Minutes of CD-ROM Workshop
June 19-20, 1989
NASA/Goddard Space Flight Center

Dr. Joseph H. King
NASA/NSSDC

Dr. Edwin J. Grayzeck
Interferometrics Inc.

The session began with opening remarks by Joe King to outline the dual goals of the Workshop: establish guidelines for the CD-ROM as a tool to distribute datasets; and evaluate current scientific CD-ROM projects as an Archive. He briefly introduced the first speaker, Jaylee Mead who welcomed the participants to Goddard Space Flight Center.

Jaylee shared her insights from two recent meetings at which the distribution of archives were the main topic. At an international conference in Geneva, there was much talk in the European community about capturing digital versions of astronomical surveys for research. The CD-ROM was often mentioned as a convenient and standard distribution medium. She urged coordination with the European groups to develop this technology for astronomical datasets. In the second case, at a recent meeting of the American Astronomical Society, the enthusiasm for this type of distributed information was highlighted. Two NASA demonstrations brought home to many colleagues from the smaller institutions that this medium was indeed low cost and standardized. She concluded by remarking that the cooperation shown in this emerging technology was commendable.

Joe King then presented the first Invited Talk describing the "CD Publisher at NSSDC". His comments outlined the process of using the workstation, including NSSDC levels of support. Current thinking calls for each user group to identify a person who will provide the organization and verification of native-format data. NSSDC can provide data technician and consulting level assistance if needed. During the presentation and ensuing discussion the following points were brought out. The CD-ROM is a powerful tool for information distribution and NASA has taken a lead by making a CD Publisher available to the scientific community. Emphasis was placed on establishing priorities for its use, e.g., NASA work first, but permitting cooperative efforts amongst responsible groups. The logic behind the choice of a standalone IBM-based machine, used for organization of the data, was stressed. Future upgrades would include SPAN access to the Publisher, especially for text files, as well as support for newer transport media, e.g., 8mm helical scan tape. Then the discussion centered around the NSSDC mastering contract, which gave the potential users an estimate of costs. (Current information shows the mastering fee at $1000 with replicas averaging $2 per disc.) NSSDC's goal is to provide a CD Publisher user with the hardware and software tools to design the dataset for distribution.

Ed Grayzeck described the "premastering process" at NSSDC during the creation of the first two CD-ROMs. Flexibility provided by the Publisher allows full origination of data, but the real work comes in scoping out the user platform and software requirements. The current level of software demands some knowledge of the ISO standard but will be improved by continual upgrades from Meridian. A sample set of commands, along with basic outline of the process is given in the attached viewgraphs. Discussion mainly

focused on various data representation (binary, floating point, ASCII) and description (FITS, PDS, CDF, ASCII). People commented on the small quantity of scientific CD-ROMs (30) but felt that the number would soon grow with the release of expected multi-disc sets (see Appendix A, Projected NASA Scientific CD-ROMs). In the latter case, there was concern over the longevity of the material but most felt that the gradual nature of expected disk deterioration would enable us to keep track of the archive before a catastrophic failure.

The last NSSDC presentation was given by Don Sawyer to layout a series of proposed guidelines for CD-ROM construction. His main thrust was to identify common ground for making the discs easier to use as NASA products that may be accessed in standard ways. The overlays included layouts for the surface art, volume ID, and directory structure. An immediate question about authorship, and recognition was broached; the flip side was identifying a responsible party or organization with knowledge of the data. Discussion included details of the ISO standard, which specifies bit positions for prescribed VTOC parameters. The Volume ID is one of those fields TBD at the time of initializing an ISO file structure. The proposed algorithm for choosing a letter code was well received but may be too restrictive for a subfield, e.g., experiment. Experience with various platforms (PC, microVAX) led to the firm statement that NASA should take the lead to generally identify a scheme for multi-disc use, e.g., juke-box. The proposed organizational structure drew heated response. Though most agreed how to order the data, the actual labels became cumbersome. Disagreements were voiced about calling files ABSTRACT or directories DATA. The most basic conclusion was to hide some of this information in the machine readable VTOC. At this point, the use of VOLDESC.SFD files (CCSDS) to generically define a dataset on the CD-ROM was discussed. The exact state of such syntax and the software support were outlined and follow-up information about the various formats and standard documents will supplement these proceedings. It was suggested that a reasonable response period (4 weeks) was needed to digest the CD-ROM Workshop information and provide useful comments on the Guidelines.

The second round of talks attempted to evaluate the production of various CD-ROM test discs. Lee Brotzman, of the ADC, led off the presentations by outlining the "Selected Astronomical Catalog" project. His emphasis was placed on knowing your data and documentation thoroughly and providing the verified input. The rudiments of file transfer on the Publisher formed a large segment of his discussion. Points relating to format specification again stressed the need to be flexible and duplicate data if necessary. His experiences with data integrity led to a round of statements that checking both the input and output of CD-ROMs was necessary. A general consensus emerged that the actual mastering best be left to the commercial plants so that the publisher worries mainly about data integrity.

Next on the agenda, the Comet Giacobini-Zinner Test Disc was described by Mike Aronsson and Archie Warnock. The former outlined the extent of the archive, and the diversity of the data. In retrospect the design objectives were met by largely following the lead of such groups as PDS. The second talk was initiated by a thorough description of the index structure necessary to give a scientist full access to the data. Most agreed that the user will often design clever approaches to the information but only if it is well documented and accessible to many platforms and operating systems. For this reason, the IHW had split the original FITS file into a header and pure data segment, while keeping the byte stream format. In addition, detached PDS labels had been provided to describe data. Tests on various platforms indicate that the ASCII data as well as images are well suited to this approach for CD-ROM. There were many questions regarding the mix of FITS and PDS descriptors; a discussion of binary table representation was found to be well described in both systems. Some drawbacks to this approach was the large number of files (12000+) that will cause problems when first mounting CD-ROMs on Apple Macintosh computers. The key statement regarding the directory population (larger than 40) was that tests had not shown any degradation in performance. For the future Halley Archive, new changes include an ASCII sortable data directory and the full integration of the browse approach to ordering the data.

As a PDS representative, Randy Davis next described the Voyager project. He stressed the success at using a premastering vendor to cope with a multi-disc and multi-year dataset. He also detailed the evolution of careful scrutiny that each step still requires and yet mistakes are made. People asked about the time schedule for the full set and problems with such a large dataset. His talk explored the PDS structure, from its design to current Object Description Language upgrades that permit the detailing of tables and images. The structure of the PDS discs was found to be compatible with the NSSDC proposal, especially in the use of VOLDESC.SFD files. Discussion about the PDS standards, the evolution of dictionaries, and the decision to both compress and subsample data was active. The compatibility of the ODL with other standards such as PVL was debated. Finally, the future use of XAR was outlined and its use stressed not because of DEC usage but as a full implementation of the ISO standard.

Another example of CD-ROM rojects was the Guide Star Catalog and its precursor the "Sampler". Helmut Jenkner logically went through the design for the test discs and final product. He stressed the need for breadth in laying out such an archive media. His discussion showed how the platform and user community played a part in this project. This was followed by Bob Hanisch who outlined software support for CD-ROM. After deciding on the platform, STScI adopted a beta driver to their STSDAS software for use by astronomers. After staging the data from the CD-ROM, various DBMS relational functions within their package were adequate for the expected search. In the area of improvements,

people wanted to know how flexible the system would be. In addition, it was pointed out that the working environment for STSDAS (IRAF) had certain system calls that were specific to a given operating system and platform. People inquired about the distribution of these discs and future disposition of the actual Guide Star Images; direct contact with STScI personnel was recommended although other publications will carry details for requests. Final reflections on the data format question were considered by giving us an update of FITS. The IAU adopted FITS as its distribution format and which is now recognized as a standard; in addition, it is expandable (binary tables) and stable (introduction of hierarchical keywords). Discussion centered around the time scale for such work including the IEEE floating point acceptance.

Chris Finch then presented his joint project (NODS-PDS) experience in designing a complicated image CD-ROM. His main point was to define the user base, which in this case represented more than PC users. For that reason the original CD-ROM design was modified to include fewer files as well as a structured directory layout. Compression and quick-look images proved to be a useful concept as long as fully documented for the scientist. Problems encountered during the premastering phase led to some firm recommendations: organize your data tapes completely, test not only the data prep phase, but also check a reasonable set of discs after delivery. The NODS group is pushing forward with other projects including Geostat and TOGA data. Questions indicated a concern about data quality in the mastering phase. Various problems with decompression and file organization were detailed, and the NODS group felt that their experience plus the advantage of using a hands-on system such as NSSDC was needed.

There was a brief report from Mike Prather on two upper atmosphere projects (STEP and AAOE) now using the CD-ROM technology as a viable replacement for tapes, i.e., as an interim archive. CD-ROM's are competitive for such a cohesive (campaign style) dataset that the ease of use and distribution outweigh the cost. In addition, the pioneering work on table and image manipulation had made such projects as the TOMS archive feasible for distribution.

To acquaint the group with other Government initiatives in this area, Jerry McFaul from the USGS spoke to the group as SIGCAT representative his slide presentation and handout (SIGCAT COMPENDIUM) brought out some issues regarding hardware and disc manufacturing. Various stages of support from industry were outlined, from logical standards (ISO) to the player drivers themselves. Most agreed that the government archivers must continue to insist on standards and push vendors and users to work together. Discussion centered on the advances in both premastering and display hardware. People were invited to the upcoming SIGCAT presentation of the CD Professional, a system that manufactures a CD prototype while you wait, and a "juke-box" for discs. It was pointed out that USGS was pushing for internal consistency for

CD-ROMs within the agency such as had been done internationally by the NEIC.

As a continuation of that discussion, Mike Martin brought to light the experiences he had accumulated about the disk structures contents. He had strong recommendations for NASA archivers to push for standards and security using the full ISO implementation. He emphasized the need to form a distributive network rather than centralized nodes so that the user gets information about his data quickly and easily. One of his handouts (Voyager Uranus Imaging CD-ROMs) listed software available at JPL (see Appendix B for Additional Software Tools). It was agreed to support the Bulletin Board now available through SIGCAT at USGS. The final questions again sought to pin down the distribution mechanism for non-scientists and it was decided that these proceedings would be a first attempt at collecting that background.

Dan Klinglesmith presented his recollections to summarize the meeting. A copy of his viewgraph topics are as follows: archival tool, producers checklist, common features, and problems. A lively discussion followed that included a rediscussion of the proposed guidelines; the suggestion was made that if NASA can streamline its CD-ROM effort, it may become a de facto standard.

In the listing of problems three main points were brought out. First, the distribution of CD-ROM's should be broadened to other groups, e.g., education, as a secondary target. Next, that the material on the disc should be a referenced "publication" with an author or group identified. Finally, the issue of copyright for data, especially if the information is made available to the general public, must be investigated. Examples were given regarding distribution effects and most agreed that with the proper peer review, the providers responsibility ended with creation of the CD-ROM. Most decried the lack of "proper" instruction for first time users, but no clear mechanism for this type of effort was identified.

In regards to authorship, opinion was divided. The current databases are usually compilations which are identified with a group. Most agreed that a published manuscript was an available option, but people wanted to also pursue registering the CD-ROM as a book with the Library of Congress. (NSSDC recognizes this as an action item.) This evolved into a discussion of copyrights, and whether they can exist for data from NASA. (This is another action item.) Everyone agreed that these three points need to be addressed soon, as NASA is quickly populating the CD-ROM titles and a clear policy is needed.

The meeting was adjourned by Joe King, and Ed Grayzeck described to the various groups the hardware demonstrations that would follow.

APPENDIX A
Projected NASA Scientific CD-ROMs

YEAR	VOLUME/SET DESCRIPTION	NUMBER	GROUP
1989	Voyager to the Outer Planets	2+8+	PDS
1989	Guide Star Catalog	1+2	STScI
1989	Selected Astronomical Catalogs	1+1	ADC
1989	Comet Giacobini-Zinner	1+1	IHW
1989	Oceanographic Data	1+2	NODS
1989	Planetary Data	2+	PDS
1989	Atmospheric Data	2+	TOMS
1989	ATMOS Spectra	1+	ATMOS
1989	ISTP Test Data	1+	ISTP
1990	Halley Archive	20+	IHW
1991 ?	Venus Radar Data	60+	Magellan
1992 ?	Viking Orbiter Images	30+	PDS
?	Guide Star Images	1500?	STScI

APPENDIX B

ADDITIONAL SOFTWARE TOOLS

There are a number of software tools (IMDISP) made available from PDS (see the handout on Voyager Uranus Imaging CD-ROMs). Additional packages can be accessed through SPAN (node = CHAMP) at NASA/Goddard (as listed below with the appropriate Path for CHAMP) and by contacting the person via e-mail or phone.

SOFTWARE (MS-DOS)

FTB   (1)   Lee Brotzman   champ$user1:[BROTZMAN.FTB]
                  (CHAMP::BROTZMAN
                  zmleb@scfvm.gsfc.nasa.gov)

FITSCONV   (2)   Archie Warnock   champ$user6:[WARNOCK.SOFTWARE]
                  (CHAMP::WARNOCK)

FITSUTIL   (3)   Ed Grayzeck   champ$user6:[GRAYZECK.CDROM]
                  (CHAMP::GRAYZECK)
PDSUTIL   (3)
SHELL   (3)

SOFTWARE (MAC II)

BROWSER*   (4)   Lee Brotzman
                  (CHAMP::BROTZMAN
                  zmleb@scfvm.gsfc.nasa.gov)

* Distribution by floppy; for technical questions, please contact Dana Swift, 918-299-2621

1. Browser for FITS format data tables

2. Conversion for FITS headers to ASCII text

3. User shell that assists in CD-ROM set-up as well as points to existing software such as FTB, IMDISP, FITSUTIL, and PDSUTIL

4. Similar to FTB but also includes image access through FITS header

CD-ROM AS AN ARCHIVE TOOL
Workshop Agenda

June 19-20, 1989

MONDAY, JUNE 19

SESSION 1:	PREMASTERING AT NSSDC	
9:00	Welcome	Mead-NSESCC/GSFC
9:15	CD Publisher at NSSDC	King-NSSDC/GSFC
10:05	*Coffee*	
10:20	Premastering Process	Grayzeck-NSSDC/GSFC
11:10	Guidelines for CD-ROM Construction	Sawyer-NSSDC/GSFC
12:00	*Lunch*	

SESSION 2:	EVALUATION OF CURRENT PROJECTS	
1:10	Astronomical Data Center "Selected Astronomical Catalog"	Brotzman-ADC/GSFC
2:00	International Halley Watch "Comet Giacobini-Zinner"	Aronsson-IHW/JPL Warnock-LSPN/GSFC
2:50	*Coffee*	
3:10	Planetary Data System "Voyager to the Outer Planets"	Davis-LASP/UCo
4:00	Space Telescope Science Institute "Guide Star Catalog"	Jenkner, Hanisch-STScI
6:00	Cocktails at Austin's	
7:00	Dinner at Austin's	

CD-ROM AS AN ARCHIVE TOOL
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TUESDAY, JUNE 20

SESSION 3:	FUTURE DIRECTIONS	
9:00	Joint CD-ROM Projects "West Coast Time Series"	Finch-NODS/JPL
9:50	*Coffee*	
10:05	*Group Picture*	
10:20	Standards for the CD-ROM	McFaul-USGS/SIGCAT
11:10	Disc Structures and CD-ROM	Martin-PDS/JPL
12:00	*Lunch*	

SESSION 4:	SUMMARY	
1:30	Overview of CD-ROM Workshop	Klinglesmith-LSPN/GSFC
2:30	Optional Demo of NASA Micros, CD Publisher	
	CD Publisher - Halley Browse	Grayzeck-NSSDC/GSFC
	386 Workstation - G-Z Images	Esfandiari-CDP/GSFC
	286 Portable - Index Search	Warnock-LSPN/GSFC
	Mac II - Voyager Images	Martin-PDS/JPL

CD Publisher at NSSDC

Joseph H. King
Head, Central Data Services Facility
National Space Science Data Center

Presented at

CD-ROM WORKSHOP: CD-ROM AS AN ARCHIVAL TOOL

National Space Science Data Center
Goddard Space Flight Center
June 19-20, 1989

Meeting Objectives

MEETING IS ORIENTED TO POTENTIAL CREATORS OF FUTURE CD-ROM'S

- **What Are Good Data Sets for Building CD-ROM's?**
    - Distribution of Multiple Copies (.GE. Tens of Copies)
    - Access from PC/Workstation Environment
    - .....

