LASER DISC TECHNOLOGY APPLICATIONS OF NAVIGATIONAL CHART COMPILATION AND IMAGE DISPLAYS

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BIOGRAPHICAL SKETCH

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ABSTRACT

The National Ocean Service's (NOS), Office of Charting and Geodetic Services is exploring the applications of laser disc technology for its charting and geodetic programs. Two separate but related projects are currently underway.

The first is a cooperative government agency project to develop a prototype system to enhance communications and operations for an emergency response system. The system will use analog videodisc, microcomputer, and telecommunication technologies to improve information exchange. The NOS will use this opportunity to evaluate the potential of analog discs in computer assisted chart compilation, document storage and data retrieval applications.

The second project will investigate the potential of the digital disc to store and display aeronautical chart navigational data in an aircraft environment. The six month feasibility study will survey digital cartographic requirements of advanced avionic systems; analyze future NOS production and electronic distribution alternatives; conduct a technology conference with potential users and developers of new navigational systems; and formulate concepts for a low cost technology demonstration of digital cartography.

INTRODUCTION

During the last quarter century, the cost, the energy consumption and size of computers of comparable power have decreased by a factor of 10,000. Computational speed has increased by a factor of 200 (Toong and Gupta 1982). Until recently, advances in mass memory have not kept pace with these technological improvements in computer equipment. The 12 inch diameter analog laser disc can store up to 108,000 images; the same size digital laser disc is capable of storing 2 billion bytes of digital data. Manufactured by

laser optical equipment, laser discs represent low cost, easily portable, high density storage media. When integrated with today's inexpensive microcomputer processors, laser discs may revolutionize the production and distribution of cartographic data and speed the wide spread use of electronic chart systems.

THE ANALOG DISC

Analog discs store information as television pictures. The discs are produced from a master videotape which directs a low power laser beam to expose a pattern of pits on the photosensitive surface of a glass master disc. Each image is recorded on one of 54,000 separate tracks per side. After additional processing, plastic production discs can be mass produced at nominal costs. The disks can be read by commercially available off-the-shelf laser disc players. As the disc spins at 1800 rpm, a lower powered laser detects light reflection from the pit pattern and displays the recorded image on a video monitor. The playback laser can randomly access any one image in less than 3 seconds. When interfaced with a microcomputer, the analog disc may represent an

> ....alternative to or interim measure for, the digital data base. The vast storage capacity of these discs would allow the equivalent of hundreds of map sheets to be placed on a single side disc..... This image can be displayed on a video monitor, digitized by the host minicomputer and used as a base product in the creation of specialized products..... In addition to the use of the videodisc map as a cartographic base, all of the standard map analysis can be performed with computer assistance (Loomer 1984).

In December 1983, the Aeronautical Charting Division (ACD) received a $6,000 grant from the NOS Science and Technology Council to study potential cartographic applications of videodisc technology. By February of 1984, ACD learned of a proposed project by the Army Corps of Engineers (COE), Water Resources Support Center. In cooperation with the United States Geological Survey and the Federal Emergency Management Agency, the COE was designing a videodisc prototype system to enhance communications and planning activities for an emergency response for the southwestern United States. The system would use videodisc, microcomputer and telecommunication technologies to improve information exchange. Since limited funding prevented full utilization of the videodisc's storage capacity, the COE was seeking additional support from other interested agencies. NOS used this opportunity to dedicate the original $6,000 grant plus an additional $14,000 from the NOS Aeronautical and Nautical Charting Divisions to investigate the application of videodisc technology in the compilation and revision of navigational charts.

As currently proposed, the two sided disc will be available in March 1985 and contain approximately 108,000 images of

maps, charts, diagrams, satellite and aerial photographs, and related narrative data. The NOS portion will consist of nautical and aeronautical charts, aerial photographs, geodetic network diagrams, chart indexes and narrative navigational data. In addition to the disc, the prototype workstation will include a laser disc player, color monitor, graphics interface board, light pen and associated software to permit individual frame access, graphics overlay and telecommunications capabilities. The NOS has procured a 16-bit microcomputer with a 10 megabyte hard disk, color monitor and modem which will control the laser disc player in the merging of analog disc imagery with digital data overlays and permit communications between remoted workstations.

