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AN INTERACTIVE TRAINING AND REFERENCE PROGRAM  
FOR THE  
CANADIAN FOREST FIRE BEHAVIOR PREDICTION SYSTEM<sup>1</sup>

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**ABSTRACT:** The Canadian Forest Fire Behavior Prediction (FBP) System, developed by the Forestry Canada Fire Danger Group, was completed in 1991. The FBP System is a complex, empirical and theoretical system that uses fuels, weather, and topographic information to predict a variety of fire behavior characteristics including rate of spread, fire intensity, degree of crown involvement, and fire size and shape. Effective use of the FBP System by fire managers in their decision-making activities requires that individuals be familiar not only with the system's inputs and outputs but that they also have a thorough understanding of the underlying principles on which the system is based.

In general, fire researchers within Forestry Canada have supported and participated in traditional technology transfer activities such as: developing field references and decision-aids, conducting seminars and workshops, instructing at training courses, and assisting in field trials. Recent advances in technology have, however, made it possible to create a more comprehensive, innovative, and potentially effective training and reference program for the FBP System to complement and enhance common approaches to technology transfer.

The interactive training and reference program created for the FBP System was developed cooperatively by the University of Manitoba and the Canadian Forest Service. It is a comprehensive, highly visual, non-sequential, multimedia program that permits the principles and concepts of the FBP System to be explored in a manner that is driven by the user's curiosity. It was developed on a Macintosh computer using Aldus Supercard and incorporates features such as on-line help, dynamic graphical display, and the use of short video sequences. The system is currently at the beta test stage and illustrates the capability of this medium for creating effective technology transfer and training tools.

**KEYWORDS:** technology transfer, training, interactive, multimedia, fire behavior prediction

## INTRODUCTION

The Canadian Forest Fire Behavior Prediction (FBP) System (Forestry Canada Fire Danger Group 1992) is a complex empirical and theoretical system that uses fuels, weather, and topographic information to predict a

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variety of fire behavior characteristics. This system was developed by the Forestry Canada Fire Danger Group<sup>4</sup> and is one of four subsystems identified within the Canadian Forest Fire Danger Rating System (Stocks et al. 1989). The FBP System, which was released in an interim form in 1984 (Lawson et al. 1985), was completed in 1991 and is described in a detailed technical report published by the Forestry Canada Fire Danger Group (1992).

Effective use of the FBP System by fire managers requires that individuals be familiar not only with the system's inputs and outputs but that they also have a thorough understanding of the underlying principles on which the system is based. To ensure that this can occur, a significant emphasis must be placed on technology/information transfer. Traditionally, members of the Fire Danger Group have supported and participated in a wide variety of technology transfer activities. This has included the production of field references, workbooks, and operational decision-aids (e.g., posters, slide rules, etc.); conducting seminars and workshops; instructing at training courses; and assisting in field trials and implementation of new products. Recent advances in technology have, however, made it possible to develop interactive computer programs that can enhance traditional forms of technology transfer by making it more creative, comprehensive, and potentially more effective. Thus, in the fall of 1991 a project to explore the construction and utility of an interactive multimedia program for the FBP System was initiated. This paper describes the process used to develop the multimedia program and illustrates a few of its primary features.

## THE FBP SYSTEM

The FBP System is a complex mathematical model that contains in excess of 80 equations which relate 14 input parameters to 4 primary and 11 secondary outputs (Figure 1). Many of the relationships within the system are derived from an empirical data base consisting of information on 495 wildland fires (409 experimental fires and 86 well-documented wildfires), most of which occurred in Canada. Some aspects of the FBP System are, however, theoretical drawing upon the knowledge and experience of the Fire Danger Group members. The nested and inter-related aspects of the FBP System made it an ideal candidate for testing the capabilities of using a hypermedia based system for fire behavior training and information transfer.

## DEVELOPMENT OF THE INTERACTIVE MULTIMEDIA PROGRAM

Upon completion of the FBP System in 1991 a series of four 3-day workshops were conducted in various regions of Canada. Traditional lectures were used in combination with simple numerical calculations and operational exercises in an attempt to explain the fundamental aspects of the FBP System to potentially key users (e.g., fire behavior officers, duty officers, and training personnel). Upon completion of the workshops it was apparent that the FBP System was sufficiently complex that a standardized mechanism for technology transfer and training was required. Thus, development of a workbook that would complement the scientific report on the FBP System began (Hirsch 1994). The materials created for the technology transfer workshops and the workbook then served as a basis for the initial development of the interactive multimedia program for the FBP System.

