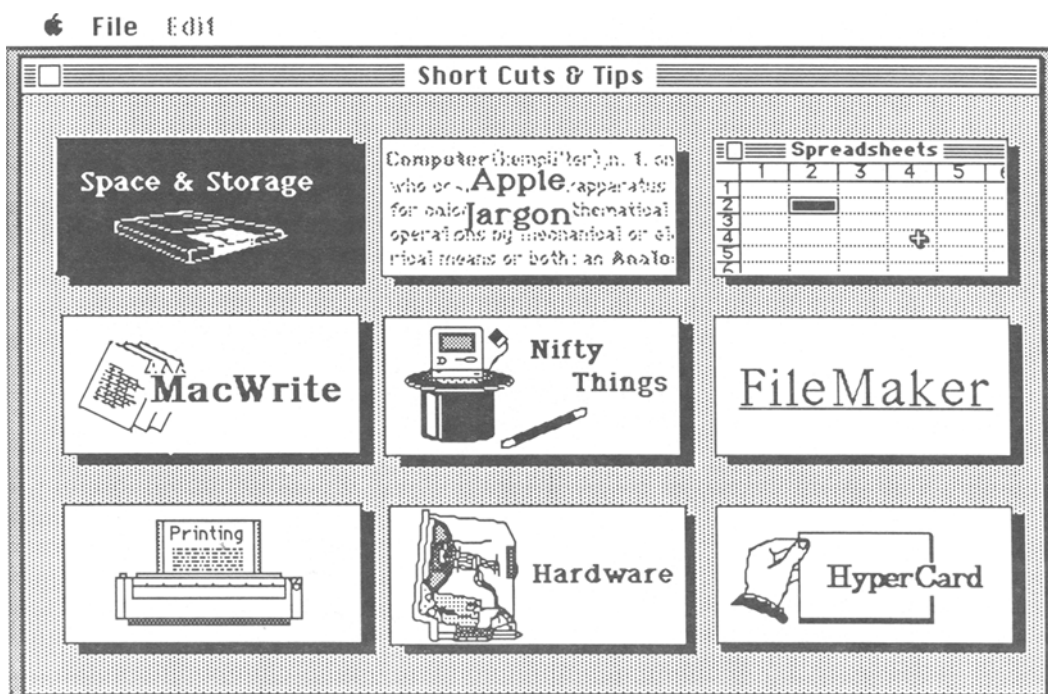


Figure 4. "Short Cuts & Tips" menu.

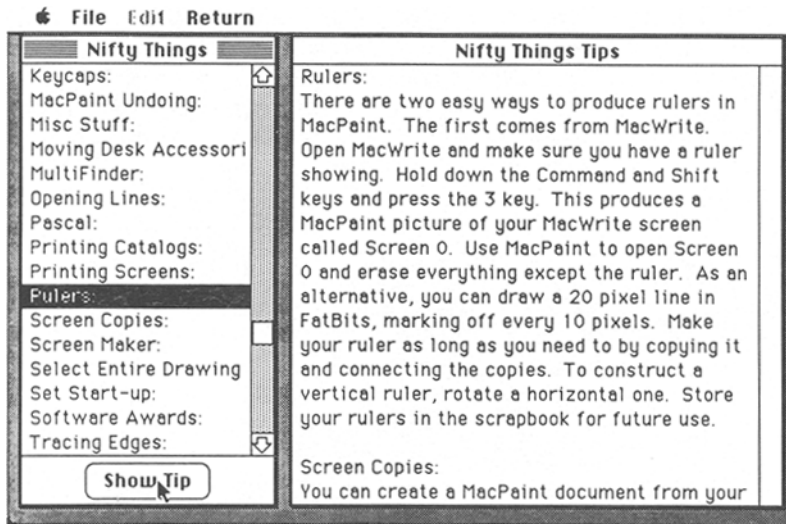


Figure 5. Tip selection and description windows.

tions in the tip-information window. Once a tip has been selected and shown, the tip description remains on display in the information window until replaced by a new tip description or until the user leaves "Short Cuts & Tips" entirely.

While in an active "Short Cuts & Tips" category, the user can use the pull-down menu to activate a different category of tips. When a new category of tips is first activated, the old tip list in the tip-selection window is replaced by the tip-selection list for the new category. If the user selects and shows a tip from the new selection list, the tip-information window for the new category appears with the appropriate tip description displayed. This capability allows the user to browse through all of the tip lists without losing the current contents of the information window. Thus, the user is able to skip back and forth

at will within "Short Cuts & Tips," activating different types of tips and browsing through tip-selection lists, tip descriptions, or both. Again, as with "Micro Facilities," one can either "Exit" to the master menu, or "Quit" the Disk.

