

## **CREWES computer systems**

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### **ABSTRACT**

This paper describes the computer systems and software used by the CREWES Project. The primary processing system, based on Sun hardware, is discussed in detail. This paper also mentions some of the PC based geophysical and mathematical processing packages used in research. Microcomputers and software used in generating the annual CREWES Research Report are also discussed. After a description of the CREWES network, the paper ends with two lists that detail the project's hardware and software.

### **INTRODUCTION**

The CREWES Project's computer systems are an integral part of the project's research facilities. The primary uses of our systems are seismic data processing and research. We use a variety of hardware and software combinations to aid in our research, and actively pursue new hardware and software solutions to common geophysical problems. In cases where no solutions exist, our research involves developing new software. A secondary use of our systems is to aid in the preparation of papers and documents, such as the annual CREWES Research Report.

### **SUN SYSTEMS**

The computer system that CREWES researchers primarily use is a cluster of networked Sun computers. This cluster contains seven Sun Sparcstation 2's, one Sun Sparcstation 1+, and one Sun Sparcserver 670MP. Six of the Sun Sparcstation 2 workstations are used by the University of Calgary's Department of Geology and Geophysics for teaching geophysical processing. Thanks to the cooperation of the department, these systems are available for CREWES researchers during off-peak hours. The largest Sun computer, the Sun Sparcserver 670MP, also belongs to the department.

The cluster is configured to make the user environment as consistent as possible from one workstation to another. The Sun system is set up with one server system (Sparcserver 670MP) and a number of ancillary workstations (Sparcstation 2's). The server system has the largest and fastest disk drives. These are used to store application programs, user files, and large datasets. Seismic data processing makes heavy use of disk I/O. To reduce the load on the network and improve I/O performance, each of the workstations has a 700 megabyte disk drive attached. These disk drives serve as data work space and provide additional swap space that is required by seismic processing software. Since each workstation has its own CPU and disk, individual workstations are unaffected by the processing on other workstations. To make the user environment consistent, all our Sun systems use NFS (the Network File System) to make users'

files available network-wide. With the aid of a program called the "automounter" users' files are made to appear local to the system, regardless of whether they reside on the local system, or are connected via network. This network transparency greatly simplifies the use of the system.

## **LANDMARK / LGC**

Over the past four years Landmark/LGC has donated hardware and software to the University under its University Industry Partnership Program. Under this program, Landmark donated an IBM RT workstation with associated I/O peripherals and a color plotter. Landmark continues to support CREWES by providing its latest software releases for the Sun platform. CREWES runs these packages on a dedicated Sun Sparcstation 2 with two 19 inch colour monitors.

Among the software products we have received from Landmark are SeisWorks/3D, SeisWorks/2D, Stratworks, LogEdit, and SyntheSeis. SeisWorks/3D and SeisWorks/2D are seismic interpretation packages used for horizon picking, fault interpretation and correlation, seismic attribute analysis, and data display. Using SeisWorks one can display data with contours, in time slices, and with 3-D perspective. StratWorks is a geologic interpretation package used for stratigraphic correlation of well logs. With it, one can create cross sections, contours, and maps of picked horizons. The last two packages, LogEdit and SyntheSeis, perform well log editing and synthetic seismogram generation, respectively.

On the now discontinued Landmark RT we run "2D Plus", "3D Plus" and "UNISEIS". 2D Plus and 3D Plus perform interactive interpretation of 2-D and 3-D stacked seismic sections. The UNISEIS modeling package performs 2-D modeling using a variety of geometries. Crosshole, VSP, and multi-component seismic have all been modeled on UNISEIS and then processed using CREWES processing systems.

## **LANDMARK/ITA**

The primary seismic processing software on the Sun system is Landmark/ITA's "Insight" processing system. This software runs on a number of common UNIX platforms, including Sun, IBM, Silicon Graphics and others. Portions of the software package support a graphical user interface, while other parts are driven by text files containing processing commands. The software provides field tape demultiplexing, pre-stack and post-stack processing, 3-D processing and a variety of interactive picking and display modules. It is capable of processing at high speed, by using a powerful math coprocessor board. This coprocessor, made by CSPI, uses an Intel i860 RISC chip and is capable of 80 million floating operations per second. Although most Insight routines run with or without the coprocessor, it is required for demultiplexing.