The original reasons for undertaking the creation of the multimedia program were to determine whether such a program could:

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<sup>4</sup>Current members of the Fire Danger Group are: R.S. McAlpine -Chair (Petawawa National Forestry Institute), B.J. Stocks and T.J. Lynham (Great Lakes Forestry Centre), M.E. Alexander and B.S. Lee (Northern Forestry Centre), and B.D. Lawson (Pacific Forestry Centre). Also a major contribution to the development of the FBP System was made by C.E. Van Wagner who recently retired from the Petawawa National Forestry Institute.

- (a) be used as an educational tool by fire behavior instructors and in a self-learning environment, and
- (b) serve as a useful interactive reference for fire researchers and fire suppression staff involved with the daily use of the FBP System.

The project has been a joint effort of the University of Manitoba, Department of Computer Science and the Canadian Forest Service, Northern Forestry Centre. The development process itself was highly interactive and non-linear, consisting of the construction of conceptual units, evaluation by the development team, refinement, feedback and input from other potential users, and additional refinement. A particular challenge in the design phase was to ensure that the full capability of the available technology was utilized rather than simply creating a software version of existing materials. This required a truly inter-disciplinary developmental approach whereby many ideas were brought forward, evaluated, modified, and sometimes rejected. This process was made possible only because of the good communication and interaction between all members of the development team. A beta version of the program is currently being tested and production for use on other computing platforms is being considered.