**"Rights & Responsibilities"**

Activating "Rights & Responsibilities" from the master menu activates a menu screen that shows choice boxes with labels and pictures representing computer access policy, copyright policy, warranties, and "Truth & Consequences" (Figure 6). Opening "Truth & Consequences" provides the user with a series of case-study situations involving possible violations of United States and Commonwealth of Pennsylvania copyright laws. Written to describe situations students might actually en-

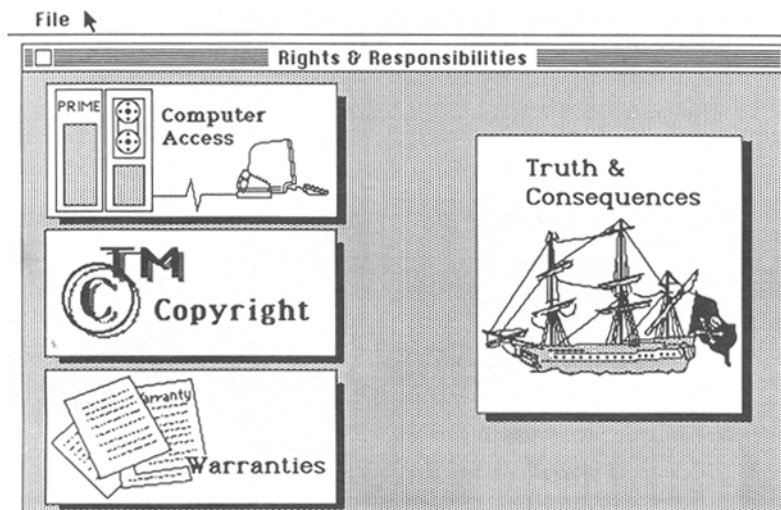


Figure 6. "Rights & Responsibilities" menu.

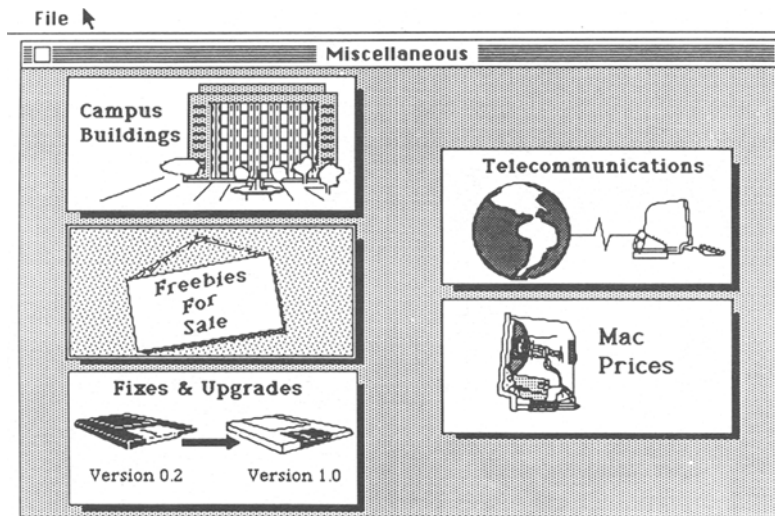


Figure 7. "Miscellaneous" menu.

counter, the case studies are presented as an interactive, true-false quiz, with an explanation for each answer. As the user proceeds through the quiz, a running score is provided. While in the quiz, the user can "Exit," "Start Over," or "Quit" at any time.

If the user activates the "Copyright" policy box, information about the university's copyright policy on software written by students and faculty appears in an information window. Similarly, appropriate information is provided for the user who activates the "Warranties" or "Computer Access" policy choice boxes. While any of these information windows is on the screen, the user can either "Exit" to the "Rights & Responsibilities" screen or "Quit" the Disk.

#### "Miscellaneous"

From the master menu, the "Miscellaneous" box opens to show choice boxes with labels and pictures for such

things as campus buildings, freebies, fixes and upgrades, telecommunications, and Mac prices (Figure 7). "Campus Buildings" accesses the campus map. Since the function of a map is to aid its user in locating things, this version of the map provides the user with the capability of interactively searching for various offices, departments, and buildings on campus. For example, pulling down the appropriate menu allows the user to find the Department of Psychology, Sociology and Anthropology by selecting that department from the list of those presented (Figure 8). After the selection has been made, the program highlights the building that houses the department. Clicking the mouse button on the building activates an information box that gives the user a description of the department and how to find it.

