BCS IMPLEMENTATION OF THE SDRC GRAPHICS SYSTEM

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Abstract

A BCS software development project currently under way will result in a unique implementation of the SDRC Graphics System (SGS). SGS includes SUPERTAB, which is an interactive graphics processor which creates finite element geometry, node and element loads, and boundary conditions. It also includes OUTPUT DISPLAY for postprocessing of NASTRAN solution results. The BCS software supports input to SGS by means of a command board consisting of a preprinted command menu mounted on a digitizing tablet. The menu contains the entire SUPERTAB and OUTPUT DISPLAY command repertoire. SGS is controlled by a succession of picks from the command board. In addition, two display screens are utilized, with graphics and labelling information written to a high resolution storage tube device, and textual information to the color raster screen.

Objectives

The work described herein is part of an internal development effort currently being undertaken at BCS. The overall objective of this effort is to improve engineering productivity for NASTRAN analysis, by improvements to the user interface. The user interface is defined as the environment in which the user interacts with the computer. It includes the dialog which occurs between the user and computer, as well as the input/output devices by which the user communicates with the computer.

It was intended that the system have value for a broad range of structural engineering users, and that it be easy to learn. In addition to supporting NASTRAN, the same user interface was to be offered for ANSYS, STRUDL and STARDYNE. The hardware was required to be relatively inexpensive, with the capability to grow with the needs of the engineering organization. Since engineering analysis normally occurs over a brief but intensive period during the life of an engineering project, the system had to be relatively easy for engineers to relearn after periods of not being used.

Approach

The requirement to support a wide class of users led to the adoption of a distributed processing approach. This was perceived to provide the greatest flexibility in matching computing power to the needs of individual engineering projects. In this context distributed processing can

be characterized as: (1) the user interface provided locally on a minicomputer, (2) the analysis programs supported, maintained and executed on a central mainframe computer, and (3) an efficient means for communicating data between the two systems.

The subject of this discussion is the creation of an improved user interface to finite element model preparation and output processing. Areas of particular concern were the form of the dialog between the user and the minicomputer, the input and display devices used, and the amount of training required to effectively use the system.

It was intended to make use of specific features offered in the minicomputer environment which have not until recently been widely exploited. This includes the ability to use multiple input/output devices, and to concurrently execute multiple programs which interact with each other in a realtime environment.

It was recognized that significant technical capability already exists in the form of interactive graphic finite element modeling software. This dictated that the modeling capability itself should be acquired rather than developed, allowing more effective use of resources. These resources could be applied to the development of the user interface to complement the functionality which could be acquired from the marketplace.

The SGS Graphics System

A number of finite element input and output processing programs were considered to be adaptable to meeting the objectives of this project. The SDRC Graphics System (SGS) was selected, and was obtained through a license agreement with Structural Dynamics Research Corporation.

SGS supports preand postprocessing for a variety of analysis programs, including NASTRAN, ANSYS, STRUDL and STARDYNE. It consists principally of two programs, SUPERTAB and OUTPUT DISPLAY. SUPERTAB is an interactive graphics finite element model preparation program. OUTPUT DISPLAY is the postprocessing complement to SUPERTAB, providing deformed geometry, mode shape and stress contour displays. An ancillary program, DATA LOADER, is used to convert the output of NASTRAN, ANSYS, STARDYNE and STRUDL into a form readable by OUTPUT DISPLAY.

SGS has a broad existing user base, including aerospace, automotive, mechanical and architectural/engineering disciplines. It supports both raster color and high resolution storage tube graphics and operates on a variety of miniand mainframe computers, including those of particular interest to this project: the PDP 11/23 microcomputer and the VAX 11/750 minicomputer.

Current SGS User Interface

Interactive control of SGS is by means of a hierarchical command language. Commands are entered either by keying in character strings, or by keying in line numbers corresponding to lines displayed on dynamic sub-menus appearing in the refresh buffer region of the Tektronix screen.