- **What Has Been Learned From Recently Built NASA CD-ROM's?**
    - Several to be Discussed

- **What Are the Steps In Creating a CD-ROM?**
    - In Particular, What is Premastering?

- **What Are the Rules for Use of NSSDC's Premastering Workstation?**
    - Must be NASA Work
    - Standards (Requirements vs. Recommendations)
        . Formats and Structures
        . Metadata Files ("Labels," Text, Etc.)
        . Disk Surface Art
    - Logistics and Scheduling

- **What Are the Optional NSSDC Support Levels Provided?**
    - And What Are the Costs of Each?

**FOR NSSDC: To Finalize Contents of Document Summarizing Policies, Requirements, Etc., on
        Use of NSSDC Premastering Workstation**

CD-ROM/PREMASTERING ENVIRONMENT AT NSSDC
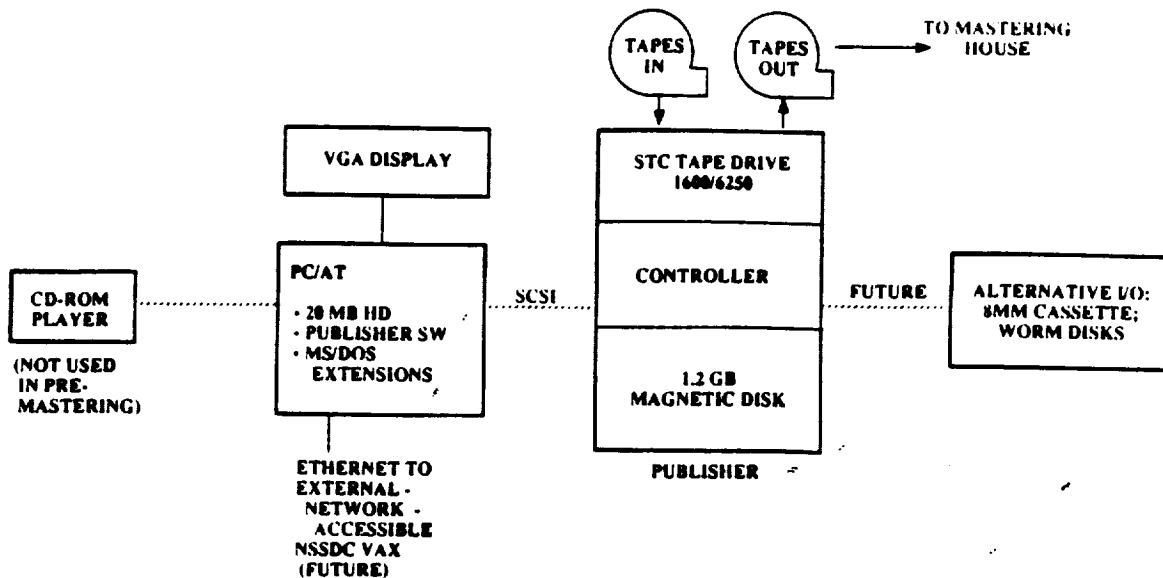
NSSDC PREMASTERING HISTORY TO DATE

- Meridian CD Publisher Competitively Selected, Fall 1988

- CD Publisher Emplaced, January 1989

- First CD Premastered, March 1989 (ADC Catalogs/Brotzman)

- Second CD Premastered, April 1989 (IHW [Comet GZ]/Grayzeck)

- This Workshop, June 1989

- JPL Use of Workstation, Summer 1989 (PDS/Martin)

Types of NSSDC Support Available

1. Guidance in Publisher Equipment and Software Usage
2. Consulting on Organizing Data, Metadata, and Index Files
3. Creation of "ISO-9660 Tapes" from ISO Mag Disk Files (Routine, But Time Consuming)
4. Interaction with NSSDC-Contracted Mastering Vendor
5. Consulting on CD-ROM Data Retrieval and Display Software
6. Consulting on CD-ROM Compatibility with Various Computers and Operating Systems

It is Not Intended That Users be Able to Deliver "Native Format" Data Tapes to NSSDC and, With Little or No Interaction, Have NSSDC Subsequently Create and Deliver CD-ROM's.

Each Group Creating a CD-ROM will Need a Scientist Who Understands End Users Natural Access Paths to the Data, and a Software (Or Equivalent) Person Who Can Define/Organize/Build the Data/Metadata/Index Files Accordingly

Types of NSSDC Support Available

USER COSTS:

There Will be No Charge for the Basic Use of the Premastering Workstation. Support Charges Will Be Assessed at Rates of About $30/Hr for 1, 3, and 4 Above, and About $70/Hour for 2, 5, and 6 Above. NSSDC will Typically Expect Funds Transfer from Using NASA Groups After Disk Creation and Billing. User Will Pay for Mastering at TBD Rate (About $1500/First Copy and $2/Subsequent Copies).

SCHEDULING:

NSSDC will Assign Time on the Workstation According to Priorities NSSDC Sets. NSSDC to Provide Limited Office Space for Visitors.
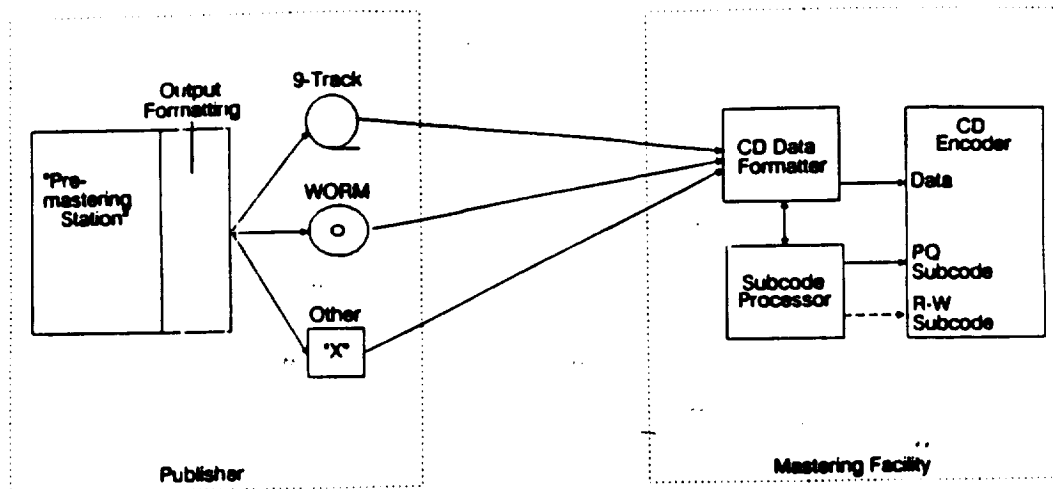
PREMASTERING PROCESS

Ed Grayzeck

NSSDC/Code 633

&

Interferometrics,Inc

Design Process

1. Select data for "publishing" after verification

2. Consider user platform and software

3. choose medium of data transport to Publisher
   - tapes, floppies, SPAN

4. choose format for metadata
   - text, FITS, PDS

5. Script out flow of data
   - management

6. Compose documentation
   - background, formats, appendices

7. Determine access to data
   - index tables, e.g., delimited

8. Plan out Auxiliary data
   - ephemeris, e.g., Comet Giacobini-Zinner

9. Organize into data directories

Premaster Build Process

1. Know the size of dataset and partition hard disk (PARTDISK)

2. Know the number of files, adjust cluster size for MS-DOS build

3. Verify all tapes, use TAPE utilities for file count and inspection

4. Copy data tapes or floppies onto disk, usually MS-DOS partition

5. Verify the disk copy by inspection of files plus total count

6. Then copy from staging to assembly partition preserving directories

7. Set up ISO partition for file origination (INITISO)

8. COPYISO files to ISO partition (batch file can set directory size)

9. Test access software on assembly and ISO partitions for accuracy

10. Modify ISO root directory and complete changes (FINALISO)

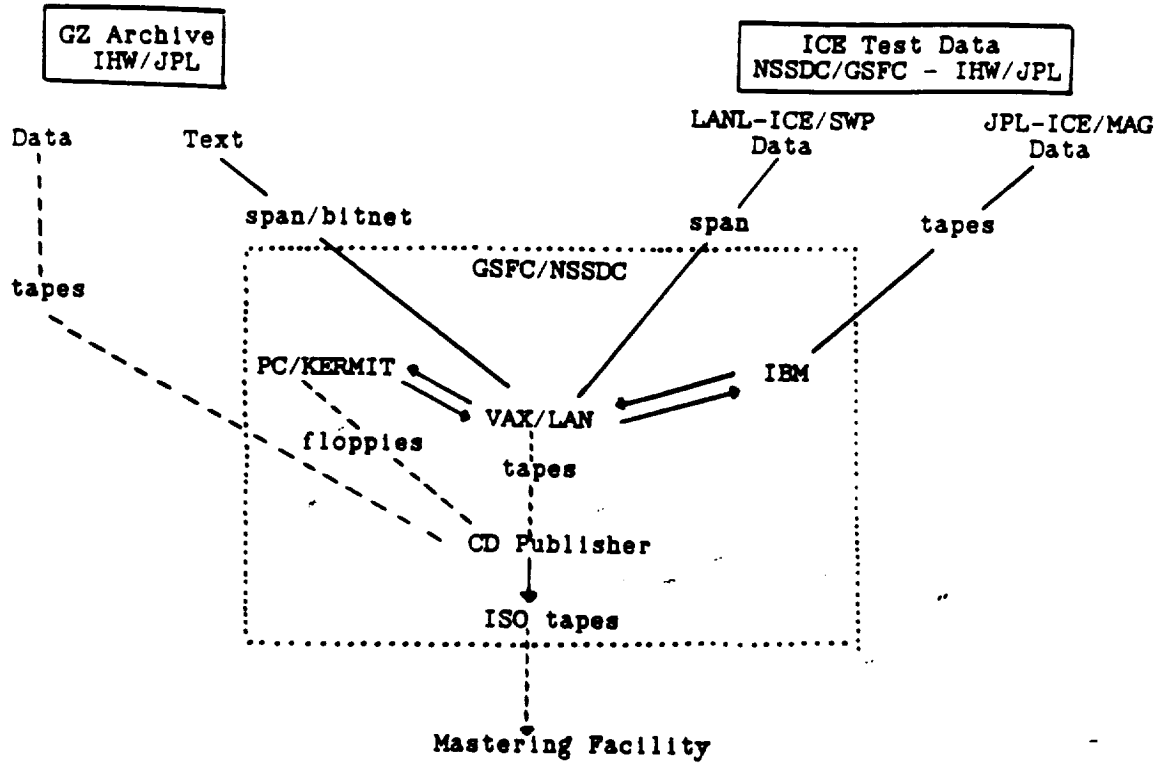Table 6 — Supplementary Volume Descriptor

BP	Field name	Content
1	Volume Descriptor Type	numerical value
2 to 6	Standard Identifier	CD001
7	Volume Descriptor Version	numerical value
8	Volume Flags	8 bits
9 to 40	System Identifier	a1-characters
41 to 72	Volume Identifier	d1-characters
73 to 80	Unused Field	(00) bytes
81 to 88	Volume Space Size	numerical value
89 to 120	Escape Sequences	32 bytes
121 to 124	Volume Set Size	numerical value
125 to 128	Volume Sequence number	numerical value
129 to 132	Logical Block Size	numerical value
133 to 140	Path Table Size	numerical value
141 to 144	Location of Occurrence of Type L Path Table	numerical value
145 to 148	Location of Optional Occurrence of Type L Path Table	numerical value
149 to 152	Location of Occurrence of Type M Path Table	numerical value
153 to 156	Location of Optional Occurrence of Type M Path Table	numerical value
157 to 190	Directory Record for Root Directory	34 bytes
191 to 318	Volume Set Identifier	d1-characters
319 to 446	Publisher Identifier	a1-characters
447 to 574	Data Preparer Identifier	a1-characters
575 to 702	Application Identifier	a1-characters
703 to 739	Copyright File Identifier	d1-characters, SEPARATOR 1, SEPARATOR 2
740 to 776	Abstract File Identifier	d1-characters, SEPARATOR 1, SEPARATOR 2
777 to 813	Bibliographic File Identifier	d1-characters, SEPARATOR 1, SEPARATOR 2
814 to 830	Volume Creation Date and Time	Digit(s), numerical value
831 to 847	Volume Modification Date and Time	Digit(s), numerical value
848 to 864	Volume Expiration Date and Time	Digit(s), numerical value
865 to 881	Volume Effective Date and Time	Digit(s), numerical value
882	File Structure Version	numerical value
883	(Reserved for future Standardization)	(00) byte
884 to 1 395	Application Use	not specified
1 396 to 2 048	(Reserved for future standardization)	(00) bytes

MS-DOS Sample Programs

ANSID2T	Transfer disk files to ANSI- or IBM-labelled tapes
ANSIT2D	Transfer ANSI- or IBM-labelled tape files to MS-DOS partition
D2T	Copies MS-DOS files to unlabelled tape
SIM	Provides a CD-ROM simulation
T2D	Copies unlabelled tape to disk
TBACKUP	Backs up MS-DOS files from disk to tape
TRESTORE	Restores files from a backup tape to MS-DOS partition

ISO 9660 Sample Programs

ANST2ISO	Transfer ANSI-labelled tape files with XARs to ISO partition
COPYISO	Copies files from a MS-DOS partition to an ISO partition
FINALISO	Transforms the extended ISO directory structure into a normal ISO 9660 format
INITISO	Writes the root ISO directory structure into an ISO partition
MODVOISO	Modify parameters in ISO root directory
SIM	Performs a CD-ROM simulation
TRESISO	Restores files from a backup tape to an ISO 9660 partition

General Support Programs

CDRFILL	Overwrite obsolete data on ISO partition before data transfer
DOSCLEAN	Erase obsolete data on MS-DOS partition before build
PARTDISK	Partitions CD Publisher drives into logical mass storage units
TDUMP	Provides interactive dump of tape to console

```
C:\>initiso 0: /pa
Meridian Data initialize ISO device. Version 1.04
Copyright (c) Meridian Data Inc 1988.  All rights

Enter Bibliographic file name (default = ""):
Enter Abstract file name (default = ""):
Enter Copyright file name (default = ""):
Enter Volume Id (default = ""):
Enter Volume Set Id (default = ""):
Enter Application file name (default = ""):
Enter Publisher Id (default = ""):
Enter System Id (default = ""):
Enter Root size (default = 16384):
Enter Path table size (default = 16384):
Enter volume size (default = 650993664):

Initialize ISO 0 (yes/no)? [no ]
```

