NRC FORM 426A (2-79) NUCREM 1201

U.S. NUCLEAR REGULATORY COMMISSION

PUBLICATIONS RELEASE FOR UNCLASSIFIED NRC CONTRACTOR AND CONSULTANT REPORTS

(Please Type or Print)

1. REPORT NUMBER *(If any)*: EGG-M-3 785

Obtain in advance from Division of Technical Information and Document Control

2. DISTRIBUTION CATEGORY NO. *(If any)*

Insert appropriate number from the NRC Distribution Category List (see NUREG-0550)

3. TITLE AND SUBTITLE *(State in full as shown on document)*

A General Data Base Driven Graphic Animation System

4. AUTHORS *(If more than three, name first author followed by "and others")*

Kenneth D. Russell, Howard D. Stewart, Nick Curtis

5. NAME OF CONTRACTOR: EG&G Idaho

MAILING ADDRESS *(Number and street, city, state and zip code)*: P.O. Box 1625, Idaho Falls, ID 83415

TELEPHONE NO.:

6. DATE MANUSCRIPT COMPLETED:

7. NRC PROGRAM SPONSOR/TECHNICAL MONITOR: FUAT ODAR

TELEPHONE NO.:

8. CONTRACT DATA

a. CONTRACT OR FIN NUMBER *(Do not list DOE contract number)*: A6343

b. IF CONTRACTOR IS AUTHORIZED TO PRINT, PLEASE PROVIDE THE FOLLOWING INFORMATION

Number of Copies Printed	Estimated Composition Cost	Estimated Printing Cost

9. TYPE OF DOCUMENT *(Check appropriate box)*

- [ ] a. TECHNICAL REPORT
  - (1) FORMAL
  - (2) INTERIM
- [x] b. CONFERENCE PAPER
  - (1) TITLE OF CONFERENCE PAPER: A General Graphics Animation Tool
  - (2) DATE(S) OF CONFERENCE: May 19-22, 1986
  - (3) LOCATION OF CONFERENCE: Anaheim, CA
- [ ] c. OTHER *(Indicate type of item, e.g., thesis, speech, journal article, guide, etc.)*

10. SPECIAL DISTRIBUTION *(Send all copies to the Distribution Services Branch, Division of Technical Information and Document Control.) (Specify special instructions such as "Make available only as specifically approved by program office." or "Send to attached addressees." Submit addressed mailing labels for special distribution. Continue instructions on reverse or separate sheet if necessary.)*

11. PATENT CLEARANCE *(If applicable)*

Forward completed, signed NRC Form 426A together with the related documents for review, TO: Appropriate Patent Counsel

- [ ] a. PATENT CLEARANCE NOT REQUIRED
- [XX] b. PATENT CLEARANCE GRANTED
- [ ] c. PATENT CLEARANCE DENIED

d. PATENT COUNSEL'S SIGNATURE | DATE

12. SUBMITTED BY

a. NAME OF AUTHORIZED CONTRACTOR OFFICIAL OR NRC MONITOR *(Type or print)*: D. J. Claflin

b. OFFICIAL'S ORGANIZATIONAL UNIT: Publications Processing - EG&G Idaho

c. SIGNATURE *(Authorized contractor official or NRC Monitor)*: D J Claflin | DATE: 01-07-86

Howard D. Stewart, Kenneth D. Russell
and J. Nick Curtis
Idaho National Engineering Laboratory
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415

ABSTRACT

Most attempts at the graphic animation of data involve rather large and expensive development of problem-specific systems. This paper discusses a general graphics animation system designed to be a tool for the development of a wide variety of animated simulations. By incorporating device-independent graphics procedures and using relational database storage of graphics and control information, considerable flexibility in the design and development of animated displays is achieved.

INTRODUCTION

The graphic animation of time series data at the Idaho National Engineering Laboratory (INEL) has greatly enhanced the analysis capabilities of many scientists and engineers. The system developed to perform these animations is called NECTAR. This system was developed by a team of scientists, engineers, and computer analysts from EG&G Idaho, Inc. It is written in FORTRAN 77 and currently being run on two CDC (Control Data Corporation) 176 computers at the INEL. It is now widely used at the INEL and is also used increasingly at other sites.

The NECTAR system began as the Nuclear Plant Analyzer (NPA). It was originally designed to be used by the Nuclear Regulatory Commission (NRC) for the analysis of nuclear plant data produced by large modeling codes.[1] It was soon realized that a general purpose graphics animation system would be a valuable analysis tool for any type of time series information.[2] The NECTAR system was designed, therefore, to accommodate data from many sources. This system may graphically animate historical data ("replays") or data which is being produced concurrent with the animation ("simulations"). The latter type of graphics animation allows real-time manipulation of simulation codes while observing the results in full color on a high resolution graphics monitor.

A GENERAL GRAPHICS ANIMATION TOOL

The NECTAR system represents an improvement over many conventional graphics animation systems because of the diversity of the data to which it can be applied and because of its adaptability to various display devices.