## **GMA**

In the past year, GMA donated six complete GMA Explorational Software Systems to the University of Calgary. This software runs on PC-compatible systems and is available to CREWES researchers through the facilities of the Department of

Geology and Geophysics. Their system includes the packages: STRUCT, LogM, Wave-X, and GrITS. Two of these packages, STRUCT and LogM, are modeling systems – one for structural modeling, and one for stratigraphic modeling. Wave-X is a wavelet extraction program that can interactively extract shaping or matching filters. The final program, GrITS, is used for stratigraphic interpretation of 2-D seismic data.

### **ADDITIONAL PC BASED SOFTWARE**

Although UNIX based applications are generally preferred, there is a large pool of excellent PC based software which we use. Hampson-Russell's AVO and Vista are two such geophysical packages. A number of others are listed in detail in the software list at the end of this paper. The project also uses PC and Macintosh based packages for performing mathematics, statistics and graphing. One of the most popular Macintosh packages we use is Deneba's Canvas. This software is used for making drawings for the CREWES Research Report, as well as slides and overheads for the annual CREWES sponsors' meeting and tutorial day. Our most heavily used programs, however, are word processors.

#### **Document preparation**

Each year the work of the CREWES Project is summarized in its research report. The report is a very complex document including contributions from a large number of authors as well as several diagrams, plots, pictures and tables. In an attempt to simplify the management of this document and to ease its assembly, we have attempted to produce as much of the report as possible by computer. Having an electronic copy of the report enables us to archive the report in a form that won't degrade over time. This permits us to make first-generation quality reprints of papers.

The majority of the report is prepared on Apple Macintosh computers using Microsoft Word and Aldus Pagemaker for word processing. Many of the diagrams are produced using Deneba's Canvas drawing package, while most graphs are produced by Cricket Graph. Some of the other images were scanned from paper originals using a flat-bed scanner and Adobe Photoshop software. A smaller portion of the report was generated using PC word processing packages, such as Wordperfect and MS Word for Windows.

In the past year we have attempted to streamline our electronic archival of the CREWES research report. The ultimate goal is to distribute and archive the entire report on CD-ROM. At this point we have set up a system in which papers are archived on a single hard disk connected to our Sun cluster. Using the Macintosh's built-in network file sharing, our Macintosh computers are able to access this disk to retrieve archived papers. Our primary stumbling block has been the storing of photographic and seismic figures. When digitized, they tend to take up a great deal of room and the scanning (digitizing) process is a slow, painstaking procedure. It is hoped that developments in scanning hardware and software will allow us to reach our goal of full electronic archival in the near future.

## NETWORK

Due to the distributed nature of our data processing facilities it has been vital that all our systems communicate easily and rapidly. To reach this goal we use an Ethernet based network running two common networking protocols: IP (TCP/IP) and Appletalk. These support features such as file sharing, remote system access, printer sharing and electronic mail.

The CREWES network is connected to the Internet network: a network that connects most Canadian and American universities as well as commercial organizations and research organizations around the world. Network access is made possible through a connection to the University of Calgary's network, which is part of Internet. This connectivity allows us to exchange information and data with others doing research in similar fields. Internet has also been very useful for obtaining free software developed at other universities.

All our systems support at least the minimum of IP network programs: Telnet and FTP. These are programs for remote system access and network file transfers respectively. Many of our UNIX and DOS computers have the additional capability of supporting NFS (the Network File System). NFS allows disk drives that are connected to any single computer to be accessed from all other computers on the network. Whereas NFS comes standard with Sun's operating system, DOS support for NFS is provided by software from the Canadian based "Beame and Whiteside" company. Although software can be purchased for our Macintosh systems to work with NFS, we have chosen the route of making our Sun systems Appleshare compatible. "Appleshare" (to be discussed later) is Apple's non-compatible equivalent to NFS. The union of NFS and Appleshare on our network give us formidable file sharing capabilities.