7

GUIDELINES FOR
CD-ROM CONSTRUCTION

Donald M. Sawyer

Central Data Services Facility

National Space Science Data Center

Presented at

CD-ROM WORKSHOP: CD-ROM AS AN ARCHIVAL TOOL

National Space Science Data Center

Goddard Space Flight Center

June 19-20, 1989

NSSDC	GUIDELINES FOR CD-ROM CONSTRUCTION	GSFC
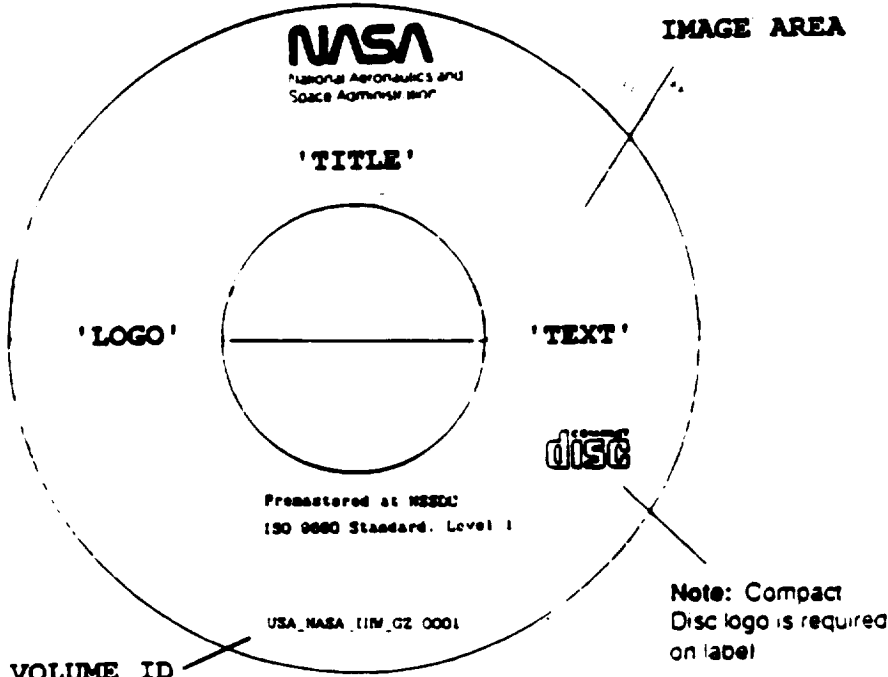
GUIDELINES DOCUMENT

- NSSDC will provide a document for users of NSSDC's Premastering Workstation

  - Objective is to facilitate effective, and long term, user access to all CD-ROMs produced on NSSDC's workstation

  - REQUIREMENTS: Required standards to be followed will be described

  - RECOMMENDATIONS: Suggested standards will also be described

- Comments from this workshop will be useful in shaping first issue

- Document will evolve as experience is gained (previous CD-ROMs remain acceptable)

- CD-ROMs, for which eventual archiving at NSSDC is likely, are also subject to additional constraints NOT described in this document

  - Contact NSSDC for data submission guidelines

	GUIDELINES FOR	
NSSDC	CD-ROM CONSTRUCTION	GSFC

PROPOSED 'REQUIREMENTS' SUBJECT AREAS

- Disk Surface Art

- Volume ID: Structure and Content

- Publisher ID (NSSDC)

- High Level Disk Organization

- Use of Standard Formatted Data Unit (SFDU) Labels
  - Consultative Committee for Space Data Systems Standards

	GUIDELINES FOR	
NSSDC	CD-ROM CONSTRUCTION	GSFC

PROPOSED STANDARD: CD-ROM DISK SURFACE ART

NASA
National Aeronautics and
Space Administration

'TITLE'

IMAGE AREA

'LOGO'   'TEXT'

disc

Premastered at NSSDC
ISO 9660 Standard. Level 1

USA_NASA_IIM_GZ_0001

"FULL" VOLUME ID

Note: Compact
Disc logo is required
on label

PROPOSED STANDARD: FULL VOLUME ID

- Objective: Provide unique ID for manual and automated disk volume inventory management, with opportunity for adoption by other organizations world-wide
- Format of Full Volume ID (24 characters maximum):

  Country_Agency_Discipline_Mission_Sequence#

  e.g. USA_NASA_PDS_VG_0001

  USA_NASA_NSSD_DE14_0001

  - Each element is 4 characters or less, with no spaces
  - Each element is separated with underscores
- Requires establishment of Volme ID registration authorities
- Proposed mapping to ISO CD-ROM directory (VTOC)
  - CD-ROM Volume ID = Mission_Sequence#
  - CD-ROM Volume Set ID = Country_Agency_Discipline_Mission

- Issues
  - Potential for non-unique Volume Id in a jukebox setting
  - Some implementations impose a 12-character limit on Volume Id and Volume Set ID
  - CD-ROM Volume Set ID functionalilty has been restricted

PROPOSED STANDARD: HIGH LEVEL DISK ORGANIZATION

- 'Root' directory shall contain only two files, as follows:
  - ABSTRACT.TXT
    - Provides human reader with starting point for understanding volume
    - Includes nature of data and overall organization
    - ASCII text file
  - VOLDESC.SFD
    - Provides standard software with starting point for understanding volume
    - Uses SFDU labels and construction rules to organize all other files into a sequential structure
    - ASCII text file
- 'Root' directory shall contain at least the following two directories:
  - DOCUMENT
    - Contains files (and/or directories as needed) whose content describe: Data Formats; Souce of Data; Processing Histroy; Use; Quality; etc.
  - DATA
    - Contains files (and/or directories as needed) whose content are: Data of primary interest to CD-ROM producer

PROPOSED STANDARD: HIGH LEVEL DISK ORGANIZATION (cont'd)

- 'Root' directory may also contain any or all of the following directories:
    - INVENTRY
        - Indicies to efficiently locate sub-sets of the data
    - SUPPLMNT
        - Data of secondary interest to CD-ROM producer
    - SOFTWARE
        - Documented source code, and/or executable code, facilitating data access

- Directory structure may look as follows:

```
                                  |.User Determined Names--->
root---|---ABSTRACT.TXT
       |---DATA-------------|---ORGANIZD----------|-----TOPIC
       |                    |                      |-----TIME
       |                    |---TESTFILE.DAT
       |
       |---DOCUMENT---------|---OVERVIEW.TXT
       |                    |---FORMATS-----------|-----TOPICFMT.TXT
       |                    |---DICTONRY.TXT       |-----TIMEFMT.TXT
       |                                           |-----INDIFMT.TXT
       |---VOLDESC.SFD
       |---INVENTRY---------|---INDICIES.TXT
```
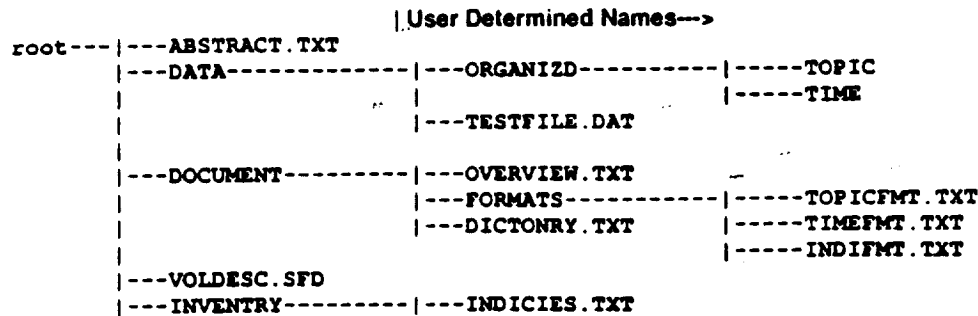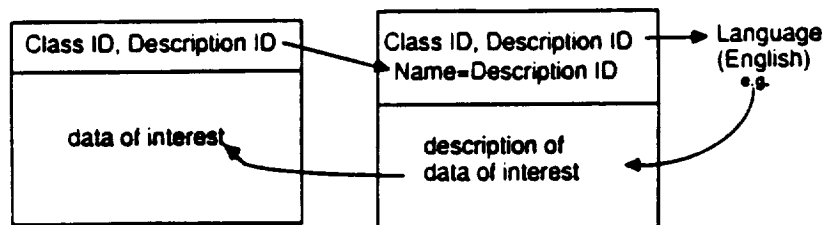
PROPOSED STANDARD: VOLDESC.SFD FILE

- Used to create a sequential view of all files on the volume (all file names are listed)
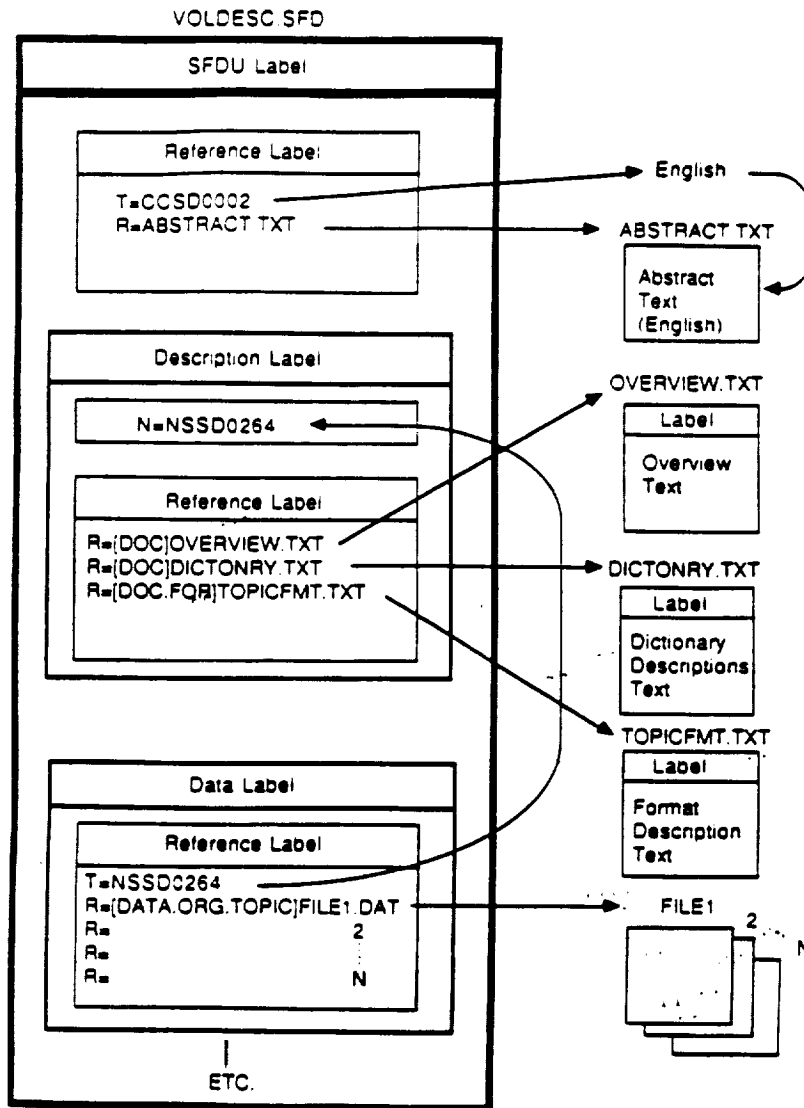- Used to apply SFDU labels to any files not already containing SFDU labels

- SFDU labels and construction rules provide:
    - Means to classify data as: Data, Supplementary, Description, Attributes, Volume, Dictionary
    - Means to label data with an identifier of format and description
    - Means to aggregate data into related collections

- Basic SFDU labeled object functionality appears as follows:
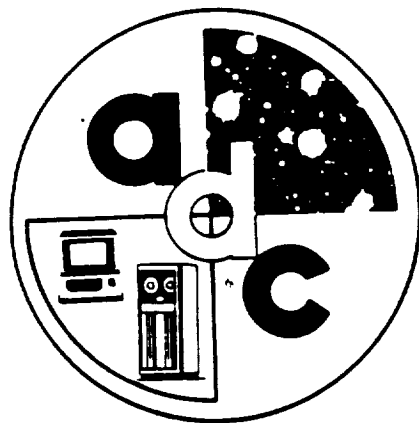

□ = SFDU Label(s)

CONCEPTUAL VIEW OF VOLDESC.SFD FILE

VOLDESC.SFD

SFDU Label

Reference Label
T=CCSD0002
R=ABSTRACT.TXT

→ English

ABSTRACT.TXT

Abstract Text (English)

Description Label
N=NSSD0264

OVERVIEW.TXT

Label
Overview Text

Reference Label
R=[DOC]OVERVIEW.TXT
R=[DOC]DICTONRY.TXT
R=[DOC.FOR]TOPICFMT.TXT

DICTONRY.TXT

Label
Dictionary Descriptions Text

TOPICFMT.TXT

Label
Format Description Text

Data Label

Reference Label
T=NSSD0264
R=[DATA.ORG.TOPIC]FILE1.DAT
R= 2
R=
R= N

FILE1 2 ... N

ETC.

NSSDC	GUIDELINES FOR CD-ROM CONSTRUCTION	GSFC

CHARGE TO WORKSHOP PARTICIPANTS

* PROVIIDE NSSDC WITH CRITIQUES AND SUGGESTIONS REGARDING:

  - SCOPE OF GUIDELINES DOCUMENT
  - APPROPRIATENESS OF PROPOSED REQUIREMENTS, AND SUGGESTED ADDITIONS
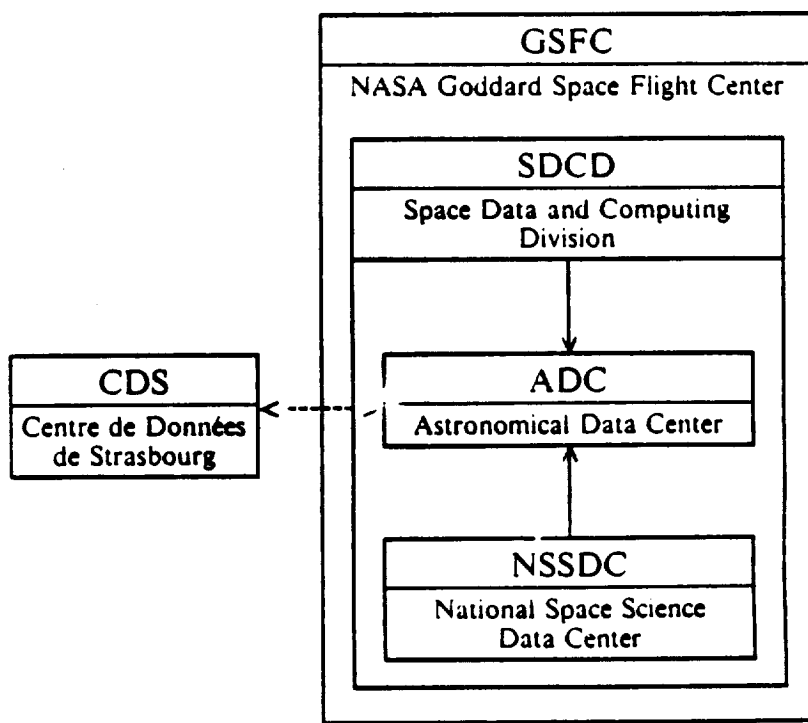 - RECOMMENDATIONS FOR OPTIONAL STANDARDS TO BE FOLLOWED

The Astronomical Data Center CD ROM Test Disk

Selected Astronomical Catalogs

Lee E. Brotzman
(ADC/STX Corp.)