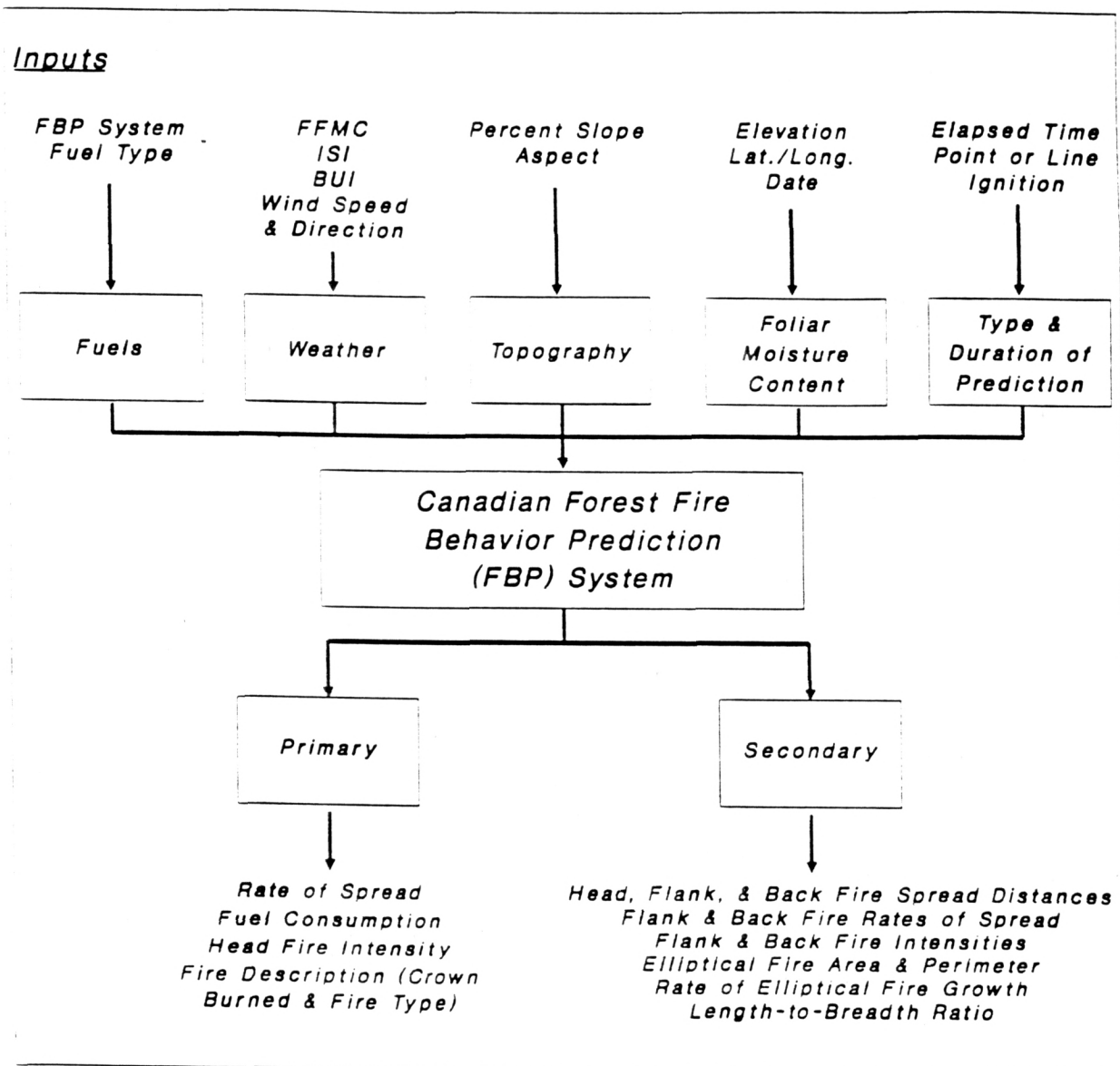


Figure 1. Structure of the Canadian Forest Fire Behavior Prediction System (adapted from Forestry Canada Fire Danger Group 1992).

# THE INTERACTIVE MULTIMEDIA PROGRAM

## General Features

The interactive multimedia training program for the FBP System was developed for the Macintosh computer with Aldus SuperCard being used as the primary multimedia vehicle. This hardware/software combination was chosen because it was ideally suited to the creation of a program that would meet the desired design criteria as specified below. A detailed discussion regarding the software design and development in relation to the complexity of the subject matter is presented in Hoskins et al. (1994).

The design criteria required to achieve the objectives of this project and to utilize the best aspects of the traditional instructional environment necessitated the multimedia system to be highly interactive, user-friendly, and comprehensive. It also had to have an attractive graphical interface, the capability to use both photographs and video, and had to avoid, if possible, a rigid hierarchical form. The incorporation of these features resulted in a program that allows the explorative examination of the principles and concepts of the FBP System to be driven by the curiosity of the user. For example, the user can investigate a topic at a superficial level or they can explore a particular concept right down to the fundamental equations and raw data used to construct a specific model.

## Examples

Discussion of all aspects of the multimedia program are beyond the scope of this paper. As well, the program is highly interactive and some of its features are difficult to depict in static presentation; however, the following examples are given in order to indicate the general style of the program and some of its basic features.

### Example 1 - Fuel Type Descriptions

Fuel type is one of the major inputs required by the FBP System to predict fire behavior. The FBP System has 16 general fuel types, which represent most of the major fuel associations found in Canada. Selecting an appropriate fuel type is an artful process and requires a good understanding of the composition, form, size, arrangement, and continuity of each fuel type in the system. To allow users to become familiar with the FBP System's fuel types, a "standard" photograph (De Groot 1993) of each fuel type is available in the program (Figure 2). In this window, the user has the ability to explore the various characteristics (i.e., stand, forest floor, organic layer, surface fuels, ladder fuels) of the fuel type, or through the distinctive features button, identify its key characteristics. A second photograph depicting the variation that can exist within a given fuel type can also be accessed using the variation button.