A recent addition to our network has been the addition of Appletalk support to our Sun systems. The Appletalk networking protocol shares some of the features of the IP protocol: file sharing (called Appleshare), electronic mail, and printer sharing. The primary benefit of adding Appletalk support to our Suns is that our Macintosh computers can make use of the Suns as file servers. Users can save their Macintosh files directly into their accounts on the Sun systems in the same manner that they would store their files on a personal floppy disk. User files can then be backed-up on a frequent basis from one central location. The Sun systems benefit from Appletalk as well. Using the Appletalk protocol, the Sun systems can print to any of the Appletalk network printers, such as our Apple LaserWriter printers.

Another important use of our network is to allow our Macintoshes and PC's to be backed-up, over the network, to tape drives connected to our Sun systems. Public domain software called "Mac Dump" allows us to do this on our Macintoshes. On our PC's we use a file archiving program to copy the entire contents of a hard disk to a file on a Sun hard disk (via NFS). We then copy the archive file to tape for off-line storage. In the future, we hope to use more sophisticated software (from Beame & Whiteside) to perform network backups.

## ACKNOWLEDGEMENTS

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## REFERENCES

Bland, H.C., and Howell, C.E., 1991, CREWES Computer Systems: CREWES Research Report, v. 3, 59-64

## HARDWARE LIST

Sun Sparcstation 2	Personal Computers
two 19" colour displays	Zenith 286 (IBM PC compatible)
Exabyte 8200 tape drive	3 Apple Macintosh IIsi
Disk space totalling 2.5 gigabytes	Apple Macintosh SE/30
	Apple Macintosh Plus
	IBM PS/2 Model 70
Sun Sparcstation 1+	High Capacity Data Media capabilities
19" colour display	9 track "round reel" tape (1600,
Quarter inch cartridge tape drive	6250 BPI)
Disk space totalling 700	Quarter inch cartridge
megabytes	DAT (Digital Audio Tape)
Sun Sparcserver 670MP (University	Exabyte (8mm Video Tape)
owned)	CD ROM
9 track "round reel" tape drive	Plotters/Printers
Versatec Plotter Controller	Versatec C2700 Thermal colour
Quarter inch cartridge tape drive	plotter
CD ROM drive	Versatec 8242A 42" plotter
Disk space totalling 6 gigabytes	Versatec 8224 24" plotter
	(University owned)
Six - Sun Sparcstation 2 (University	Versatec ECP42 42" colour
owned)	plotter (University owned)
19" colour display	
Archive Python DAT tape drive	
Disk space totalling 800	
megabytes per workstation	
IBM RT/Landmark	
Disk space totalling 900	
megabytes	
Dual 19" colour graphic displays	
9 track "round reel" tape drive	
Colour thermal transfer plotter	

## SOFTWARE LIST

The following list describes all the software we use on a regular basis. This list excludes system software, compilers, system utilities and lesser-used software. Although care has been taken in preparing this list, it is likely that portions of the list are inaccurate or out of date. For this reason, this list should be considered a guideline only, and not a source of authority for product information

<b>Modeling</b>			
Package	Vendor	Description	Operating System
MIMIC	Sierra	Geologic modeling and mapping; preparation of models for ray tracing	UNIX
QUIK	Sierra	2D & 3D seismic ray tracing field short records, CMP gathers, stacked sections before and after time migration, VSP, P, S, and converted waves.	UNIX
VESPA	Sierra	Wave equation migration; shot records, VSPs, offset VSPs	UNIX
SLPR	Sierra	Display of results on screen or hard copy	UNIX
UNISEIS	Applied Geophysical Software inc.	2D Ray-trace modeling for offset, normal incidence, normal emergence, VSP, or crosshole geometries. P, S and converted waves	AIX (RT)
LogM	GMA	Well log based seismic modeling; display & edit well logs, synthetics, geologic & seismic cross-sections	MS-DOS
STRUCT	GMA	Seismic modeling of structural geology using vertical incidence or normal incidence ray tracing or diffraction modeling	MS-DOS
AVO	Hampson and Russell	Interactive AVO modeling, analysis, and inversion.	MS-DOS
Outrider	MicroSeis Technology	Multicomponent modeling	MS-DOS