Jaylee M. Mead
(NASA/GSFC)

GSFC
NASA Goddard Space Flight Center

SDCD
Space Data and Computing Division

ADC
Astronomical Data Center

NSSDC
National Space Science Data Center

CDS
Centre de Données de Strasbourg

Functions:

a) acquisition
b) verification
c) documentation
d) distribution
e) on-line access

of astronomical source catalogs

ADC Archives

Catalog Inventory

> 550 catalogs, > 1450 individual files, ≈ 2.3 Gbytes

Categories

- Astrometry
- Photometry
- Spectroscopy
- Combined and Derived Data
- Cross-Identifications
- Non-Stellar Objects
- Plate Sorted Data
- Miscellaneous

Status Codes

A Fully checked out and documented

B Briefly checked out

C Not checked out

D Temporarily removed from list

E Not yet received by ADC

Initial Study

Aug. '87	**Capitol Microcomputer User's Forum Seminar on CD ROM Technology**
	• Tabular data easiest to handle
	• Costs lower than expected and falling fast
	• Interest high and rising, especially for desktop machines

Sep. - Nov. '87   Learning period. Books, articles, discussions, SIGCAT.

Astrophysics Data Workshop. First pressure to support FITS tables.

Dec. '87   Pilot Project planned:

Disk 1 Flat, fixed-length text files, minimal data indexing, some PC retrieval software.

Disk 2 FITS tables, more extensive indexing, improved software support (microVAX, Sun?)

Disk 3 + ???

CD ROM Discussion Group

SPAN Electronic Mail Conference

Brotzman, Mead, Warren, Raugh, Hill — ADC
Wells — NRAO, AIPS, co-author of FITS
Martin — Planetary Data Systems, CD ROM developer
Hanisch — STScI, STSDAS, chair WGAS
Shames — STScI, Chief of Systems Branch
Warnock — International Halley Watch

Topics of Discussion

a)   FITS vs. text vs. other formats (PDS, custom, etc.)

b)   Desktop vs. workstation computing environments

c)   Outside review of FITS conversion effort

d)   Directory structure and file formats of the ADC CD ROM

The ADC User Survey

Mailed to 450 requesters of digital data in last three years.
159 (35%) surveys returned.

| Respondants interested in CD ROM — total 78 (49%) | | | | | | | | | | | |
| Access to FITS reader? | | | | Interest in FITS tables? | | | | Prefer FITS or flat files? | | | |
Reply	#	%	total%	Reply	#	%	total%	Reply	#	%	total%
No	20	n/a	26	Blank	15	75	19	Blank	12	60	15
				No	5	25	6	Text	8	40	10
Yes	58	n/a	74	Blank	5	9	6	Blank	13	22	17
				No	15	26	19	Text	20	34	25
				Yes	36	62	46	FITS	12	20	15
				Some	2	3	3	Both	5	9	6
								None	8	14	10

ADC FITS Test Tape

The Bright Star Catalog, 4th ed.

Uppsala General Catalog of Galaxies

Smithsonian Astrophysical Observatory Star Catalog

AGK3 Catalog of Positions and Proper Motions

Combined List of Astronomical Sources, Version 3.1

Distributed to Software Development Teams For:

- AIPS — Don Wells, NRAO
- IRAF — Doug Tody, KPNO
- STSDAS — Bob Hanisch, STScI
- MIDAS — Preben Grosbøl, ESO
- PDS — Mike Martin, JPL

CD ROM Layout

Subdirectories

ASTROM, PHOTOM, SPECTRO, NONSTELL, MISC
Within these, each catalog in its own subdirectory

File Formats and Naming Conventions

Type of Information	File Type	Extension
Documentation	Var. Text	.DOC
Catalog data files	Fixed Text	.TXT
Separate FITS header	Fixed Text	.HDR
Standard FITS Table	Stream	.FIT

"Text" means records are delimited by CR/LF sequence
"Stream" means records have no inter-record delimiters

Access Software

MS-DOS FITS Table Browser

Source Language: Turbo Pascal 5.0
(Currently being ported to Turbo C 2.0)

Functions:

- Select FITS file
- Decode table header(s)
- Select display columns
- Scroll by line or page

Planned Enhancements:

- Improved display selection
- String/value search in columns
- Copy lines to text or FITS files
- Convert: FITS to Text, Text to FITS

CD ROM Publishing

Preliminary Data Processing

This is by far the most expensive phase

- Convert to computer-readable form (n/a)

- Decide on disk file formats
  - PDS, FITS, "naked" ASCII and/or binary

- Document the data
  - Printable ASCII, T$_E$X, word processor

- Decide on directory hierarchy
  - "human-readable" *vs.* "computer-readable" names

- Prepare input tapes for CD Publisher
  - ANSI, IBM Standard, or unlabelled

- Prepare test data and expected results

Pre-Mastering on NSSDC CD Publisher

- Read the documentation

- Prepare DOS environment
  - Editors, compilers, utilities

- Prepare CD Publisher
  - Format and "clean" mass storage ($\approx$ 1 hr)

- Initial tests; build small sample
  - Necessary to validate all those assumptions

- Build the disk (1 – 2 days)
  - Use the DOS partition
  - Use batch files for loading Publisher
  - Build in pieces; testing often
  - Keep a record of build
  - Backup (5 – 6 tapes; $\approx$ 1.5 hr)

- Prepare pre-master tapes
  - Copy DOS partition to ISO (1 – 8 hr)
  - Bring at least a dozen tapes for backups
  - Bring a good book ($\approx$ 3.5 hr/set * 2 sets)

Mastering and Replication

- Prepare artwork
  - Use suggested layout
  - One film positive per color
  - Use GSFC Graphics Art Facility

- Procurement of Replicas
  - NSSDC Contract

- Submitting materials
  - Finished product in 5 days
    (If they use the right mailing address)

INTERNATIONAL HALLEY WATCH

Mikael Aronsson
Jet Propulsion Laboratory
Mail Stop 169-237
4800 Oak Grove Drive
Pasadena, California 91109

A.   INTERNATIONAL HALLEY WATCH

1. Nine Disciplines: Astrometry
                            Infrared Studies
                            Large Scale Phenomena
                            Meteor Studies
                            Near Nucleus Studies
                            Photometry & Polarimetry
                            Radio Studies
                            Spectroscopy & Spectrophotometry
                            Amateur Observations

2. Spacecraft Data: ICE [P/G- Z]
                            Giotto ----------
                            Sakigake
                            Suisei |----[P/Halley]
                            Vega-1 |
                            Vega-2 ----------

B.   WAYS OF REPORTING DATA TO LEAD CENTER

1. Magnetic Tape

2. Electronic Transfer [e.g., electronic mail]

3. Floppy Disc

C.   DATA FORMATS

1. FITS: Binary Data - Images
                          Spectra
                          Tables
          ASCII Table Data
          ASCII Text Data
          Headers Only

2. ASCII Tables [some P/Halley Spacecraft Data]

3. EBCDIC Tables [Sakigake & Suisei Data]

D. DESIGN OBJECTIVES FOR IHW CD-ROM

1. User Friendly

2. How Will It Be Used?

   - Characterize temporal behavior

   - Crosscorrelate observations obtained by different disciplines

   - Locate all data obtained in a particular time interval

   - Locate data obtained with a particular filter or in a particular spectral range

   - Locate data with a particular field of view (imaging) or aperture location (non-imaging)

   - Locate Data obtained at observatories with certain instrumental characteristics

   - Locate data from a particular discipline or subnet of a discipline

2. System Independent

3. Archive => Read-Only-Memory Satisfactory

4. Longevity

5. Size

6. Cost

The International Halley Watch P/Giacobini-Zinner CD-ROM

Archibald Warnock III
ST Systems Corp.
IHW/Large Scale Phenomena Network
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

A. Directory Structure
  1. Followed basic PDS recommended structure
      a) Separate directories for browse images, calibration data, compressed images
      b) Data from ICE was split by instrument into separate subdirectories,
  2. Data directories were arranged chronologically (except for ICE data)
  3. Individual disciplines were merged (except LSPN) ·.
B. Index files
  1. All were constructed as delimited tables
      a) all fields delimited with commas
      b) character fields enclosed in quotes
      c) each row is delimited with the characters <CR><LF> to simulate a disk record structure, thus avoiding the problem of "semi-infinite" record length (no 2880-byte records in FITS disk files)
  2. Assumed the product of a search is the name of a data file
  3. No FITS headers were supplied (but could be - the format is fully FITS compatible)
  4. ASCII structure files and dBASE III+ .dbf header files were supplied, as well as dBASE III+ programs for creating each database
  5. Index types
      a) Quick Look Index
          1) made from keywords common to all disciplines
          2) separate pre- and post-perihelion tables to limit file size
      b) Printed Archive Index
          1) one table per discipline/subdiscipline
          2) duplicates the fields included in the printed archive tables
      c) Net Specific Indexes
          1) required by only three disciplines (LSPN, Radio, Spectroscopy)
          2) constructed from fields requested by the DS
      d) Observatory Codes Index
          1) gives name, address and IHW system code for each contributing observatory
C. Trial Balloons
  1. Compressed images
      a) Used previous-pixel algorithm to code 16-bit images as 8-bit data streams, yielding roughly 40% compression
      b) Draft FITS proposal documented COMPRESSED image data structure in general and previous-pixel algorithm in particular

2. Separate FITS headers and data files
    a) Allows multiple headers (FITS, PDS, etc.) to describe a single copy of the data set.
    b) Simple OS concatenation function recreates "genuine" FITS, if necessary
    c) Allows DBMS access to tabular data without requiring FITS reader
    d) Allows a PC/CD-ROM configuration to be the file server to the large image processing packages (AIPS, IRAF, STSDAS, MIDAS) via scratch disk and Ethernet or serial connection

D. Supporting Documentation
    1. Description of tree structure
    2. Description of file names
    3. Description of index tables
    4. Brief description of FITS and PDS formats
    5. General background and Lead Center Preface
    6. Description of codes for contributing observatories
    7. Background appendices from each discipline

E. Supplied Software
    1. Ephemeris interpolation program from Astrometry net (source and executable)
    2. Decompression routines from Large Scale Phen. (subroutine source only)

F. Suggested Changes
    1. Astrometry files into separate subdirectory
    2. Subdirectory names like \Y1985\M09\D13\H00 to preserve correct time ordering
    3. Executable versions of decompression program for VMS, MS-DOS (and Unix?)
    4. Keep primary and extension headers in a single file but separate from data file
    5. Interleave LSPN Browse images with data from other networks

June 16, 1989 7:40 PM

Planetary Data System CD-ROMs

A Presentation to the
NASA CD-ROM Workshop
Goddard Space Flight Center
19 June 1989

Randy Davis
Space Operations and Information Systems Division
Laboratory for Atmospheric and Space Physics
University of Colorado
Boulder, CO 80309-0392
(303) 492-6867

Planetary Data System CD-ROMs

What's Available Now

- **Space Science Sampler 1 — 800 of the best images of Uranus, its rings and its moons taken by the cameras aboard the Voyager 2 spacecraft**

- **Space Science Sampler 2 — Over 1,500 files of scientific data on the Earth and our solar system, including comet data**

- **Three disk set containing all Voyager images from Uranus**
  - **Full resolution compressed images for scientific analysis**
  - **1/4-resolution images for browsing**

- **Software for accessing the disks available for VAX/VMS and Sun/Unix**

- **Software for data display available for IBM PC and Macintosh**

Coming Soon to a Computer Near You

- **Selected Voyager images from Saturn (2 volumes)**

- **Selected Voyager Jupiter images (3 volumes)**

- **Voyager non-imaging data**

- **We would also like to do a 'Best of Neptune' disk soon after Voyager 2 flies by that planet in August 1989**
  - **No firm plans, however**

- **Viking IRTM and MAWD data**

- **Viking images of Mars (50+ volumes)**
  - **Long-term project, currently in the planning stage**
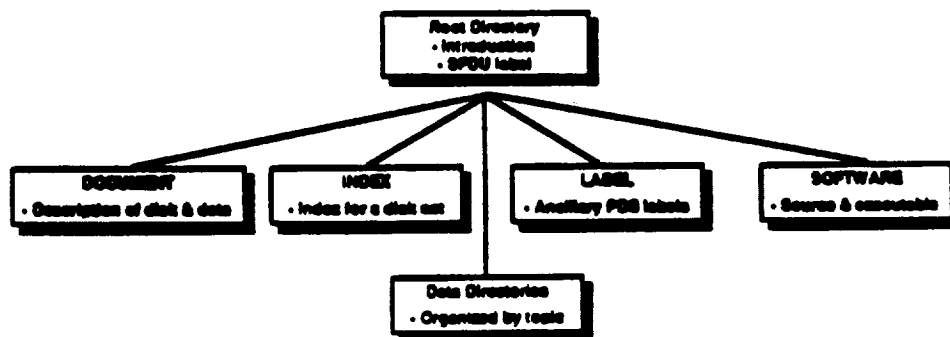
Planetary Data System CD-ROMs

Format of the PDS CD-ROMs

- Our disks conform to interchange level 1 of the ISO 9660 standard
  - Except for the Science Sampler 1, which is in older High Sierra format
  - Level 1 limits directory and file names to eight characters
- Disks have a 'NASA standard' volume ID
- All files have extended attribute records
- We use stream, fixed-length and variable-length record formats
  - Variable length records are encoded in VAX format
- Many files are in SFDU format and most have PDS labels encoded in the Object Description Language
  - We use both embedded labels (located at the beginning of a data file) and detached labels (in a separate label file)

Laboratory for Atmospheric and Space Physics University of Colorado at Boulder
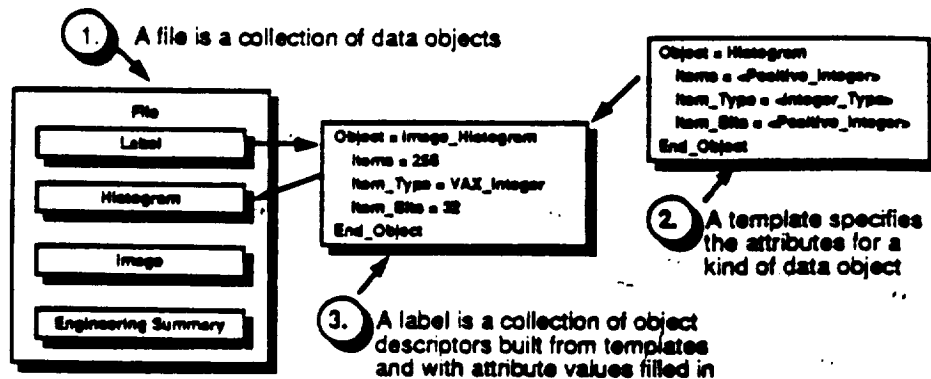

Planetary Data System CD-ROMs

Layout of PDS CD-ROMs

Laboratory for Atmospheric and Space Physics University of Colorado at Boulder

How PDS Labels Work

1. A file is a collection of data objects

```
Object = Histogram
  Items = <Positive_Integer>
  Item_Type = <Integer_Type>
  Item_Site = <Positive_Integer>
End_Object
```

```
File
  Label
  Histogram
  Image
  Engineering Summary
```

```
Object = Image_Histogram
  Items = 256
  Item_Type = VAX_Integer
  Item_Site = 32
End_Object
```

2. A template specifies the attributes for a kind of data object

3. A label is a collection of object descriptors built from templates and with attribute values filled in

Status of PDS Labels

- **Version 1 of the Object Description Language is defined in the PDS document *Standards for Preparation & Interchange of Data Sets***
  - Development of future versions will be carefully controlled

- **Software is available for reading and writing PDS labels**
  - Version 1.2 of the PDS label software, with a few fixes and enhancements will be out in a month or two

Planetary Data System CD-ROMs

About Our Disk Production

- When we started work on the Voyager disks in 1986, personal CD-ROM publishers were not a viable option

- Therefore, we contracted with Reference Technology of Boulder to do the production work

- Reference Technology does the premastering and contracts with Digital Audio Disc Corporation (DADC) in Terre Haute, Indiana to do the mastering and replication

- Overall, this arrangement has worked very well

Laboratory for Atmospheric and Space Physics   University of Colorado at Boulder

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Planetary Data System CD-ROMs

Summing Up Our Experience

- Data preparation has been much harder and taken much more time than expected
    - Most of the big issues and delays we encounter occur in the data preparation phase

- Premastering has been harder than expected
    - Executing and verifying the layout of disks with thousands of files in dozens of directories is difficult

- The mastering and replication step has been easier than anticipated
    - Turnaround is fast and we haven't seen an unreadable replica yet

- Disk distribution can be a big burden
    - The 'market' for space science CD-ROMs includes amateur astronomers, educators and computer hobbiests

Laboratory for Atmospheric and Space Physics   University of Colorado at Boulder

ORIGINAL PAGE IS
OF POOR QUALITY

The Guide Star Catalog

Helmut Jenkner
Space Telescope Science Institute

CD-ROM Workshop
Goddard Space Flight Center
19-20 June 1989

The Guide Star Catalog (GSC)

- Required to support the operation of the Hubble Space Telescope (HST).