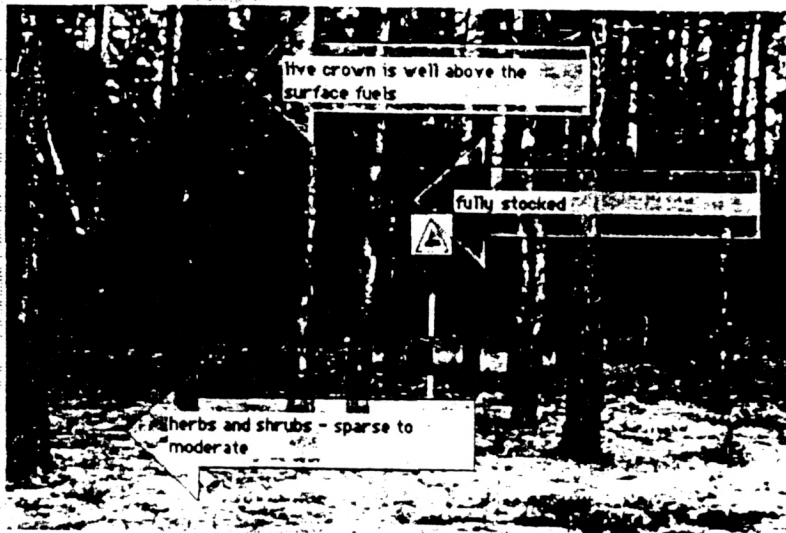
After examining each fuel type the user also has the opportunity to test their knowledge in the fuel type test module (Figure 3). This module consists of over 70 fuel type photographs that are accessed randomly and the user is required to choose the fuel type they believe is illustrated by the photo. Correct answers are rewarded with short applause and incorrect answers receive a brief quacking sound. Upon leaving the program the students score is tallied and displayed for their own information.

### Example 2 - Rate of Spread

In the FBP System the predicted rate of spread (ROS) is based on a fuel type specific correlation between the Initial Spread Index (ISI) and the ROS. The basic ROS relationship can then be adjusted according to the slope (steepness and direction) and increasing fuel availability (as indicated by the Buildup Index (BUI)). The calculation process is relatively complex, involving over 20 separate equations in some instances. The multimedia program permits the detailed investigation of each step required to calculate ROS; however, more importantly the user can

## C-3 Mature Jack or Lodgepole Pine

### Standard



Distinguishing Features



Variation



Figure 2. A window within the multimedia program illustrating the distinctive features of the Mature Jack or Lodgepole Pine (C-3) fuel type.

dynamically and interactively explore the impact that changing the input parameters has on the output values (Figure 4). In this interactive environment the user simply has to position a dot at a desired point on the graph and the associated ROS value is calculated. If necessary, the original data on which the relationship was based can be viewed.

### Example 3 - User-friendly Help Features

The multimedia program is not only interactive but also extensive. This is illustrated by the fact that detailed information can be stored in the program and accessed by the user when required. For example, Figure 5 shows the glossary of abbreviations and acronyms that can be accessed through the help menu. In this window, the full name of each parameter is provided, and if selected the user can see the actual equation for the term. Also available in the help menu are a conversions calculator permitting values in one type of measuring system to be converted to another (e.g., m/min to chains/hour), and a soft copy of the entire FBP System technical report as produced by the Fire Danger Group (1992).