<b>Processing</b>			
Package	Vendor	Description	Operating System
Insight	ITA	Complete processing package including demultiplexing, pre-stack and post-stack processing with interactive displays	UNIX
Vista	Seismic Images Software	Interactive seismic processing from shot record to final stack, synthetic seismograms.	MS-DOS
FDTools	Seismic Images Software	Design 3D surveys, acquisition parameters	MS-DOS
Vista Vision	Seismic Images Software	Seismic plotting program for Vista output files	MS-DOS
Wellpro	Genix Systems	Interactive VSP processing	MS-DOS and UNIX
PCVSP	Kostelnick	One layer crosswell & VSP ray tracing	MS-DOS
Strata	Hampson Russell	Post-stack seismic inversion and processing. Well log manipulation	MS-DOS

<b>Interpretation</b>			
Package	Vendor	Description	Operating System
SeisWorks/3D SeisWorks/2D	Landmark	Seismic interpretation with horizon picking, fault interpretation and correlation, seismic attribute analysis and data display	UNIX
StratWorks	Landmark	Geologic Interpretation	UNIX
2D Plus	Landmark	Interpretation of 2D seismic stacked sections; automatic horizon picking, computer contouring and mapping; attribute analysis	AIX (RT)
3D Plus	Landmark	Interpretation of 3D seismic stacked sections; automatic horizon picking, computer contouring and mapping; attribute analysis	AIX (RT)
GrITS	GMA	Stratigraphic interpretation of 2-D seismic data.	MS-DOS

<b>Mathematics</b>			
Package	Vendor	Description	Operating System
Matlab	Mathworks	Mathematics and statistics package with 2D and 3D graphing capability	UNIX and MS-DOS
Theorist	Prescience	Mathematics and statistics package with 2D and 3D graphing capability	Macintosh
Cricket Graph	Cricket Software	Graphing; simple statistics and data manipulation	Macintosh

<b>Log Software</b>			
Package	Vendor	Description	Operating System
LogEdit	Landmark	Well log editing	UNIX
SyntheSeis	Landmark	Synthetic seismogram generation	UNIX
Wave-X	GMA	Wavelet extraction from well logs	MS-DOS Macintosh
LogM	GMA	Entry, computation and management of well logs. Can generate synthetic seismograms.	MS-DOS

<b>Document Processing</b>			
Package	Vendor	Description	Operating System
Word	Microsoft	Word processing with equation capability	Macintosh MS-DOS
Wordperfect	Wordperfect Corporation	Word processing with equation capability	MS-DOS
Expressionist	Allan Bonadio Associates	Visual mathematical equation editor	Macintosh
Canvas	Deneba	Drawing, slide making	Macintosh
Words, Graphics & Art	Kinetic	Visual Presentation Software	MS-DOS
Photoshop	Adobe	Scanning and image processing (colour and B/W)	Macintosh

<b>Miscellaneous</b>			
Package	Vendor	Description	Operating System
Rat	Digirule	Digitizing of well logs, seismic horizons, etc.	MS-DOS
AXXSES	Digtech	Modem access to well data (locations, tops, production, cores, etc.) and well-log digits.	MS-DOS
Norton Utilities	Norton	Disk and system management utilities	MS-DOS Macintosh
Quattro	Borland	Spreadsheet with graphing, database, statistics and data manipulation capabilities	MS-DOS

<b>Networking</b>			
Package	Vendor	Description	Operating System
HCL-eXceed/W	Hummingbird Communications	X-Window server software for PC's under Microsoft Windows	MS-DOS
BW-NFS	Beame and Whiteside	TCP/IP software, including Telnet, FTP, and NFS. Also supports network printing.	MS-DOS
CAP	Free	Appletalk support for UNIX systems. Supports file sharing, printing services, and backup	UNIX