- The GSC was developed between 1982 and present; updates required throughout the operational lifetime of HST.

- Contains data on 18,819,291 objects in the 7th to 16th magnitude range, of which more than 15 million are stars.

The Guide Star Catalog (cont.)

- For each pointing, HST uses its Fine Guidance Sensors to lock onto a pair of Guide Stars.

- The Guide Star Selection System uses the GSC to select appropriate pairs of stars depending on pointing details, and transmits them to other parts of the ground system.

- GSC data are also required by HST observers to verify target coordinates in the GSC frame of reference.

- In addition, many other astronomical applications possible.

GSC Construction

Based on about 1500 Schmidt plates of the entire sky.

Processing steps for each plate:

- Digitization into 14,000 x 14,000 rasters, with 25 micron resolution (PDS Microdensitometers).
- Sky-background determination.
- Object identification.
- Photometric and astrometric calibration.
- Object classification (star vs. non-star).
- Catalog update.

GSC Properties

- Astrometric accuracy: 0.3 to 0.5 arc seconds.
- Photometric accuracy: 0.2 to 0.3 magnitudes.
- 18,819,291 objects; 25,126,027 entries.
- Nomenclature: GSC xxxxx yyyyy, where the first field specifies the "region" number, and the second is an ordinal within it.
- Organized into 9537 regions of varying size with approximately constant population.

GSC Publication

- Complete description in series of four papers in the Astronomical Journal; to be submitted later this year.

- ST ScI Preprints in final edit.

- Supporting tables (but not the GSC) published on fiches with the papers.

- Publication of complete data on set of two CD-ROMs.

GSC CD-ROMs

- ISO 9660 Format with XARs (Extended Attribute Records).

- Files in FITS (Flexible Image Transport System) table format.

- Pre-mastering performed at ST ScI using TMS Disc Architect IV software.

- CD-ROMs manufactured by Discovery Systems.

- First printing: 500 sets.

CD-ROM Content

Root directories:

- **README.TXT** - Introductory text

- **GSC** - Directory of GSC region files

- **TABLES** - Directory for GSC supporting tables

CD-ROM Content - Directory TABLES

COMMENTS.TBL	-	Introduction and general comments.
PLATES.TBL	-	Information on plates used in the GSC.
PROCESS.TBL	-	Image processing parameters.
ASTR_CAL.TBL	-	Parameters of astrometric calibrations.
PHOT_CAL.TBL	-	Parameters of photometric calibrations.
C_UP_POP.TBL	-	Catalog update population statistics.
ST_POP.TBL	-	Population statistics for stars.
NS_POP.TBL	-	Population statistics for non-stars.
REGIONS.TBL	-	Boundaries of GSC regions.
C_RE_POP.TBL	-	GSC region population statistics.
LG_REG_X.TBL	-	Index to large regions.
SM_REG_X.TBL	-	Index to small regions.
XREF_P2R.TBL	-	Plates to regions cross-reference table.
XREF_R2P.TBL	-	Regions to plates cross-reference table.

CD-ROM Content - Directory GSC (Vol. 1)

Subdir.	Declination		Regions	
	from	to	from	to
N0000	+00 00	+07 30	0001	0593
N0730	+07 30	+15 00	0594	1177
N1500	+15 00	+22 30	1178	1728
N2230	+22 30	+30 00	1729	2258
N3000	+30 00	+37 30	2259	2780
N3730	+37 30	+45 00	2781	3245
N4500	+45 00	+52 30	3246	3651
N5230	+52 30	+60 00	3652	4013
N6000	+60 00	+67 30	4014	4293
N6730	+67 30	+75 00	4294	4491
N7500	+75 00	+82 30	4492	4614
N8230	+82 30	+90 00	4615	4662
S0000	-00 00	-07 30	4663	5259

CD-ROM Content - Directory GSC (Vol. 2)

Subdir.	Declination		Regions	
	from	to	from	to
S0730	-07 30	-15 00	5260	5837
S1500	-15 00	-22 30	5838	6411
S2230	-22 30	-30 00	6412	6988
S3000	-30 00	-37 30	6989	7522
S3730	-37 30	-45 00	7523	8021
S4500	-45 00	-52 30	8022	8463
S5230	-52 30	-60 00	8464	8839
S6000	-60 00	-67 30	8840	9133
S6730	-67 30	-75 00	9134	9345
S7500	-75 00	-82 30	9346	9489
S8230	-82 00	-90 00	9490	9537

CD-ROM Statistics

Frames	306,675	302,153
Blocks	1,226,700	1,208,612
Bytes	628,070,400	618,809,344
MBytes	598.98	590.14
Start Address	00m 02s 00f	00m 02s 00f
Last Address	68m 11s 00f	67m 10s 53f

SPACE TELESCOPE SCIENCE INSTITUTE

CD-ROM Guide Star Catalog Interface

- CD-ROM reader hardware
- Interface driver software (**cdrom**)
- Applications interface (STSDAS, including FITS reader)

SPACE TELESCOPE SCIENCE INSTITUTE

The cdrom command

- Installed as a Unix© command.
- Enables users to read the disk.
- Interactive.
- Most of the commands are identical to the Unix commands of the same name.
- Directory and file names may be an absolute or relative path.
- Unlike Unix, commands and file names are case insensitive.

cdrom commands

cd *directory*	Change the current working directory. If the argument is omitted, it changes to the root directory.
cp *CD_file disk_file*	Copy a file from the CD to the file system.
dump *filename*	Print a formatted dump of the file on standard output.
exit	Terminate the program.
ls *directory*	List the contents of a directory. If the argument is omitted, it lists the contents of the current working directory.
new	Advise cdrom that a new CD is in the reader and prints information about the disk.
pwd	Print the current working directory.
type *filename*	Print a file from the CD to standard output.

Sample cdrom dialog: copy region number 5249 from the CD to magnetic disk.

```
% cdrom
Planetary Data System CD ROM utility program
Commands: new cd pwd ls dump type cp help exit

Format: ISO 9660

Volume set: RME
Publisher: SPACE TELESCOPE SCI INST
Data preparer: MERIDIAN_DATA_CD_PUBLISHER
Application:
Creation Date: 12-21-1988

cdrom> cd /catalog/m0000
cdrom> cp 5249.gsc 5249.fits
cdrom> exit
```

The STSDAS cdgasp package

cdrom	Interact with the CD-ROM (run the host **cdrom** command).
extgst	Extract the stars in the user's field from a list of tables.
fttostt	Convert a list of FITS tables to STSDAS tables.
intrep	Compute and interactively refine a plate solution and find target coordinates based on the plate solution.
overlay	Mark guide stars on an image.
regions	Obtain guide star region files as STSDAS tables.
sgscind	Search the guide star catalog index table for regions overlapping user's field.
stgindx	Copy the catalog index table from CD to an STSDAS table.
targets	Find target coordinates. Puts together the separate tasks

The CD-ROM Guide Star Catalog

This optical CD-ROM sampler contains a subset of the Hubble Space Telescope guide star catalog and sample images from guide star plate scans. The catalog comprises tables containing coordinates and magnitudes of guide stars brighter than approximately $12m_v$. The sample images are small subsets of guide star plate scans.

Organization of the Disk

The disk is organized in a directory structure identical to a Unix file system. That is, there is a root directory and subdirectories containing files and/or directories. The name of the root directory is / and subdirectory names are separated by /.

```
/ Root Directory
    README.TXT  Explanatory information (ASCII)
    catalog  Catalog directory
        index.tbl  Catalog Index (FITS table)
        p0000  Directories containing northern declination zones
            0000.gsc  FITS Region tables
            0001.gsc
                ⋮
        p0730
            ⋮
        p8230
        m0000  Directories containing southern declination zones
        m0730
            ⋮
        m8230
    images  Images directory
        fits  FITS format sample images directory
            30_dor.fit
                ⋮
            sn1987a.fit
        st  ST format sample images directory
            30_dor.hhh
            30_dor.hhd
                ⋮
            sn1987a.hhh
            sn1987a.hhd
```

1

The README.TXT file in the root directory is an ASCII text file further describing the orga-
nization and contents of the disk. The index.tbl file in the catalog directory is a FITS table
containing the coordinates of each catalog region.

The guide star catalog data are in subdirectories of the catalog directory. Each catalog
directory contains guide star regions for a band of declination 7.5 degrees wide. The name of
the catalog directory indicates the declination zone by the letter p for positive declinations or
the letter m for negative declinations followed by a four digit code for the declination of the
band in degrees: 0000 to 8230. For example, directory /catalog/m4500 contains region files
with declinations between −45°00′ and −52°30′. The region table files are names sequentially,
that is with no relationship to position. To determine which file corresponds to a particular
region of the sky, you can read the index table (/index.tbl) which contains the name and
coordinates of the corners of each region.

There are two directories containing the same sample images in two different formats:
/images/fits/ contains FITS format images whose names have the extension .fit and the
directory /images/st/ contains images in ST format comprising pairs of files with the exten-
sions .hhh and .hhd. The sample image data are small subrasters of digitized scans of guide
star plates.

Reading the disk

The cdrom program, installed as a Unix command, enables users to read the disk. You type
commands to move through the directory structure, list files, or copy files onto the file system
on magnetic disk. Most of the commands are identical to the Unix commands of the same
name. Directory and file names may be an absolute or relative path. Note that unlike Unix,
commands and file names are case insensitive. That is, you can type in upper or lower case or
mix them at will.

cd *directory*	Change the current working directory. If the argument is omitted, it changes to the root directory.
cp *CD_file disk_file*	Copy a file from the CD to the file system.
dump *filename*	Print a formatted dump of the file on standard output.
exit	Terminate the program.
ls *directory*	List the contents of a directory. If the argument is omitted, it lists the contents of the current working directory.
new	Advise cdrom that a new CD is in the reader and prints information about the disk.
pwd	Print the current working directory.
type *filename*	Print a file from the CD to standard output.

For example, to copy region number 5249 from the CD to your current Unix working direc-
tory:

    % cdrom

    Planetary Data System CD ROM utility program
    Commands: new cd pwd ls dump type cp help exit

2

```
Format: ISO 9660

Volume set: RNE
Publisher: SPACE TELESCOPE SCI INST
Data preparer: MERIDIAN_DATA_CD_PUBLISHER
Application:
Creation Date: 12-21-1988

cdrom> cp /catalog/m0000/5249.gsc 5249.fits
cdrom> exit
%
```

To change to the root directory and see the explanatory information:

```
cdrom> cd
cdrom> type README.TXT
```

You can use an applications package to convert the FITS format tables to another format.

The STSDAS cdgasp package

The STSDAS package in IRAF includes tasks to convert the FITS format region tables to STSDAS format tables which are then usable by other STSDAS tasks. In particular, the cdgasp package in the stlocal package performs simple astrometry with the guide star catalog data and an arbitrary image, providing a subset of the STScI GSSS GASP facility. To use this package, log into IRAF, type stsdas and then stlocal, and finally cdgasp to make available the appropriate tasks. This package includes tasks to search the index table, copy region tables from the CD, convert from FITS to STSDAS tables, etc.

cdrom	Interact with the CD-ROM.
extgst	Extract stars from a list of tables.
fttostt	Convert a list of FITS tables to STSDAS tables.
intrep	Find target coordinates based on a plate solution.
overlay	Mark guide stars on an image.
regions	Obtain guide star region files as STSDAS tables.
sgscind	Search the guide star catalog index table.
stgindx	Copy the catalog index table from CD to an STSDAS table.
targets	Find target coordinates.

The most general task is targets. It searches the guide star catalog for objects wihin the user's field, extracts those stars from the catalog, allows the user to identify the guide stars with objects on an image, obtain a plate solution, and compute the coordinates of arbitrary targets in the field. It is necessary for the user to know the center, size and scale of the target image. See the help pages for cdgasp and other stsdas packages for more detailed information.

Joint CD-ROM Projects:

"West Coast Time Series"

by
C.J. Finch
NASA Ocean Data System
Jet Propulsion Laboratory

NODS
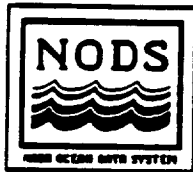
CDROM as Archive Tool Workshop
Goddard Space Flight Center
National Space Science Data Center
Greenbelt, Maryland
June 19-20, 1989

THE DATA

West Coast Time Series (WCTS)

- Digital imagery of phytoplankton pigment concentration (ocean-surface productivity) from the Nimbus7 Coastal Zone Color Scanner

- Collected between 1979 and 1986 at the Scripps Institute of Oceanography

- Covers the west coast of North America from Vancouver to Baja.

- These data are integral to oceanographic studies of large-scale physical and biological dynamics in the California Current System (CCS). Ships and other in situ measurements cannot provide repeated, synoptic, high-resolution data necessary to observe the variability of the CCS.

DATA PRODUCTS

- 4 different image-types

    1. tiles
    2. quick-look tiles
    3. mosaics
    4. clouds

- more than 6000 images total

- must be organized for quick retrieval based upon time and space, i.e.:

"I need all of the images for the Santa Barbara region for January, 1979"

"I'm interested in any data you have for the California Coast during the summer of 1980; the images must be cloud free"

"I have temperature data for the Gulf of California and need any clear images for that region."

THE USERS

- Who are they?

    -Research scientists from various scientific disciplines with various levels of computer skills; they tend to be less patient and less willing to spend a long time learning a new system. The also have the money, in most cases.

    -Graduate students with limited resources and usually pretty good computer skills; they have more time to 'play' but are less likely to have an influence on major purchases.