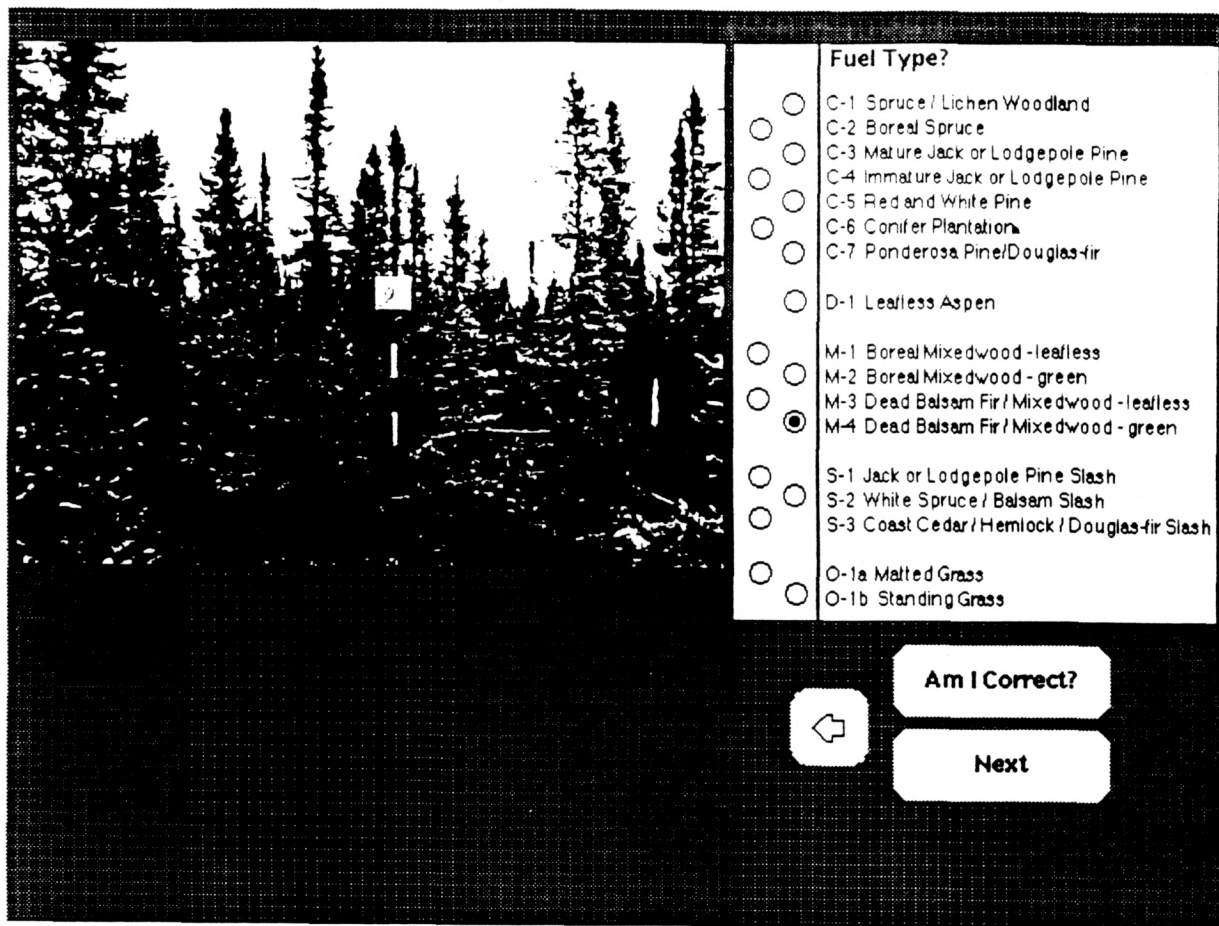


Figure 3. An example of the multimedia programs's fuel type quiz module.

There are three other interesting features of the multimedia program that cannot be exemplified in this paper. They are:

- (1) the interactive calculation of all intermediate and final FBP system outputs based on input data entered by the user,
- (2) the ability to dynamically plot curves or simple elliptical fire shapes based on a set of user designed inputs, and
- (3) the use of short video sequences to illustrate different rates of fire spread and fire intensities.

### CONCLUDING REMARKS

In working with the multimedia program, it has become apparent that this type of program should be used to complement or enhance current methods of technology transfer and training rather than replace them. For example, with this program a fire behavior instructor will be able to present scenarios interactively (say through a computer projection system) and dynamically explore the various aspects of the FBP System based on input from the students. As well, exercises can be created where students working in groups will be able to examine for themselves how a particular function within the FBP System works and reacts. Use of this program in conjunction