Using the NOS 1:250,000 scale Houston Terminal Area Chart as a test case, all nonregulatory, low rate of change data will be recorded on the videodisc. Specific regulatory, high rate of change data available in digital form will be downloaded from a remote main frame computer facility to the microcomputer. The ability to accurately overlay digital data from the microcomputer on the analog disc imagery will be investigated. Should this technique prove feasible, the compiler could update and position digital data changes interactively using the analog disc image as a reference background. Once all digital updates have been made, the digital data could be read to a laser plotter device to produce appropriate size negatives for printing. These negatives could be later registered to the corresponding base negatives in the photo-mechanical production of printing plates.

The large image storage capacity of the analog videodisc and the data base management and graphics potential of the microcomputer may provide an alternative to the labor intensive digitizing process and its associated mass storage requirements. The use of analog disc technology in automated cartography may give new meaning to an old adage. Since a single video image requires the same space as 22,000 bytes or characters, it may still be true that "one picture is worth a thousand words", even 16-character words.

THE DIGITAL DISC

Digital discs record and store data as binary values similar to magnetic disc systems. Digital discs are produced by low power lasers that burn holes or form bubbles ranging in size from 0.4 to 5 microns on the recording layer of the disc. The holes or bubble formations represent binary zeros or ones. This high density packing of binary coding permits the two billion byte storage capacity of each 12 inch diameter disc. Digital discs range in size from the 14 inch/4 billion byte to as small as the 2 inch/40 million byte version. The equivalent of a 5-1/4 inch floppy disc size capable of storing 550 million bytes may soon become a standard size for microcomputer applications. Random access times are in the range of 100 to 150 milliseconds.

The NOS with support of the Federal Aviation Administration (FAA) is exploring the potential of digital discs to

facilitate the production and distribution of cartographic data as well as a new medium to display NOS aeronautical chart information and graphics in a cockpit environment. The application of map data to electric cockpits is already being evaluated in numerous government and private sector research and development efforts. All these programs, however, will require a readily available and reliably accurate navigation data base. The current perception of potential users and hardware developers is that electronic map displays will not be practical until a suitable data base is available - possibly not for 5-10 years (Elson 1984). Consequently, independent, specialized data bases supporting unique hardware requirements are beginning to appear in the marketplace. The eventual affect of various nonstandard electronic chart symbologies on public safety issues are as yet undefined.

Both the Defense Mapping Agency and the NOS have been building digital data bases principally to support automated paper chart production. With the current and projected flexibility of these digital data files and the commercial availability of portable mass storage devices, such as digital discs, automated chart production will be expanded to include the development of digital cartographic products. A demonstration of digital cartography may be necessary to merge the needs of potential users with the resources of hardware developers and NOS/FAA data base compilers to ensure the successful development of electronic charts.

This project is being contracted through the United States Air Force Wright Aeronautical Laboratories. Wright Patterson's mission in the design of advanced cockpit systems and its outstanding test facilities makes it an ideal site for follow on efforts should this initial six month feasibility study prove promising. Begun in January 1985, Phase I consists of a concept definition which includes:

- A survey and analysis of industrial and government programs planning to use digital cartography. This effort will include a review of the data needs of advanced avionics equipment and a measure of the positional data by kind, volume and accuracy level required. The insight provided may reduce the lead time and development costs of future NOS digital products.

- A technology assessment of alternative strategies for electronic publishing and distribution of future NOS cartographic products.

- A technology conference with potential users and hardware developers requiring digital cartographic data input. The conference will be a combination of briefings and workshops involving industry and government developers of avionic products and requirements. The goal of the conference will be to create a forum for the interchange of ideas; a mutual awareness of available resources; and an understanding of research and development in related technologies.

- A preliminary analysis and definition of a low cost concept for evaluating digital aeronautical data in a general aviation aircraft. The capability of the digital disc will be evaluated to store and display digital map data using low cost avionics. The necessary NOS production and distribution posture to support this new medium will also be defined.

CONCLUSION

Through carefully monitoring and evaluating evolving technologies such as analog and digital laser discs, the NOS is striving to keep pace with future avionic system digital data requirements, while continually improving its present paper chart production process.

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