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DEVELOPMENT OF THE REACTOR SAFETY FILM

by

Nancy N. Sheheen

ABSTRACT

This paper summarizes the text and describes the processes followed to develop the first computer-generated film of LASL's Reactor Safety efforts. The 11-1/2 min film with narrative and musical background gives a brief overview of reactor components, of how LASL's Reactor Safety groups develop and verify computer codes to anticipate accidents, and of how these codes were applied to the Three Mile Island accident.

I. INTRODUCTION

In August of 1978, the Public Relations group of the Los Alamos Scientific Laboratory (LASL) contacted four divisions and requested participation in an exhibit for the Seventh Annual Energy Technology Conference to be held in Washington, D. C. in March of 1979. The four divisions, L (Laser Research and Technology), G (Geosciences), Q (Energy), and CTR (Controlled Thermonuclear Research), are actively involved in various energy research projects. Subsequent meetings were held to define the audience, the schedule, and the scope of our presentations; in others, we presented an overview of the Nuclear Safeguards, Reactor Safety, and Energy Technology work in Q-Division.

From these discussions, it became clear to us that the Q-Division Reactor Safety work could not be communicated sufficiently by sample equipment or posters with captions. The Reactor Safety staff are engineers and computer scientists who develop, verify, and apply large and sophisticated codes using the world's largest and fastest computers for the evaluation of postulated

accidents as well as actual occurrences in nuclear reactors. Our findings subsequently are transferred to the Nuclear Regulatory Commission (NRC) for guidance in developing and assessing licensing guidelines for the safety of the reactors. The code verification effort is ongoing as users or the NRC identify areas of further development, or as findings from experimental facilities become available. We therefore determined that the best medium for communicating our message was by using LASL computers to develop a visual presentation.

Visual sequences had often been used by the reactor safety analysts for presentation of technical data; however, these presented only singular concepts and were limited to highly technical presentations. No attempts had been made within the effort to develop computer-generated technical material into an educational form.

Two very creative FORTRAN programs had been written for the LASL computers that we were able to use. The MAPPER program was well known within our groups and was employed for graphs and slides. We also decided to use ANIMATE, a program developed by David A. Dahl and Kenneth Rea (of H-8) to add more capability to MAPPER. ANIMATE permitted MAPPER coordinates and vectors to be varied by time and frame. Thus, movement, split screen, rolls, scrambling of letters, and similar "tricks" could be used to enhance the visual depiction of material. David Dahl instructed us on how to use ANIMATE and Billy R. Claybrook of PUB-4 gave us guidelines on motion picture production, FR-80 resolution (1024 x 1024), and video resolution (512 x 512) as our working parameters.

II. DEVELOPMENT

The personnel committed to the development of the film comprised a technical writer, a graphic artist, a senior programmer, and a data analyst. The two programmers began learning ANIMATE while the script was written.

Our first intention had been to develop a 3-5 min film with eye-catching color and unique music background similar to the original ANIMATE film. However, as Reactor Safety personnel evolved the outline and details to be covered, this became impractical.

The script required numerous rewrites and modifications to ensure comprehensive coverage and technical accuracy. This made it difficult to prepare a "flow diagram" for development of the graphics. In addition, the computer

personnel were under great pressures because of conflicting demands on their time and on computer usage. This problem was never really resolved; concessions simply were made on all sides as crises arose to accommodate pressing project deadlines. When we felt the script was approaching final form, we prepared a flow chart that identified visual effects for the script. The artist graphed still sequences so that the coordinates could be measured easily. We also used the graphics tablet for frames too difficult to plot (see Fig. 1). We then recorded the script so that the visual sequences could be synchronized to the narrative.

III. MAJOR PROBLEMS

Several problems required resolution from the outset. First, ANIMATE had been written for the NOS system. Our programmers determined that the files should be transferred to LTSS to permit larger files and easier access. Next, we needed a means of showing fluid flow. This required much experimentation and weeks of effort to develop a workable system. Our programmers had to begin learning ANIMATE by addressing difficult technical problems.

A third problem was the extremely complex reactor core that was central to our film. We flashed integral parts while showing fluid flow and moving equipment. This highly involved sequence required approximately 25,000 vectors per frame and took approximately 3 h of computer time to redo a 1-min sequence. A still frame of this sequence is shown in Fig. 2.