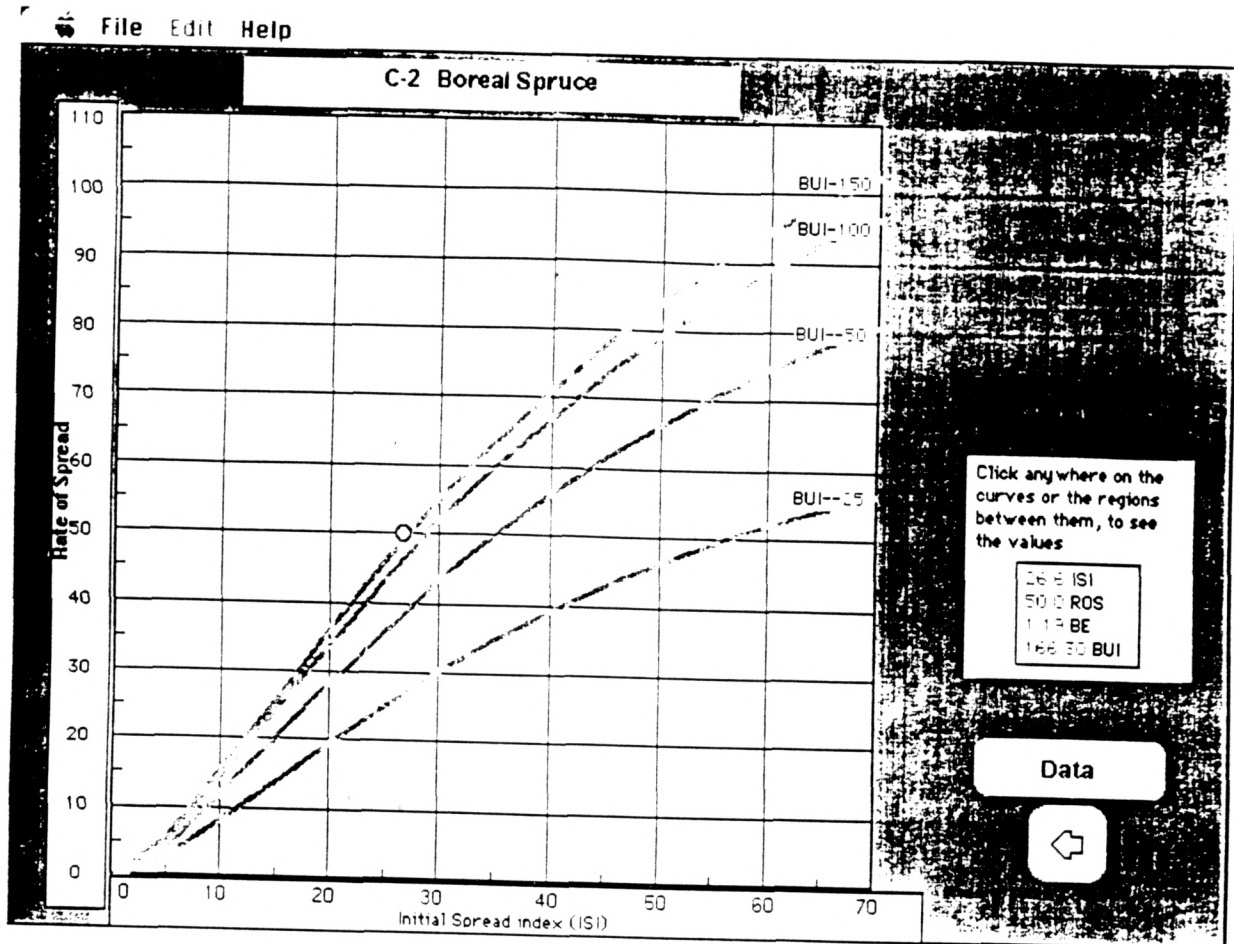


Figure 4. The relationship between the Initial Spread Index (ISI), Buildup Index (BUI), and the rate of spread (ROS) for the Boreal Spruce (C-2) fuel type as presented in the multimedia program.

with a student workbook on the FBP System is also possible in a self-learning environment, and because of the comprehensive nature of the program it serves as an excellent detailed reference on the FBP System.

The prototype development stage of this project has illustrated that it is possible to create an interactive multimedia training and reference program for a relatively complex and non-sequential topic. The use of the FBP System as the subject area for this project has pushed available technology to its limits; however, there is hardware and software now available that makes the creation of such programs possible, affordable, and enjoyable. This project has also resulted in the desire to investigate other uses of this medium to document and analyze various types of fire research information (e.g., temporal information, video footage, photographs, verbally recorded observations, etc.) in an interactive, simultaneous manner.