Operation of SGS requires that the menu tree structure and command hierarchy be observed when proceeding from one operation to another. SGS command input is organized into a series of tasks and subtasks, each related to a specific function in model building or output processing. For data creation via SUPERTAB, the Geometry Definition task supports the development of structural models in terms of geometric primitives such as points, lines, arcs, surfaces and volumes. Another task, Mesh Generation, creates finite element networks over this geometric definition. Alternatively, the Model Preparation task allows the explicit creation and generation of nodes, elements, coordinate systems and boundary conditions. Other tasks relate to control of graphic display and to the reading and writing of files. For processing analysis results using OUTPUT DISPLAY, deformed geometry and contour mapping tasks manipulate output data for graphic display.

A Tektronix 4014 terminal or a raster color graphics terminal serves as the input/output device for user dialog and graphic display. Dialog text and graphic displays are written concurrently to the terminal. A large digitizing tablet, connected to the Tektronix 4014, can be used to input geometry data directly from engineering drawings.

The use of a single device for input and output permits SGS to operate on a variety of different miniand mainframe computers using a standard graphics terminal. There is minimal dependency upon the terminal configuration.

Enhancements to SGS

Enhancements made to SGS were designed to take advantage of that fact that in a minicomputer environment multiple input and output devices can be assigned to a single user. The enhancements to SGS consist of replacing a standard graphics terminal with two display devices, a command board and a keyboard. A specially developed program, the Command Interface Program, provides the software interface between SGS and these input/output devices.

Additionally, a large digitizing tablet connected to the Tektronix 4014 can be used to input data directly from engineering drawings, similar to the standard implementation of SGS.

Display Devices

The need to overlay graphics and command text is precluded by the use of two display devices, permitting physical separation of graphical from textual information. The need to frequently redraw the graphic image is eliminated because dialog text no longer accumulates on the graphic display.

The user may choose between high resolution storage tube or color raster graphic display. If high resolution graphics is selected, the Tektronix 4014 is used to display graphic output. The DEC VSV/11 color raster display is used for the dialog text, which scrolls off the top of the screen as more text is added at the bottom. As with the conventional implementation of SGS, the Tektronix graphics display also supports the animation feature available with OUTPUT DISPLAY.

Alternatively, the user may choose to direct the graphic output to the color display. In this case graphics and text are displayed on two different image planes of the color monitor; however, they are logically separate. That is, although the color graphic image remains static, the text still scrolls off the top of the screen. The user may selectively erase either the graphics or the dialog text, leaving the other information unchanged.

Command Board

Input to SGS is primarily by means of a command board, which consists of a preprinted menu of commands, 13 inches square, mounted on a small digitizing tablet. The command board frees the user from the mechanics of command input, from dependence upon the keyboard as an input device, and from concern about the structure and organization of the command language. Using the command board, the user points to the operation to be executed, rather than entering a keyboard command in the form required by SGS.

The menu contains the entire SUPERTAB and OUTPUT DISPLAY command repertoire. The menu itself is printed with color coding of commands and laminated in plastic. It is permanently mounted beneath the tablet frame, creating a durable work surface. The menu is divided into functional regions, each identified by a characteristic color. The major regions are: data creation, definition of sets of entities upon which operations are performed (grouping), graphic display manipulation, SGS processing control (including file reading and writing), and output processing.

In addition, there is a menu region containing "continuation" options, or command modifiers. Many of the SGS operations require modifiers appended to them to comprise a single command. For most of these operations the set of modifiers is the same. The continuation area contains these modifiers. When an operation which requires a modifier

is picked, another pick is made from the "continuation " region. Once this second pick is made, the command is actually sent off to SGS for execution. Having a single command specified by a double pick enables a significant condensation of all possible commands into a set which can easily be contained on the preprinted menu.