The map of campus buildings also allows the user to browse the campus. If the user activates any building hot spot, the program presents an information box that lists

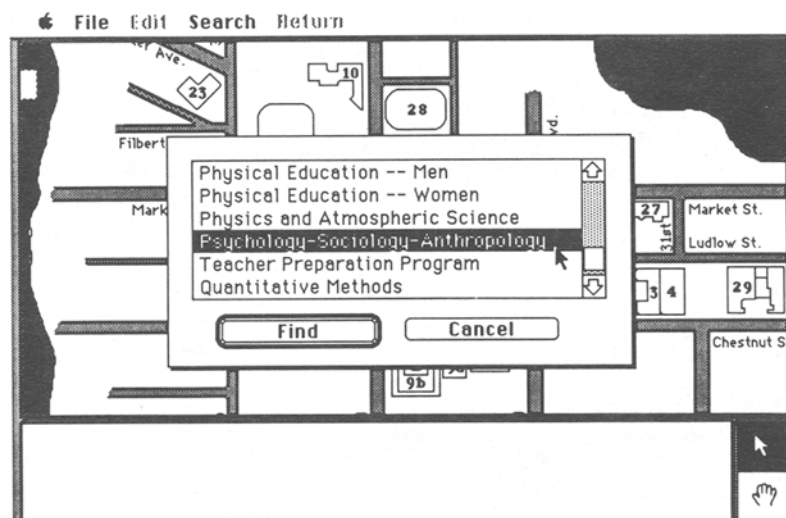


Figure 8. "Find by Department."

the offices, departments, and so forth, housed in that building. The listings in each of these information boxes contain hypertext hot spots. Selecting and activating any such line brings the user more detailed information about the selected item. For example, when one selects and activates the building in which the Department of Psychology, Sociology and Anthropology is located, the information box offers a list of several academic departments, some student services, the bookstore, etc. If the user selects and activates the line of text for "Department of Psychology, Sociology and Anthropology," the contents of the information box are replaced with information about the department, such as the location of the office, the phone number, the department head's name, and some information about the undergraduate majors offered by the department.

If the user activates any of the text files in "Miscellaneous"—for example, "Freebies for Sale," "Telecommunications," "Mac Prices"—a window opens, presenting the text in that file. For example, "Freebies" provides information on where and how to obtain a copy of the scientific font developed at Drexel, where to obtain hard copies of a variety of short, university-developed documents on optimizing the use of the Macintosh, etc. "Mac Prices" gives a relatively current listing of the prices of various repair services and hardware that are available through the university.

"Fixes & Upgrades" operates as does "Short Cuts & Tips." There are both a list of items in a title-selection window and an information window to provide descriptive information. The file contains information on different versions and upgrades of university-supported software and hardware, and "fixes" to some of the software problems that may arise either from known bugs, or from the incompatibility of different pieces of software and hardware. The user can either browse through the descriptive information or select a listing from the title list in order to see the appropriate block of text.

### Hypertext Index

The fifth choice box on the master screen contains the word "INDEX." If the user activates this box, a window appears with a hypertext index of the Disk contents (Figure 9). Once a desired segment of the information structure of the Disk has been identified, the user can use the "Show" command to go from the listing in the index directly to the indicated file or location in the information structure of the Disk. In addition, use of the index installs a "Return" menu and command in the menu bar across the top of the screen. To leave a file, the user can then "Return" directly to the index, "Exit" into the tree structure of the screen menus, or "Quit" entirely. Any user who chooses to return to the index can then select and "Show" any other item listed in the index. However, if the user "Exits" into the tree structure of the screen menus, the "Return" menu will remain in the menu bar so that at any time the user can "Return" to the index, at the location of the last item selected while the user was still in the index.

### "Something Else"

The final choice box on the master menu screen is the category "Something Else." Activation of this box puts the user directly into one of six demonstration modules. The particular module that appears is selected at random, without replacement, and if the user later reactivates "Something Else," one of the remaining demonstrations is activated. No module is repeated until each one has been activated at least once (or the application restarted).