Data Independence

Many existing systems graphically display and/or animate information from predefined sources. These systems are fixed in the sense

a. Work supported by the U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research under DOE Contract No. DE-AC07-76ID01570.

lists for the relations are fully inverted and use the B*-tree algorithm. Many other support utilities, such as recovery, rebuild, access path optimization, and data structure changing functions, are also offered. Overall, this database system has proven to be very effective in NECTAR.

Database Support

The data in this system include the background pictures stored in a device-independent format, the drivers used to animate the data, information required to compute time series data using modeling codes, historical data acquired from many different sources, and an assortment of tables and associated information.

A database editor is an integral part of NECTAR and allows editing of new and existing database information within the relations of the database. Each analyst may also choose to create his own personal database area. The integral editor allows migration of information between database areas. When an analyst chooses to review a replay or initiate a simulation, the main database or an individual's personal database is presented for review and selection as requested by that analyst.

DESIGN AND IMPLEMENTATION

NECTAR was designed to accommodate users having varying levels of experience. It can be used in conjunction with many different modeling codes without imposing unnecessary restrictions on their size. By executing a simulation, it can generate new data; this data can in turn be saved for later review in the execution of a replay. Simulations and replays are executed using a building block concept employing pictures, drivers, and maps.

Analyst Use

NECTAR is a system composed of many processors whose execution is controlled by an executive processor that minimizes the interaction required of the analyst (see Figure 1). This system uses a combination of hierarchical menus and fill-in-the-blank forms to interact with the analyst.

Since the NECTAR system was developed to offer a great many options to the analyst, it became necessary to provide assistance with its use. As an option or command is given by the user at any level, it is compared against the available options at that level. If it is not immediately recognized, an extensive process of analysis is performed by the system to determine possible abbreviations or misspellings. If a valid abbreviation is detected, it is used. A suggested option is presented to the user if any uncertainty exists within NECTAR concerning the request. If the user entering the option is still uncertain, help and/or training may be requested.

A "help" database is used to give aid whenever required and to even lead the new analyst through an online training course if requested. Since this help information is stored within the data base, it may be changed and added to as conditions require. This help is available anywhere within the system by simply typing the "?" key. An editor is provided which allows a data technician to modify or add additional training or aids at any level. This alleviates the problems that would occur if user assistance were included within the computer program itself and needed to be changed by a NECTAR system programmer. It also helps to keep the assistance current with the latest NECTAR features while greatly increasing the confidence of the new user. Since current documentation for any large system such as NECTAR may not be immediately available to the user, this online documentation, assistance, and training has proven to be extremely useful.

processed by the NECTAR system through these supplied routines. Each command is recognized and interpreted by the code being executed, and the required adjustments are then made to the simulation by that code. NECTAR simultaneously monitors computed output from the code and reflects the changes in the current graphics display.

Since each modeling and simulation code is different, the commands and keys that each recognize during execution vary as well. NECTAR provides the analyst developing the simulation deck the capability of storing code-specific keys or commands with the associated commands recognized by another user and the NECTAR system. Additional help information for the use of each command is also stored for possible review by another user during execution of the simulation. This feature allows many different modeling codes to be used in the NECTAR system and to appear as integral parts of that system even though they have been independently developed. It also allows other analysts to use a specific modeling code even though they may have little or no experience with its execution.

When a simulation is completed, the generated data may be stored as a historical replay within the system's database for later review and analysis. The review of replays in the NECTAR system is a relatively inexpensive process with much smaller CPU requirements than a real-time simulation.

Simulations and Replays

A graphics display is stored in NECTAR as a simulation or a replay. A simulation generates data concurrent with graphics animation using simultaneous execution of a simulation program and the NECTAR system. A replay graphically animates historical data from one of many different sources. Each type of animation has its distinctive advantage. Analysts at INEL use the simulation capabilities to produce and animate nuclear plant information while changing various physical parameters of that plant.[5] These capabilities may be used to simulate a nuclear accident, train nuclear plant operators to respond to various situations,[6] or allow engineers to analyze features of a plant. Replays are being used to repeatedly review previous simulations or actual experimental data obtained from tests and even to compare this data with theoretical data. Another advantage of the replay of animation data is the capability to jump from one point in time to another if required. Of course, the data can not be changed as with a simulation.

To enhance a simulation or replay, many different pictures and graphics drivers may be associated with each. This allows the possibility of many different views of the same data. For example, at INEL, a popular animation of a nuclear plant includes a picture and driver of the total plant schematic with its associated liquid levels, flows, pressures, etc. (see Figure 2); a display of the operator's console, including animated graphs, meters, and strip charts (see Figure 3); and a close-up of the steam generators with animated levels, temperature and pressure values, changing colors, condensation representations, and water droplets (see Figure 4). The analyst may quickly flip from one picture with its animated features to another during the course of a simulation, or replay to get a better understanding of a complete problem.