SUPERTAB and OUTPUT DISPLAY have a large set of commands in common. All viewing and entity set definition commands are available in each program. With this overlap it was possible to include the full functionality of both SUPERTAB and OUTPUT DISPLAY on the command board without crowding.

A major feature of the command board is the automatic traversal of the menu tree. The user need not be concerned about the hierarchical command structure or his location in the command tree. The Command Interface Program keeps track of the currently active task, and where the user is on the command tree within that task. When any command is picked, the software determines whether it needs to request SGS to change the active task. It also determines where the picked command lies within the command tree for that task, and branches to it before executing the command.

The Command Interface Program permits the alternate use of either the command board or the keyboard for command or data entry. The user can arbitrarily switch between either of these devices at any time. When one input device is activated, the other is automatically locked out until SGS is ready for the next input stream. Since numerical data is often entered during the course of an SGS session, a numeric keypad is included as part of the command board.

Because there are multiple devices with which the user interacts, the Command Interface Program sends an audible signal to the user when the system is ready for input. This signal can be toggled off if desired.

Implementation

The ability to have several programs executing simultaneously, interacting with each other, makes it possible to implement the enhanced user interface without the necessity of modifying the SGS software. In effect, it appears to SGS that it is operating in dialog with the user using a conventional terminal. In fact it is communicating with the Command Interface Program, which receives and processes SGS prompts, and creates and sends commands and data input to SGS. The ability to substitute a software for a terminal interface allowed considerable flexibility in developing a user interface which is independent of the form of the SGS command structure. In principal, any command and data input form passed to SGS through the Command Interface Software would work, as long as the input can be translated into equivalent keyboard commands recognizable by SGS.

Output from SGS is written to two separate logical units, one for graphics and one for dialog, although in conventional implementation these units are assigned to the same physical device. This enabled the graphics output to be assigned directly to the graphics device, and the dialog information to be intercepted by the Command Interface Program.

All this is accomplished without modification to SGS, so that a special version of this system does not have to be maintained.

Acknowledgement

Stan Mitchell of the BCS graphics group developed the device drivers which linked SGS to the Command Interface Program, and otherwise provided key assistance in making this concept operational.