The characteristics of the science users interested in these data make them ideal candidates for utilizing CD-ROM technology if:
- the data are well organized
- its easy for them to find what they need
- the user interface in easy to use
- the hardware costs continue to come down
- more scientific data of interest are available on CD-ROM

- What kinds of computers do they use?
  - 1-SUN   (most common)
  - 2-microVax
  - 3-PC
  - 4-VAX
  - 5-MacII
  - 6-Cray
  - 7-IBM 30/81
  - 8-Cyber 205   (least common)

- What are their expectations in terms of accessing data?

  -Many users are still most comfortable picking up the phone and talking to a real person in order to obtain data.

  -Data systems are scary if they are too big, or too hard to use.

  -Inadequate documentation is a rampant problem that user's often encounter.

  -Magnetic disk storage is ALWAYS a problem.

  -Tape storage is a smaller, but growing problem.

THE ISSUES

- data compression
- file labels and SFDU's
- disk directory structure
- documentation
- index or inventory
- software
- pre-mastering
- mastering
- distribution

DATA COMPRESSION

NODS and PDS Experience

• 3000 high-resolution images were compressed for storage on the CD-ROM.

• 3000 quick-look image representations of the compressed, high-resolution images were also stored on the disk to allow rapid browsing.

• The compression scheme used was a first-difference, run length, Huffman code procedure.
- no data lost in decompression
- compression factors of 3-5

• The program to decompress the images was on the disk in executable form for the PC, and in source-code form in both C and Fortran.

• Decompression on a PC takes about 30 seconds per image.

• Compressing the images was very time consuming in terms of both CPU and personnel.

User Reaction

• Most users weren't bothered by the time it took to decompress the images. The attitude seems to be that computers will only get faster so decompression time get faster.

• Another advantage to compressing images is that it is undesirable to have a set of more than 5-10 CD-ROMs in a volume set.

• Its preferable to integrate the decompression software with the image display capability.

• It is desirable to provide a way for users to decompress many images at a sitting.

FILE LABELS AND STANDARD FORMAT DATA UNITS (SFDU'S)

NODS and PDS Experience

- All files are identified by a PDS label containing an SFDU.

- Labels are appended to the beginning of each image file.

- Compressed images are identified by an encoding-type description in the label.

- An encoding histogram is placed after the SFDU label.

User Reaction

- Most user's never see these labels.

- Attached labels are preferable over detached labels with pointers to the image files.

DISK DIRECTORY STRUCTURE

NODS and PDS Experience

- VOLDESC file and README file in root directory.

- Top level directories:

  DOCUMENTATION   CLOUD
  INDEX   MOSAIC
  SOFTWARE   TILE

- The CLOUD and MOSAIC directories each have only 3 subdirectories (one for each year, 1979, 1980, 1981)

- The TILE directory has potentially 1200 subdirectories.

TILE

tile_a	tile_b	....	tile_y	tile_z
79, 80, 81	79, 80, 81	......	79, 80, 81	79, 80, 81
jan-dec	jan-dec	......	jan-dec	jan-dec

- NODS provided the full-path name for every file on the disk.

User Reaction
- This is an unwieldy number of subdirectories around which to navigate.

- No suggestions so far as to how to improve; .the way we did it was the most logical considering how most people want to use the data.

Vendor Reaction
- Discovery Systems was impressed by the number of subdirectories and files. This was the first time they had worked with so many.

DOCUMENTATION

NODS and PDS Experience
- A user's guide which describes the data, products and how to decompress and display the images is on the disk.

- Distributed in printed form with the disk.

User Reaction
- Users prefer to have a printed copy of the manual before they begin.

INDEX

NODS and PDS Experience
- Contains an inventory of the images on the disk.

- Simple ASCII flat-table with commas delimiting the attributes.

- Can be loaded into commercially available database management systems.

User Reaction
- No user feedback yet.

SOFTWARE

NODS and PDS Experience

• Decompression software is on the disk in executable form.

• Image display software is being distributed separately on diskette. Updates occur too frequently.

User Reaction

• Users prefer to have the software on the CD.

PREMASTERING

NODS and PDS Experience

• Premastering software is rapidly evolving. Knowing the capabilities of the premastering software can greatly improve the process.

• ISO 9660 is a read-only format. Directories must be preallocated at the proper size.

• Generate "batch" files for the premastering system to do the work for you.

• Arrange the files on the tapes in the most logical order possible. Have meaningful file names.

• Check the final product very carefully. 600MB is a lot of data, there are many possibilities for error.

FUTURE DIRECTIONS

- Satellite Ocean Data

  -Geosat (GEOdetic SATellite) Altimeter Sea
   Surface Height Data
     - 2 years of global altimetry data
     - swath oriented as opposed to images
     - small number of files, subdirectories
     - very simple program provided to read
       and subset the data tracks
     - target completion data = Aug/Sept1989
     - will use NSSDC Premastering system

  -West Coast Time Series Coregistered Sea
   Surface Temperature/Chlorophyll Data
   (reprocessed with a new algorithm)
     - image data
     - many small files
     - compressed images w/ quick-looks
       for browse
     - more integrated decompression
       and display

- In Situ Ocean Data

  -TOGA (Tropical Ocean-Global Atmosphere)

               atmospheric data
               ship observations
               drifting buoy surface data
               moored buoy surface data
               sea level data
               wind stress data

     - a study of atmosphere-ocean heat
       exchange in order to better
       understand global processes
     - will be used to verify and
       calibrate satellite measurements
     - integrated with retireval software for the
       easiest possible access and display

Standards for CD-ROM

E.J. (Jerry) McFaul

Computer Scientist

U.S. Geological Survey

Chair - SIGCAT

CD-ROM Activity in the U.S. Government

Throughout the U.S. Government, many organizations are now using CD-ROM technology to enhance their data dissemination activities. A number of these organizations are still evaluating and prototyping the technology. Many more, however, have moved into a production mode and are distributing discs on a regular basis. In an effort to highlight some of this activity as well as provide points of contact to obtain additional information, the following compendium has been assembled.

Please note that while some organizations have initiated their own CD-ROM projects, others have licensed or otherwise made available their databases to value added resellers or VAR's. In these situations, the VAR's re-package these databases and, through the addition of high performance retrieval techniques, transform them into to marketable information products. Wherever possible, the corresponding VAR information has been included.

BUREAU OF LAND MANAGEMENT (BLM)

The Bureau of Land Management has produced two prototype discs, each involving a variety of earth science databases. Some of these databases entail petroleum research information while others consist of raster scan imagery.

Title: Joint Earth Science (JES) Nos. 1 & 2
Availability: Controlled distribution.
Price: No charge to BLM affiliates.
Contact:

Dave Traudt
Geologist
Bureau of Land Management
Eastern States Office
MS 972
350 S. Pickett St.
Alexandria, VA 22304
703/461-1347

CENSUS BUREAU

The government's premier statistical agency has created two discs to date, the first a prototype and the second now available as a product containing hundreds of megabytes of useful agricultural, demographic, and population numerical data.

Known as Disc No. 2, this latest Census disc contains two major types of data. The first is the 1982 Census of Retail Trade Zipcode File and the second is the 1982 Census of

Agriculture Final County File. The Census of Retail Trade includes data on establishment size, sales, numbers of employees, payroll and type of business (SIC codes). These data are indexed by zipcode and are in dBase III format for convenient analysis.

The Census of Agriculture includes data on farms, inventories and sales of livestock, poultry, and crops harvested. The data are organized by states and counties within states and cover the entire U.S. Also included is comparable data for selected items from the 1978 Census.

Title: Census Disc No. 2
Availability: Still available.
Price: $125.
Contact:

Forrest Williams
Chief, Systems & Programming Branch
Census Bureau
Suitland Federal Center
Suitland, MD 20746
301/763-4677
FAX: 301/763-4794

VAR's marketing commercial CD-ROM discs which include data from the Census Bureau are as follows:

Jack Massey
Managing Director
Space-Time Research, Ltd.
668 Burwood Road
Hawthorne East
Victoria 3123, Australia
61-3-813-3211
FAX: 61-03-882-4209

George Hall
President
Slater Hall Information Products
1522 K Street, N.W.
Suite 522
Washington, DC 20005
202/682-1356

GEOLOGICAL SURVEY (USGS)

Geologic Data

The USGS has been evaluating CD-ROM technology for over 4 years and has produced several prototype discs containing a variety of earth science information. One of the first discs to become available for general distribution is the GLORIA disc. This disc contains sonar-scanned imagery from the Gulf of Mexico seafloor using a technique developed by the British known as Geologic LOng Ranged Inclined Asdic. This disc is the result of a cooperative effort between the USGS, NOAA and NASA to produce a scientific data disc that provides high-resolution image displays on relatively inexpensive

equipment.

Title: GLORIA
Availability: Still available.
Price: Free to scientific researchers.
Contact:

Millington Lockwood
JOMAR Office
Geological Survey
915 National Center
Reston, VA 22092-9998
703/648-6525

VAR's marketing commercial CD-ROM discs which include bibliographical databases from the USGS are as follows:

John Mulvihill
American Geological Institute
4220 King Street
Alexandria, VA 22302
703/379-2480

Mary Marshall
Marketing Manager
Online Computer Library Center (OCLC)
6565 Frantz Road
Dublin, OH 43017-0702
800/848-5878

Cartographic Data

The National Cartographic Information Center (NCIC) within the USGS has produced a CD-ROM disc containing over 2.3 million records which serve as the master index to over 12 millions frames of photography available either from the USGS or private companies. This disc known as the Aerial Photography Summary Record System (APSRS) is being placed in all of the Earth Science Information Centers around the world.

Title: APSRS
Availability: Currently available.
Price: Free to Government affiliates of USGS.
Contact:

Dan Cavanaugh

Geological Survey
509 National Center
Reston, VA 22092-9998
703/648-5908

VAR's marketing commercial CD-ROM discs which include cartographic data from the USGS are as follows:

Jack Speer
President
Buckmaster Publishing
Route 3, P.O. Box 56
Mineral, VA 23177
703/894-5777

Ken Shain
President
Geovision
270 Scientific Drive
Suite One
Norcross, GA 30092-2923

Seismic Data

The National Earthquake Information Center (NEIC) within the USGS decided several years ago begin distributing its seismic event data (earthquakes with a magnitudes of 5.5 or greater) on CD-ROM instead of traditional 9-track magnetic tapes. The program has been so successful that the NEIC is now totally committed to CD-ROM, with thousands of discs now being distributed to seismic researchers throughout the world. Their seismic data is available in a more convenient form and it is also affordable by a much larger audience of scientists, particularly in the underdeveloped countries.

Title: NEIC Event Data (Discs 1 - 4)
Availability: Still available.
Price: Free to scientific researchers.
Contact:

Madeline Zirbes
Mathematician
Geological Survey - NEIC
P.O. Box 25046, MS967
Denver Federal Center
Denver, CO 80225
303/776-1506

Hydrologic Data

A project was initiated several years ago by the Water Resources Scientific Information Center (WRSIC) of the Water Resources Division, U. S. Geological Survey, to place the complete bibliography of Selected Water Resources Abstracts (SWRA) CD-ROM on CD-ROM. The resulting disc contains thousands of abstracts from hydrologic scientific papers addressing the major water resources throughout the world.

The SWRA database is compiled from several thousand publications by WRSIC. Topics of interest to both the research and business communities are covered from 1967 to the present. This database is updated on CD-ROM every July and January. Any field may be searched by any word or combination of words found in the text. All the data on this

disc is recorded in English. Any topic, however remotely related to water, is likely to be covered in this database of over 215,000 citations and growing!

Title: SWRA
Availability: Still available.
Price: Free to Government affiliates of USGS.
Contact:

George Knapp
Hydrologist
Geological Survey
425 National Center
Reston, VA 22092-9998
703/648-6823

VAR's marketing commercial CD-ROM discs which include the SWRA database are as follows:

Fred Durr
Director, CD-ROM Development
National Information Services Corp. (NISC)
335 Paint Branch Drive
College Park, MD 20742
301/454-8039

Mary Marshall
Marketing Manager
Online Computer Library Center (OCLC)
6565 Frantz Road
Dublin, OH 43017-0702
800/848-5878

VAR's marketing commercial CD-ROM discs which include hydrologic data (daily value stream flow) from the USGS are as follows:

Roger Edmunds
Sales Manager
U S WEST Information Systems
7564 Standish Place
Suite 112
Rockville, MD 20855-2745
301/294-1449

GOVERNMENT PRINTING OFFICE (GPO)

The Government Printing Office isn't so much concerned with placing their own data onto CD-ROM as they are with helping other agencies put their data on this new medium. The GPO serves in an advisory capacity to other agencies wishing to explore CD-ROM. The newly-established Electronic Publishing Section within GPO maintains a staff of account representatives to provide technical consultation on the various aspects of CD-ROM as well as other related electronic publishing technologies.

John Chapman
Superintendent, Term Contracts Division
Government Printing Office
North Capitol & H Streets, N.W.
Stop: ED
Washington, DC 20401
202/275-2621

HOUSING AND URBAN DEVELOPMENT (HUD)

Two U.S. Government agencies recently joined forces to produce a disc containing related information from each organization. This synergistic disc was produced by the Department of Housing and Urban Development (HUD) and the Bureau of the Census. Known as the 1985 American Housing Survey, this effort represents the first time the Census Bureau has made microdata available for sale on CD-ROM. Once again, the technology of CD-ROM has provided a vehicle for stimulating and facilitating inter-agency cooperation.

Title: American Housing Survey
Availability: Currently available.
Price: $125.
Contact:

Duncan MacRae
General Asst. Deputy Asst. Secretary
Department of Housing and Urban Development
451 7th St., N.W.
Washington, DC 20410
202/755-5600

INTERNAL REVENUE SERVICE (IRS)

The IRS is continuing to explore CD-ROM technology for various applications within their organization. No discs are currently available directly from the IRS, but the point of contact for the status of CD-ROM activity is:

Peggy Carpenter
Project Manager
Internal Revenue Service
CC : IS : SD Room 4205
1111 Constitution Avenue, N.W.
Washington, DC 20224
202/786-8647

LABOR DEPARTMENT

James McCall
Program Analyst
Department of Labor

Bureau of Labor Statistics
441 G St., N.W.
Washington, DC 20212
202/633-6975

LIBRARY OF CONGRESS (LC)

The Library of Congress produced their first CD-ROM disc last year which contains the MARC Subject Authority database, sometimes referred to as the "Red Book." Their next project will (due by the end of 1989) will be a multi-disc set containing their MARC Name Authority database. Future discs will include the complete MARC Bibliographic database.

Title: MARC Subject Authority Disc
Availability: Currently available.
Price: $
Contact:

Dominick Mormino
Customer Service Officer
Library of Congress
Cataloging Distribution Service
Customer Services Section
Washington, DC 20541
202/707-1309

NATIONAL AERONAUTICS & SPACE ADMINISTRATION (NASA)

Jet Propulsion Lab (JPL)

NASA was an early user of CD-ROM and has already produced a wide variety of titles on scientific subjects. Some of these discs are as follows:

Space Science Sampler

The Space Science Sampler series includes the PDS Interactive Data Interchange disc. This disc contains data files collected during the Planetary Data System (PDS) Interactive Data Interchange (IDI) Workshop held during the spring and summer of 1986.

There are 5 major categories of files on the disc: Astronomy, Land Science, Ocean Science, Planetary Science, and Solar Terrestrial.