#### ACKNOWLEDGEMENTS

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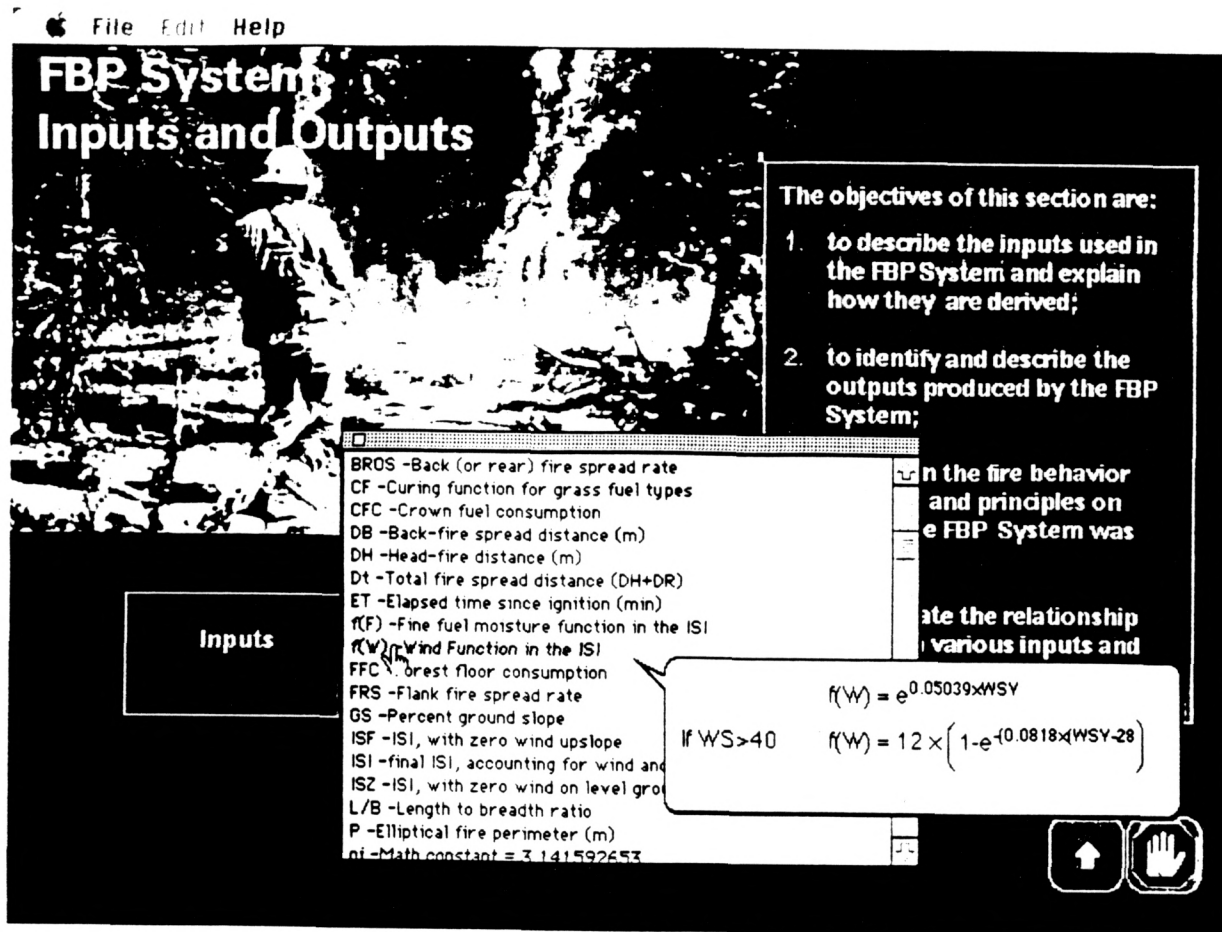


Figure 5. An example of the glossary "help" feature available within the multimedia program.

#### LITERATURE CITED

- De Groot, W.J. 1993. Examples of fuel types in the Canadian Forest Fire Behavior Prediction System. For. Can., Northwest Reg., North. For. Cent., Edmonton, Alberta. Poster (with text).
- Forestry Canada Fire Danger Group. 1992. Development and structure of the Canadian Forest Fire Behavior Prediction System. For. Can., Ottawa, Ontario, Inf. Rep. ST-X-3.
- Hirsch, K.G. 1994. A workbook for the Canadian Forest Fire Behavior Prediction System. Dept. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, Alberta (in preparation).
- Hoskins, J.A.; Hoskins, W.D.; Hirsch, K.G. 1994. An Interactive multimedia system for fire behavior training. Pages XX-XX in SAC '94, Fayetteville, Arkansas, March 6-8, 1994. ACM Special Interest Group on Applied Computing. (in press).
- Lawson, B.D.; Stocks, B.J.; Alexander, M.E.; Van Wagner, C.E. 1985. A system for predicting fire behavior in Canadian forests. Pages 6-16 in Proc. 8th Conf. Fire For. Meteorol., Detroit, MI, April 29-May 2, 1985. Soc. Am. For., Bethesda, MD. SAF Publ. 84-04.
- Stocks, B.J.; Lawson, B.D.; Alexander, M.E.; Van Wagner, C.E.; McAlpine, R.S.; Lynham, T.J.; Dube, D.E. 1989. Canadian Forest Fire Danger Rating System: an overview. For. Chron. 65:258-265.



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