Time was consistently the greatest problem for us. The programmers became involved in this project in October, were working practically full time on it by December, and pushed for a completion date of February 16 to allow for production of the finalized film. The overwhelming demands on their programming skills were further taxed by machine problems and heavy usage. That they created the excellent sequences that are evident in the first half of the film is solely due to their persistence, expertise, and dedication.

Our tight production schedule required numerous memos of justification for top priority. This inconvenienced many groups in the Laboratory and posed difficult scheduling problems for others. We succeeded in our project because of the support and assistance that we received from all areas.

Fig. 1. A still frame created on the graphics tablet.

IV. FINALIZATION

The impending deadline finally required considerable deletions from the narrative and abandonment of graphics sequences not yet completed. We therefore cut 5 min from the voice track and reused sequences whenever possible. Our finished product was not as complete as originally envisioned, but it was adequate for the first showings.

We selected the music track, had the production copy made, and presented the film to our program managers. They recognized the deficiencies and the technical errors, but gave us their full support. After all the frantic months of preparation, this support and the subsequent warm reception our film received made the effort very rewarding and gratifying to us all. The 12 subsequent showings around the country of this version and numerous requests for copies also reinforce the film's timeliness and impact.

Our completed version represented approximately 17,000 frames with a total cost (including computer time, personnel, and production expense) of \$3,400/min. The complex animation employed in the film would have cost approximately \$4,000-\$7,000/min for commercial artists to depict and would have required perhaps a year to develop. (Production expenses would be additional.) The total film effort required 70 h on the CDC-7600s; of this time, 40% was spent on software development and on development of illustration concepts. In addition, every sequence required several remakes for a satisfactory version. We estimate that succeeding films would represent a 50% decrease from the initial costs.

V. FUTURE GOALS

Our working print has been revised to correct technical errors. Also, we have developed a shorter version (7 min) that defines our Reactor Safety efforts without going into the Three Mile Island incident. This version is available on written request.

In succeeding months we plan to transfer the necessary software from LASL's CRAY computers to the Q-Division VAX computers. We intend to review the visual sequences and redo some of them. It is possible that we may insert the sections that had to be deleted earlier. This effort will progress slowly and cautiously. Our aim will be a comprehensive, educational medium that utilizes the expertise and capabilities that our groups and the Laboratory have available.

VI. SUMMARY

Our computer-generated film required tremendous orchestration and dedication to complete. It represented taking a creative framework and developing it into a highly sophisticated and complex medium that we could use for communication of our Reactor Safety efforts. Intense efforts and long hours were required, particularly of the senior programmer on the project, to develop the film within the constraints of time and programmatic demands. Further work is being done to refine the film and to develop further this highly effective means of communicating technical information to varied audiences.

VII. SUMMARY OF TEXT

The Reactor Safety film covers the following areas.

A. Introduction

1. The four types of nuclear reactors are introduced.
2. The pressurized water reactor primary- and secondary-side components are identified and shown.
3. A short explanation is given of the necessity for continued cooling after shutdown.

B. LASL's Focus

1. The focus of LASL's Reactor Safety groups is presented.
2. The means of breaking down reactor components into mathematical form is explained and shown.
3. Validation techniques are presented.
4. Significant findings of the TRAC and SIMMER codes are discussed.
5. LASL's findings were presented to Three Mile Island investigative committees.

C. The Three Mile Island Accident

1. The malfunctions and their relevance are described.
2. LASL calculations of core damage are discussed.

D. Applications

1. Computer-based analyses can be used in situations where experiments are impractical.
2. LASL personnel are making contributions to safer, more efficient nuclear power.

VIII. ACKNOWLEDGMENTS

An exhaustive effort was required by the project's senior programmer, Patrick J. Hodson, to develop extraordinary visuals against seemingly insurmountable problems. Special thanks are also due Michelle E. Shirru for her programming support and Vicki Hartford for her creative contributions. Thanks also to Jerry V. Valdez for his work at the graphics tablet.

I most appreciate the help of the Q-7 Group Leader, James H. Scott, who gave us the technical background material that got us started and who sacrificed so many Q-7 personnel to this extended project.

Michael G. Stevenson and James F. Jackson wrestled with the script, fought to give us the computer time and personnel we needed, and suffered silently over the burgeoning costs of our production. I can't begin to thank them for bearing with us and for supporting us so fully.