The current demonstrations in "Something Else" are primarily examples of courseware in use at Drexel. One courseware module is an interactive equation-graphing program that allows the user to change values for the variables in the equation and observe the effects of those changes as the equation is regraphed. Another module allows the user to do a pursuit-rotor tracking task with the

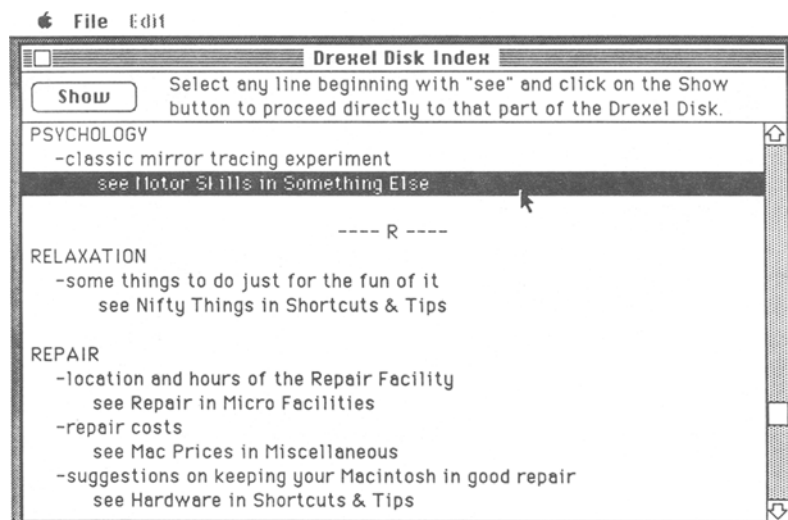


Figure 9. Hypertext "Index" window.

mouse. Some of the parameters, such as the shape of the track, can be changed to create different test conditions. Similarly, the user can set mirror-image reversals on two axes, either independently or simultaneously. In addition, the user can view data collected under various conditions during the session.

The remaining two courseware modules are slide shows illustrating major screens from two different programs. One program, on Fourier operations, is used in electrical and computer engineering. The second, on linear programming, is used in upper-level business courses. The last two demonstrations are a segment of animated graphics and a musical segment representing performing arts.

### Quitting

Once the user has reached the main menu screen, a "Quit" command is always available in the pull-down "File" menu, so that the user can quit at any time. When the user quits the Drexel Disk, a credits box appears. This box gives the names of various individuals who worked on major segments of the program. Included in the credits box is an "OK" button. Clicking the mouse on "OK" activates a final animated sequence in which a small mouse, with wheels instead of legs, rolls across the screen.

## USER REACTIONS

There are several ways to evaluate software such as the Drexel Disk. Some of these methods fall under the heading of formative evaluation (Scriven, 1967), the goal of which is to produce information useful in refining and improving the program (Hewett, 1986a). Other techniques are more appropriate for summative evaluation (Scriven, 1967), the goal of which is to make an overall decision about the efficacy of the software (Hewett, 1986a).

Systematic evaluations of the Drexel Disk have been primarily formative, conducted through the observation of users and their reactions, and through the collection of critiques written by users who have been asked to describe the things they like and don't like about the program. The evaluative information gained from these observations and written comments suggests that users consider the Disk to be well organized, informative, and easy to use. They particularly like the graphics, the campus map features ("Micro Facilities" and "Search and Find"), and the interactive quiz on software piracy. The major weaknesses that users identify are those of production errors, such as program bugs, out-of-date information, or inaccurate details. The major complaint of users is that too much of the information is provided as text. The single most controversial feature of the program is "Something Else," with respect to which users are almost evenly split. Some dislike it and think it should be removed. Others like it and think there should be more modules than there are.

Among the summative indicators of the success of the Drexel Disk are its longevity and its use as a model. Ver-

sion 1.0 was released in the fall of 1984, and version 4.0 was distributed to the incoming freshmen in 1988, along with their personal computers. An earlier version of the program was adapted, with greatly modified content, for use in the admissions office of a nearby liberal arts college. In addition, Drexel's Center for Co-operative Education undertook the development of a similar program to disseminate information to Drexel students. (Co-operative education is a plan whereby students spend several periods during their time in school alternating between 6 months of work in industry and 6 months of study in school.) Several features of the Drexel Disk are replicated in the Co-op Disk (Drexel University Center for Co-operative Education & Hewett, 1988). Most notable among these are the shallow menu structure, the provision of alternative ways of navigating through the information space, the inclusion of graphics, and the use of interactive quizzes.