Astronomical data includes star catalog files and the Infrared Astronomical Satellite (IRAS) point source catalog. The Land Science data includes Radar images of Charlevoix, Quebec and Los Angeles, multispectral analysis of sedimentary basins, and NOAA elevation averages for continental US. The Ocean Science data contains sample sea surface temperature and chlorophyll concentration image files at the root level, as well as a series of images which provide a "movie" of the global sea surface temperature over a two week period. Planetary Science includes a wide variety of scientific data for major planetary bodies.

Finally, the Solar Terrestrial data contains an interplanetary medium database prepared by NSSDC and a database which provides solar rotation averages. Also included are photometer measurements from the Dynamics Explorer spacecraft.

Voyagers to the Outer Planets

NASA is currently producing a 3-disc set called "Voyagers to the Outer Planets" which comprises over 6,500 images of the planet Uranus and its moons. Each disc in the set contains images returned by NASA's Voyager 2 spacecraft during its encounter with the planet Uranus.

The second disc in the set contains images taken during the near encounter phase, when Voyager 2 made its closest approach to Uranus in January 1986. The disc contains the best images of the rings and the satellites of Uranus. The images are the full-resolution (800 pixels by 800 scan lines) digital images returned by the Voyager cameras.

Ocean Data Systems

NASA has produced a disc containing color imagery called the West Coast Time Series, Volume 1. The data on this CD-ROM are gridded and navigated images of near-surface pigment concentration and cloud cover for the eastern Pacific Ocean derived from measurements made by the Coastal Zone Color Scanner (CZCS) on board the Nimbus-7 satellite. The data begin in December 1979, and extend through the end of 1986. This volume contains data for the first 3 years (1979 - 1981). The West Coast Time Series (WCTS) region extends from the northern tip of Vancouver Island to the southern tip of Baja California (20N to 55N), and from 105W (255) to 140W (220).

Availability: Currently available.
Contact:

Mike Martin
Planetary Systems Project Engineer
National Aeronautics & Space Administration (NASA)
Jet Propulsion Laboratory
4800 Oak Grove Drive
M/S 233-208
Pasadena, CA 91109
818/354-8751

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION (NOAA)

National Geophysical Data Center (NGDC)

The NGDC in Boulder, Colorado was one of the first agencies to produce a CD-ROM containing multiple scientific databases relating to a specific discipline. Their NGDC01 disc contains 18 different types of geomagnetic and solar-terrestrial data compiled from the holdings of the NGDC as well as NASA's National Space Science Data Center. This disc has been distributed to over 600 researchers around the world. NOAA reports that one of the exciting results of this project is that the use of their disc seems to be fostering a significant increase in the number of new discoveries and correlations of these data due to the enhanced accessibility of CD-ROM technology.

Availability: Still available.
Price: Free to scientific researchers.
Contact:

Carl Abston
Systems Advisor
National Oceanic & Atmospheric Administration
NGDC
325 Broadway (D-65)
Boulder, CO 80303
303/497-6276

National Oceanographic Data Center (NODC)

The NODC is just completing an experimental compact disc called NODC-01 containing the Pacific Ocean temperature and salinity profiles from 1900 through 1988.

Availability: Summer of 1989.
Price:
Contact:

Philip Hadsell
Oceanographer
National Oceanic & Atmospheric Administration
NODC
1825 Connecticut Avenue, N.W.
Room 422
Washington, DC 20235
202/673-5600

National Ocean Service (NOS)

The Next Generation Cartography Program is a technology demonstration project sponsored by the National Aeronautical & Atmospheric Administration (NOAA). The goal of the Next Generation Cartography Program is to meet the public need for legally recognized electronic databases for input to evolving electronic map systems. A key thrust of the Program is to meet the critical need for a compatible database to support both airborne cockpit displays and air traffic control requirements. The project has recently produced an aeronautical data sampler on CD-ROM.

David Dudish
Research Cartographer
National Oceanic & Atmospheric Administration
6010 Executive Bvld.
Room 1022 - R/C N/CG 3X 22
Rockville, MD 20852
301/443-8323

NATIONAL AGRICULTURAL LIBRARY (NAL)

The NAL will be producing several discs containing raster scan images during 1989. The NAL has also licensed their bibliography of agricultural database known as AGRICOLA to several private publishers. This database covers the literature of agriculture and related disciplines including food and nutrition. The database indexes journals, conference proceedings and translations, and includes publications from the U.S. Department of Agriculture (USDA), the Extension Service, and the Food and Agricultural Organization (FAO).

Future NAL discs will contain databases on aquaculture, food irradiation, agent orange and international agricultural research.

Contact:

Pam Andre
Chief, Information Systems
National Agricultural Library
Department of Agriculture
10301 Baltimore Bvld., 5th Floor
Beltsville, MD 20705
301/344-3813

Availability: The following VAR's market the AGRICOLA database on CD-ROM:

Mary Marshall
Marketing Manager
Online Computer Library Center (OCLC)
6565 Frantz Road
Dublin, OH 43017-0702
800/848-5878

Christopher Pooley
Sales Manager - USA
SilverPlatter Information, Inc.
37 Walnut Street
Wellesley Hills, MA 02181
800/343-0064

Mark Foster
President
Quanta Press
2239 Carter Avenue
Suite 205
St. Paul, MN 55108
612/641-0714
FAX: 612/644-8811

NATIONAL INSTITUTES OF HEALTH

Lister Hill Center

The Lister Hill Center has produced a small number of experimental discs to evaluate the effectiveness of using CD-ROM to store high-resolution X-ray images for subsequent use in their radiological training program. Among other things, the project determined that CD-ROM provided a significant improvement in the signal-to-noise ratio associated with the images compared to earlier attempts with other types of optical storage media.

Contact:

Earl Henderson
Dep. Director
National Institutes of Health
Lister Hill Center
8600 Rockville Pike
Bethesda, MD 20209
301/496-4441

National Center for Health Statistics

John Mounts
Chief, Scientific & Technical Information
National Center for Health Statistics
3700 East-West Highway
Room 1-57
Hyattsville, MD 20782
301/436-8586

National Library of Medicine (NLM)

The NLM has licensed their MEDLINE database to at least 8 VAR's. This database contains abstracts and indexes to the world's biomedical journal literature. For further information, please contact:

Rose Marie Woodsmall
Program Analyst
National Institutes of Health
National Library of Medicine
Bldg. 38, Room 2S16
Bethesda, MD 20894
301/496-8834

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS)

NTIS provides a brokerage function for many government agencies in marketing their information. Traditionally based in the print and microfiche technologies, NTIS was one of the first government organizations to experiment with the licensing of databases to be placed onto CD-ROM.

Contact:

Al Betts
Director, Quality & Technology Support
National Technical Information Service
5285 Port Royal Road - 207F
Springfield, VA 22161
703/487-4672

PATENT AND TRADEMARK OFFICE (PTO)

PTO produced their first CD-ROM disc to provide an alternative to their online information service called CASSIS. Seventy-five discs were produced and have undergone evaluation in many Federal Depository Libraries. Each CASSIS CD-ROM disc contained over 5 million patent records, with every patent and classification field searchable by the user. In addition, the disc contained abstracts of all patents issued within the last 12 months, as well as the full text of the U.S. Patent Classification Manual. Anyone who has purchased rights to a particular patent will be included in the Assignee File which was also on the disc.

The results of their first disc were so favorable that PTO has recently produced a new 2-disc set which will be updated 6 times a year. This CD-ROM set builds on their first disc and now contains the following:

Classification Information

The CASSIS/CD-ROM contains current classification information on all Utility, Design, Plant, Reissue, and X-numbered patents, as well as Defensive Publications and Statutory Invention Registrations, issued from 1790 to the present (over 5 million documents). Indexing of classification information has been optimized for rapid retrieval.
contains textural information on over 1 million patents which may be accessed in a variety of text searching modes.

Bibliographic Information

Additional information is available for Utility patents issued from 1969 to the present, and for other patent documents issued from 1977 to the present. That information includes the year of issue, the state/country of the inventor's residence, the assignee at the time of issue, the title and status (withdrawn, or expired for failure to pay maintenance fees). The most recent patent abstracts (up to 3 years depending on disc space) are also provided.

Manual of Classification

The Manual of Classification contains the titles of all classes of the U.S. Patent Classification (USPC) System. In CASSIS/CD-ROM, a class is stored as several records, with each record headed by a mainline subclass and followed by its subordinate (indented) subclasses. Each record is displayed as it would appear in the printed Manual of Classification.

Availability: Currently available.
Price: $300/yearly subscription (6 issues = 12 discs)
Contact:
Bill Lawson

Administrator for Documentation
Patent and Trademark Office
Crystal Mall 2
Suite 300
Washington, DC 20231
703/557-0400

POSTAL SERVICE (USPS)

The USPS has embraced CD-ROM technology on a very large scale. They have rolled out a nationwide program comprised of 438 CD-ROM workstations located in over 200 postal facilities to support the ZIP+4 address coding system. Many are regarding this rollout as the first real large-scale production use of CD-ROM in either government or in private industry. The 438 PC-based systems are expected to significantly reduce costs when compared to an earlier ZIP+4 system which used an online computer system.

Contact:

Michael Selnick
Program Manager, CD-ROM
Postal Service
Office of Address Information Systems
475 L'Enfant Plaza SW
Washington Headquarters, Room 7431
Washington, DC 20260-7230
202/268-3519

VAR's marketing commercial CD-ROM discs which include ZIP+4 data from the USPS are as follows:

Dennis Beaumont
Executive Vice President
Information Update Incorporated
1190 Saratoga Avenue
Suite 210
San Jose, CA 95129-3433
408/236-3297

Additional organizations in the Department of Defense are using CD-ROM technology. As these organizations often work under a different set of rules from the executive branch, they are grouped together into a separate category.

AIR FORCE

The Air Force, as with many of the DOD organizations, must contend with myriad procurement regulations and directives. In an effort to more effectively deal with this voluminous information, the Air Force produced a series of CD-ROM discs containing the complete set of procurement regulations.
Contact:

John Herman
U.S. Air Force
ESD/AVSI
Building 1704 - Rm 206
Hanscom AFB, MA 01731-5000
617/377-2713

ARMY - Cold Region Laboratory

Contact:

Nancy Liston
Army Cold Regions Laboratory
72 Lyme Road
Hanover, PA 03755
603/646-4221

ARMY - Corps of Engineers

The Army Corps has recently produced a CD-ROM disc which combines both text and graphics. This application is currently being evaluated.

Contact:

Ed Miller
Army Corps of Engineers
20 MAssachusetts Avenue, N.W.
CEIM-SP, RM 5121C
Washington, DC 20314-1000
202/272-0786

DEFENSE MAPPING AGENCY

The DMA has perhaps the most ambitious CD-ROM program in the entire U.S. Government. As of April, 1989, DMA began producing approximately 30 masters (titles) per week, with each master generating approximately 400 replications. This agency alone will double the number of titles in the CD-ROM industry by the end of 1989.

William Alford
Physical Scientist
Defense Mapping Agency Systems Center
DMASC / SGW
12100 Sunset Hills Road, #200
Reston, VA 22090-3207
703/285-5001

NAVY - Facilities Engineering Command (NAVFAC)

NAVFAC has produced a disc called the Construction Criteria Base (CCB) which is now in

its ninth quarterly update. This CD-ROM contains all of the design and building specifications to which architectural, engineering and construction firms must adhere when working on facilities for the Army, Navy or NASA.

Title: CCB
Availability: Currently available.
Price: $550/yr. to Gov't; $970 to private companies
Contact:

Gary Johnson
Program Analyst
Naval Facilities Engineering Command
NAVFAC - USNCBC - Code 15612
Port Hueneme, CA 93043
805/988-3361

All of the points of contact listed in the above compendium are members of the Government's Special Interest Group on CD-ROM Applications and Technology, otherwise known as SIGCAT. SIGCAT was formed in 1986 to facilitate the sharing of information and experiences relating to the use of CD-ROM technology throughout the Federal Government. For further information on SIGCAT, contact:
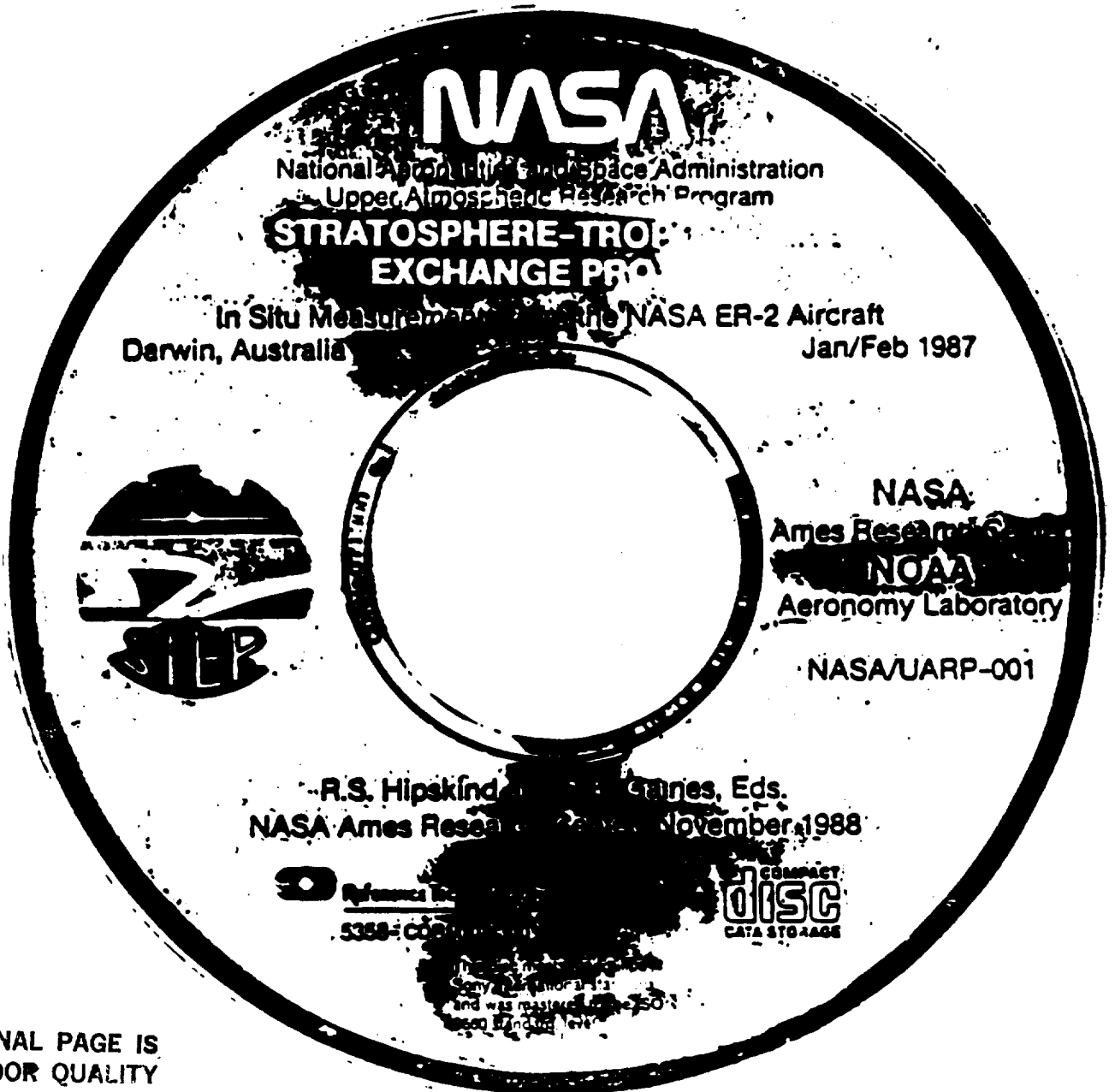
E. J. (Jerry) McFaul
Computer Scentist
904 National Center
12201 Sunrise Valley Drive
Reston, VA 22092-9998
703/648-7126
FAX: 703-648-6138

STEP AND AAOE Projects

MIKE PRATHER

Upper Atmosphere / Tropospheric Chemistry Branch

NASA Headquarters

NASA

National Aeronautics and Space Administration
Upper Atmospheric Research Program

ANTARCTIC O...