DESIGN CONCEPT

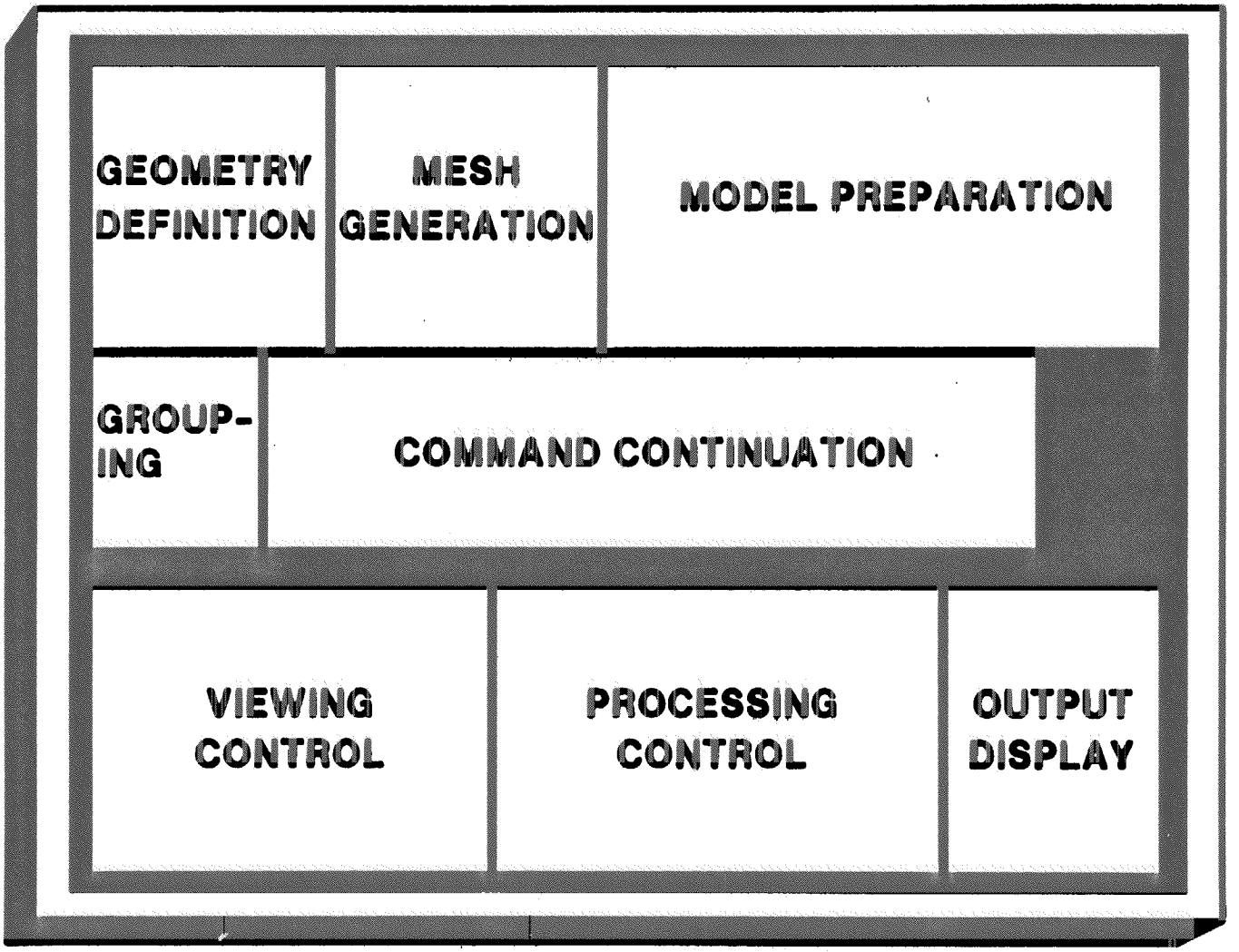
- USE EXISTING FINITE ELEMENT GRAPHICS PROGRAM
- REDUCE USER MANUAL TO ONE PAGE
- ELIMINATE KEYBOARD COMMAND INPUT
- DISPLAY GRAPHICS AND DIALOG ON SEPARATE SCREENS
- DON'T MODIFY EXISTING GRAPHICS PROGRAM

INPUT

COMMAND BOARD

- PREPRINTED MENU
- USER POINTS TO COMMAND ON MENU
- MENU PICK TRANSLATED TO EQUIVALENT SGS KEYBOARD COMMAND
- AUTOMATIC TRAVERSAL OF MENU TREE

COMMAND BOARD



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OUTPUT

- GRAPHICS SCREEN
  - HIGH RESOLUTION STORAGE TUBE, OR
  - COLOR RASTER
- DIALOG SCREEN
  - DIALOG SCROLLS OFF TOP

IMPLEMENTATION

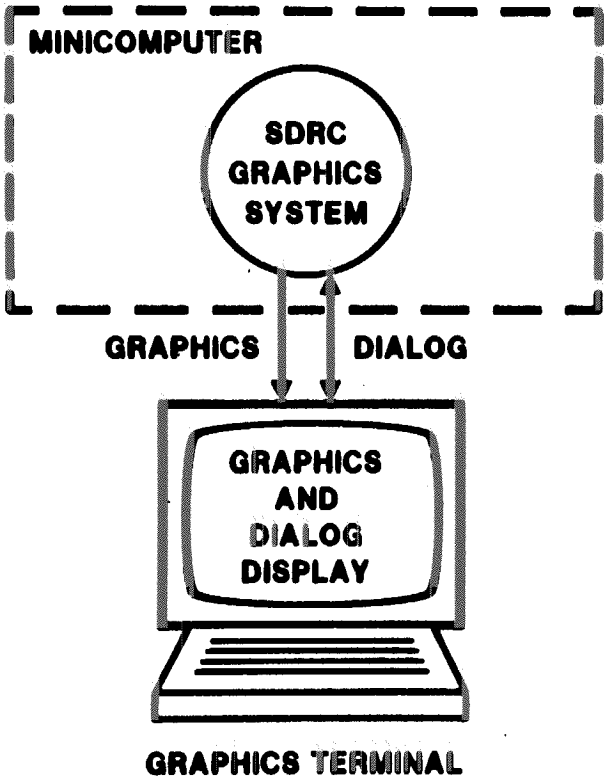
REPLACE:

- STANDARD GRAPHICS TERMINAL

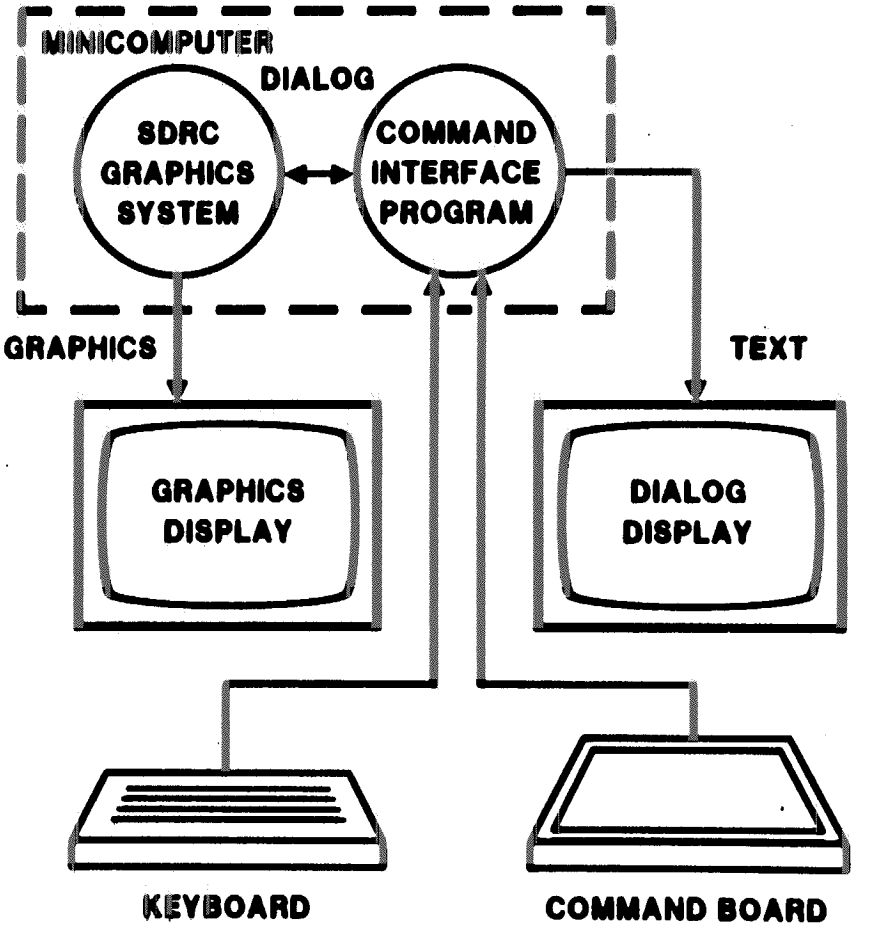
WITH:

- COMMAND INTERFACE PROGRAM
- TWO DISPLAY SCREENS
- COMMAND BOARD
- KEYBOARD

USER INTERFACE CONFIGURATIONS



ORIGINAL



ENHANCED

RESULTS

- STREAMLINE THE COMMAND INPUT PROCESS
- ELIMINATE ACCUMULATION OF TEXT ON GRAPHIC IMAGE
- MINIMIZE RELEARNING
- SEE THE FOREST AND THE TREES