Funded by a grant from the Department of Education, the first version of the Co-op Disk was distributed to all Drexel freshmen in January of 1988. Interestingly enough, some of the motivation for developing this particular program involved cost. Comparatively speaking, handing out diskettes to students costs less than handing out the printed brochures that previously had been used to disseminate much of the same information. In addition, now that the modified shell program has been completed and debugged, the Co-op Disk's contents can be updated fairly quickly with available resource-editing programs. Updating the contents of a printed brochure requires reprinting the entire brochure and discarding outdated copies of the old brochure. An updated copy of the Co-op Disk and its contents can be simply copied over the earlier copy.

Several unanswered questions about the effectiveness of the Drexel Disk remain. There are no firm data about its relative importance as part of the overall University training and support services—that is, there are no data about the frequency of the program's use or the patterns of its usage by individuals. There are two major reasons for this: a lack of money, and a lack of imagination. So far, no one has been willing to underwrite the expenses of a university-wide survey of students to ask the relevant questions about the use and efficacy of the program. Furthermore, it has not been clear how to otherwise develop a field test of a program that is intended for discretionary use, that allows for discretionary access to any and all of its contents, that has an anticipated life span of a few days to a few months, and that anybody can copy, or recopy, almost anywhere at almost any time.

## CONCLUDING REMARKS

In effect, the Drexel Disk is a hypertext guidebook that one can use with little or no Macintosh experience. The Drexel Disk also represents an example of instructional software as a tool. Although not strictly courseware, since it is not designed to support a particular course or group of course offerings, the program is nonetheless designed



for instructional purposes. Because control of the program is based on a limited number of actions or commands, no documentation is provided with the program, and none is required. In fact, one can navigate the complete structure and access its entire contents by using the mouse alone.

The program is transportable: the information on the disk is available to all who care to access it, and it may be used whenever or wherever the individual has access to a machine. The program is also multifunctional; both novice users and more advanced users can access the level of information they desire or need, ignoring information that is too sophisticated or unnecessary. Furthermore, users can do this while following access routes or paths appropriate to their expertise. New users can employ familiar commands and actions in the hierarchical menu structure to browse through the information space, gaining knowledge in the process. More experienced users who have browsed through some or all of the information structure and know what they are looking for have a series of "landmarks" to use in their search. Alternatively, they can simply activate the index and go directly to a desired location in the information structure. The provision of multiple redundant paths and hypertext linkages through the information structure eliminates the need for the user to choose or to recall only one specific path to a goal. In some cases, such as browsing the map, these linkages virtually eliminate paths entirely, because they bring the information directly to the user on demand.

More importantly, however, the Drexel Disk provides the user with a constrained knowledge space, which contains virtually anything one might need or want to know about the university in relation to the Macintosh. In fact, the program concentrates a tremendous amount of information into a single, small package. Furthermore, the program is in itself a tool for the exploration of the constrained knowledge space that it provides and structures. Since the user, not the program, determines the exploratory path at virtually all choice points, the program enables easy exploration of information but does not necessitate unwanted exposure. While the program structures the information by not allowing the user to follow all possible paths or linkages through the information, the selective inclusion of hypertext linkages within restricted domains allows the user almost complete freedom to explore within those domains.

It would appear that in this type of learning environment the major problems faced by the student will be those of developing an understanding of the structure and contents of the information provided, and of developing or maintaining the motivation to explore the information. It would appear that one major problem to be faced by the instructor-designer-architect who would create this type of learning environment involves the structuring and organization of the information so that the exploration and discovery of new, possibly unanticipated relationships is possible, natural, and encouraged, without causing the

user unnecessarily to get lost in exploration of spurious linkages or relationships. Part of the solution is to focus on providing "landmarks" and ways for the user to easily get to known or "visible" places in the information structure. Users do not have to be always aware of their current location in an information structure if they always know how to get themselves "unlost." Another part of the solution is to build in the hypertext linkages from the "bottom up," allowing only those linkages that naturally extend the questions or paths that users might need or wish to follow. For example, several blocks of information on the Drexel Disk do not contain hypertext linkages, simply because there seems to be little or no reason, either a priori or on the basis of user reactions, to believe that anyone would want to link directly from there to anywhere else not already provided for by the "Exit" and "Return to Index" commands.

A second problem for the instructor-designer-architect is user motivation. It is possible to provide students with a tremendous amount of usable and useful information that they may never know to be available unless they are motivated to look for it and to explore the various paths and linkages through the information. One way to enhance motivation for exploration involves developing a structure and a set of navigation techniques that encourage the user to explore freely, that create the confidence that one can easily get to a known and understood part of the information structure, and that convince the user that it is appropriate, even desirable, to risk getting lost or confused when the cost of an error is small and the rewards of discovery may be large.

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