Pictures

Graphics displays are stored in three associated relations of the database. The first is the picture, which is a device-independent representation of the static background display to be presented on a graphics terminal. These device-independent commands stored in the database are retrieved and converted to device-specific commands prior to being displayed on the requested graphics terminal. Since several high resolution graphics terminals are supported by

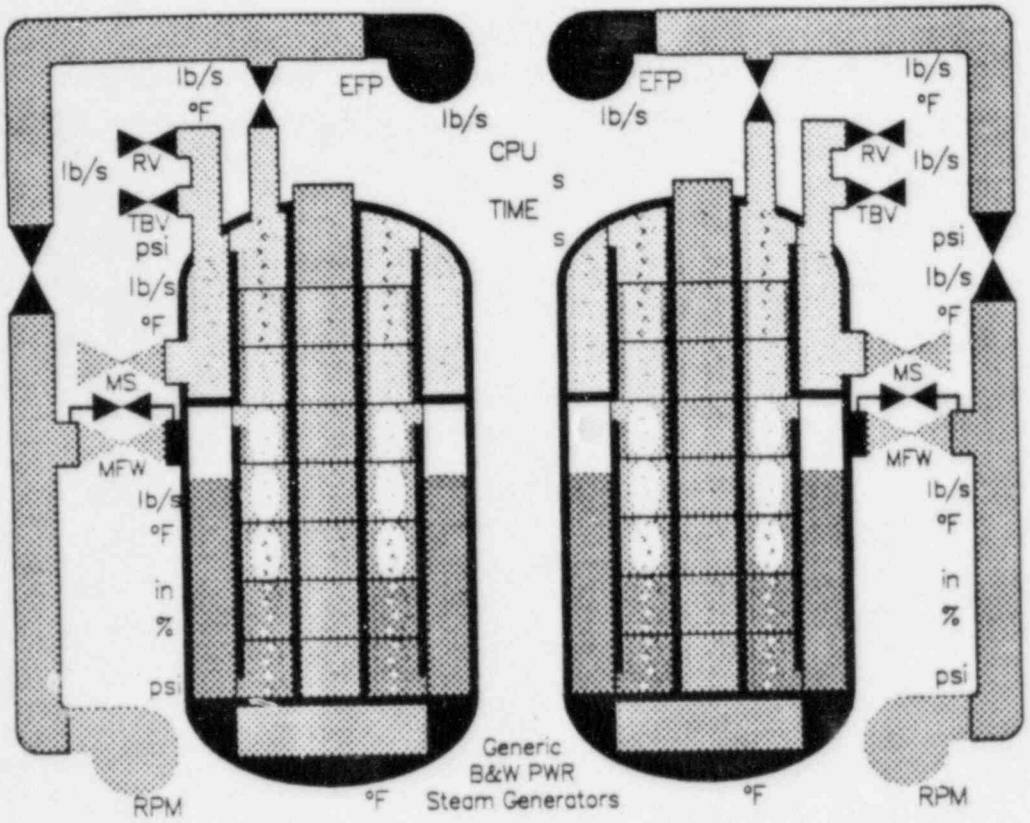

Figure 4. Schematic of once-through steam generators depicting flow regime status.

NECTAR, the system has the capability of converting this graphics information to each format. These pictures are in full color with a possibility of extremely high resolution, depending upon the capabilities of the graphics terminal being used. One of the most common graphics terminals used by NECTAR at the INEL and elsewhere is the Tektronix 4115B color-graphics terminal. This terminal gives excellent resolution and color representations.

The NECTAR system incorporates an interactive graphics development system called the Cyber Visual System (CVS) to allow creation and editing of the pictures. This system is a product of EG&G Idaho, Inc., at the INEL. The CVS allows the analyst to use a graphics terminal and connected graphics pad and to select icons and simple menus to create and/or manipulate pictures quickly and easily. Each final picture is stored in the NECTAR system's database when completed.

Drivers

The second important part of a display is the driver. The driver defines locations and methods of animating the static picture. It is composed of two parts. These are (a) the driver identifier, the characteristics, and a list of required types of data, and (b) the instructions used to animate the picture using the required data. The instructions are written in FORTRAN 77 and stored as capsules on a library to be retrieved and used when the driver is requested and the picture has been presented on the screen. A tool to help develop and test temporary drivers is incorporated in NECTAR. Each

5. J. N. Curtis, H. D. Stewart, et al., "Process Monitoring and Simulation Code Verification Using Interactive Computer Animation," Proceedings of the Third Annual Control Engineering Conference, Rosemont, Illinois, May 1984.

6. R. J. Beelman and J. N. Curtis, "Interactive Operator Guideline Evaluation Using RELAP5," First Proceedings of Nuclear Thermal Hydraulics, 1983 ANS Winter Meeting, San Francisco, California, November 1983.