NASA ER-2 and DC-8 Aircraft Measurements and
Antarctic Ozonesondes

Punta Arenas, Chile

Aug/Sep 1987

NASA · NOAA

NASA/UARP-002

R. Win... Gaines, Eds.
NOAA/ER... NASA ARC, May 1989

COMPACT
disc
DATA STORAGE

Disc Standards and CD-ROM

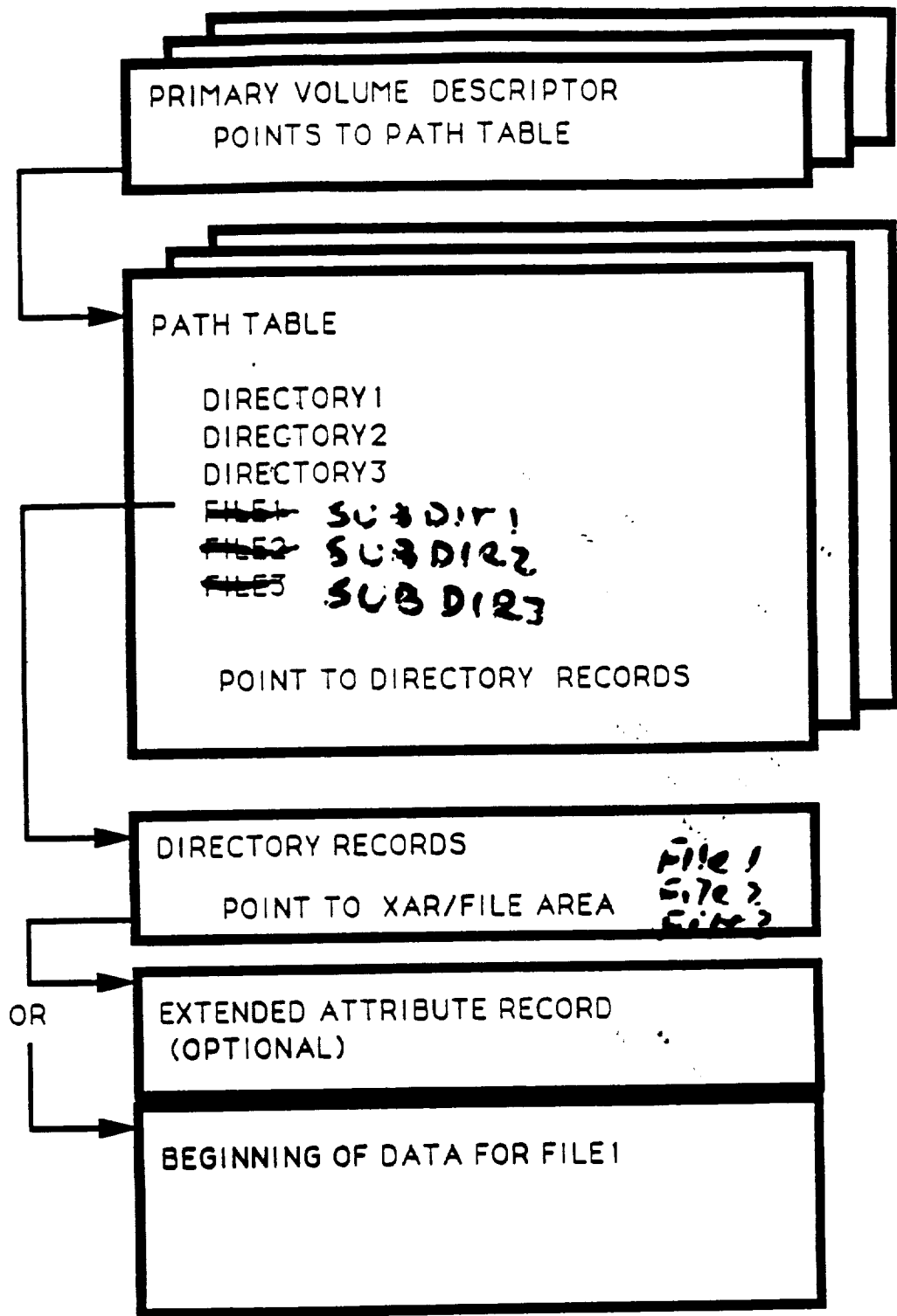## Mike Martin

Project Engineer

PDS/JPL

JPL

CD-ROM as an Archive Tool

Overview

- CD-ROM disk structure issues.

- Data Publishing and Distributable Data System concept.

- Tools for creating and using CD-ROMs.

PRIMARY VOLUME DESCRIPTOR
POINTS TO PATH TABLE

PATH TABLE

DIRECTORY1
DIRECTORY2
DIRECTORY3
~~FILE1~~ SUBDIR1
~~FILE2~~ SUBDIR2
~~FILE3~~ SUBDIR3

POINT TO DIRECTORY RECORDS

DIRECTORY RECORDS

POINT TO XAR/FILE AREA

File 1
File 2
File 3

EXTENDED ATTRIBUTE RECORD
(OPTIONAL)

OR

BEGINNING OF DATA FOR FILE1

- High Sierra format and ISO 9660 are not the same! High Sierra is defined by a working document, not an international standard and should not be used for NASA CD-ROMs.

- The ISO format allows for multiple copies of directory information, and path table but only a few vendors use this capability. If a disk is scratched on the Primary Volume Descriptor, access to all data files is lost.

- Recommendations for CD-ROM architecture:
  - Use ISO 9660!!!!!
  - Use multiple volume descriptor records.
  - Use alternate path tables.
  - File names should include version number ";1".
  - Extended attribute records? We are working with vendors to make them easy to create. Not clear how they will be used.

- Think of our data archives as stand-alone 'publications'.

- Integrate data, documentation, software and catalog in one media form.

- PDS is beginning to work toward this goal with Standards for the Preparation and Interchange of Data (SPIDS), and SPIDS workbook.

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CD-ROM as an Archive Tool

CD-ROM related tools available from PDS.

- FORTRAN code for access to CD-ROMs on VAX systems.

- C code for access to CD-ROMs on Sun systems.

- Compression source code (FORTRAN) and decompression source code (FORTRAN and C) for 8-bit images.

- C code for keyword=value parser (for object description language).

- Extended Attribute Record (XAR) builder routine for VAX.

- Dump/Edit for VAX/PC to inspect and modify binary files.

- IMDISP (IBMPC) and PIXELPUSHER (MAC II) display programs.

- In process:
  - File browser for ASCII and binary files.
  - VAX utilities for creating and testing CDROM layouts.
  - Label maker program for defining data formats.

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JPL

CD-ROM as an Archive Tool

CD-ROM related tools available from PDS. - cont.

- JPLPDS::disk$user1:[CDROM...] CD-ROM software for VAX, UNIX.

- JPLPDS::disk$user1:[IMDISP..] Image display for PC, MAC.

- JPLPDS::disk$user1:[LABULL.ODLC] Label parser routines.

- or STARGATE (128.149.35.1) username anonymous, password guest, change directory 'cd' to pub, use 'ls' to view directories.

- all files stored as VAX fixed-length (binary) or text files (source code).

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The Voyager Uranus Imaging CD-ROMs.

Eric Eliason (USGS, Flagstaff), Mike Martin (JPL)

INTRODUCTION

The enclosed set of CD-ROM disks contains the 6,538 images taken by Voyager 2 during the Uranus Encounter. The disks were produced as a cooperative effort of the Voyager Project, the Imaging Science Team, the Multimission Image Processing System, and the Planetary Data System. In the near future additional disks containing 4,000 Saturn images, 6,000 Jupiter images, and a collection of Voyager Uranus non-imaging data sets will be available. Images from the Neptune encounter will also be distributed on CD-ROM.

The Planetary Data System is working with other missions and planetary research facilities on CD-ROM disks which will contain the Viking Orbiter images, the Viking radiometry data set, and a Magellan radar archive. The Magellan project is currently planning to distribute most if its image products on a set of 60 CD-ROM disks in 1991. Other science disciplines are also adopting CD-ROM for storing important data sets, and a score of ocean, astronomy, comet, seismic, geophysical, meteorological, mapping, and terrestrial image disks have been completed or are in development.

This document provides information on how the Uranus imaging CD-ROM set can be used. Section I is a guide for obtaining CD-ROM hardware to read the disks. Section II provides a summary description of the contents of the three disks, and tools which are available to display and process the images. Section III provides a brief summary of CD-ROM technology. The Appendices provide a list of hardware and software vendors, a bibliography and a list of producers of other scientific CD-ROM disks.

I. CD-ROM READERS

In order to access the CD-ROM disks you will need a CD-ROM reader. CD-ROM readers are widely available for IBM Personal Computers and compatibles at a cost of about $800 for a drive and interface board. They are less widely available and more expensive for Macintosh computers, Digital Equipment Corp (DEC) MicroVAX computers, and Sun computers at costs ranging from $800 to $2800. Readers are not yet available for DEC VAX systems (11/780, 11/750, etc) or for most other mini and mainframe computers.

On IBM PC and Macintosh computers the software to access CD readers as standard disk drives is supplied with the CD reader. Software to access CD readers on MicroVax computers can be obtained from the PDS or USGS, Flagstaff. Integrated support of CD-ROMs on MicroVAX's is expected in the next year. Software for Sun computers is available with CD readers, but is fairly expensive.

A. IBM PC and IBM PS/2 hosts:

PC users should have no trouble finding a CD-ROM drive and interface board for their machines. Appendix A of this document lists vendors and features of popular CD-ROM drives for these host computers. The PDS has had great success with the Hitachi and Toshiba drives it is using. The Toshiba XM-3201 drive has an added advantage of being usable on an IBM PC AT, Macintosh or Sun computer. If you plan to use a CD reader with an IBM PC AT or compatible you may want to consider one of the new half-height drives. These will fit into the floppy drive enclosure beneath the 1.2 megabyte floppy drive on the AT. Another important consideration is the interface. Most drives with SCSI (Small Computer System Interface) interface boards will allow connection of up to seven drives to one interface board.

Software support for the CD-ROM drive is composed of two parts, the device driver for the CD-ROM reader, which is written by the CD-ROM vendor, and the Microsoft Extensions, which allow the drive to look like a standard disk unit on your system. Be sure to request the Microsoft Extensions, Version 2.1 when ordering a drive. Older versions may not support certain drive functions, and you will probably have to pay for an upgrade, or purchase new extensions at a later date.

B. Macintosh hosts:

PDS has tested CD-ROM drives from Apple Computer (Apple CD-SC) and Toshiba (XM-3201A1 MAC). You must specifically request the Macintosh ISO 9660/High Sierra software from Apple in order to read the Voyager CD-ROMs (and all other scientific CD-ROMs produced within NASA). The initial Macintosh ISO software checks every file on the CD-ROM when a disk is loaded in the drive, which can be a very time-consuming process. Ask for the latest updated version of the ISO drivers when purcasing a drive.

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C. **Digital Equipment Corp. hosts:**

There is no commercially available CD-ROM hardware for VAX minicomputers based on the UNIBUS (VAX 11/780, 750, etc.), and none is expected in the near future. Consider installing a drive on newer VAX hardware, and accessing the data via DECNET. Users with Q-BUS based MicroVAX and VAXstation computers can purchase a CD-ROM drive directly from Digital Equipment Corp. The RRD-50 is a CD-ROM reader which comes with an interface board capable of hosting two CD-ROM drives. The initial price for the drive and interface board was $1200, but DEC has been selling this package for about $500 in recent years. A new DEC reader, the RRD-40 is priced at $2800.

D. **SUN Hosts:**

Delta Microsystems provides a drive and software for Sun Minicomputers. Don Anderson of Arizona State University (ASUIPF::ANDERSON) has developed access software for use on Sun computers. It is anticipated that Sun will supply support for CD-ROM drives in the near future.

E. **Other:**

Contact your computer vendor for information about CD-ROM support.

II. VOYAGER CD-ROM CONTENTS

CD-ROM Volumes 1 through 3 contain the images returned by NASA's Voyager 2 spacecraft during its encounter with the planet URANUS. Future volumes in the "Voyagers to the Outer Planets" series will contain images from the other planets visited by the twin Voyager spacecraft.

There are two groups of images in this collection. The first group of images are the full-resolution (800 pixels by 800 scan lines) digital images returned by the Voyager cameras. No additional processing has been performed to enhance the images. The images are compressed to permit us to pack more data onto each volume but they can be restored to their original resolution using algorithms described in other documentation. Image decompression software and I/O access routines written in several programming languages are available on each CD-ROM and on the JPLPDS node of the Space Physics Analysis Network (SPAN).

The image numbers of the full-resolution images are shown below for each CD-ROM:

Volume 1 - Images 24476.54 to 26439.58
Volume 2 - Images 26440.04 to 26949.43
Volume 3 - Images 26951.07 to 27628.47

The second group of images was produced by converting all of the Voyager images taken at Uranus to a special 'browse' format. Browse images consist of every fourth pixel of every fourth scan line, resulting in an image of 200 pixels by 200 scan lines. You can use browse images to quickly locate

an image of interest to you and then go back to the compressed version of the image to get the full 800 pixel by 800 scan line resolution. The browse image collection is located on Volume 3.

Located on each CD-ROM volume and on the JPLPDS SPAN node is a document file named VOLINFO.TXT that describes in detail the organization of this disk and the format and content of the Voyager Uranus images. It is highly recommended that you read the VOLINFO document before trying to process image files. (The VOLINFO.TXT file can be found on the SPAN node and directory:

JPLPDS::DISK$USER1:[CDROM.VAX]VOLINFO.TXT)

The CD-ROM directory named INDEX contains a file IMGINDEX.TAB which is an index to all of the Uranus images. The index table is human and machine readable. While you can locate images by simply searching through the index yourself, the table has been designed so that it can be easily loaded into most database managers for fast and efficient searching. The file named INDXINFO.TXT in the INDEX directory describes the index table in detail.

The CD-ROM directory named SOFTWARE contains source and executable versions of image decompression software written in Fortran, C and VAX Macro assembly language. There is one executable decompression program for IBM PCs and another for VAX VMS systems. The file named SOFTINFO.TXT in the SOFTWARE directory describes the software in detail. Software also exists on the JPLPDS node of the SPAN network. See details below for more information on software.

Each compressed full-resolution image is contained in a file and the compressed image files are located in directories named after the principal target of the image. In alphabetical order the directories containing compressed images on the Uranus volumes are:

Directory Name	Directory Contents
ARIEL	Images of satellite Ariel
MIRANDA	Images of satellite Miranda
OBERON	Images of satellite Oberon
TITANIA	Images of satellite Titania
UMBRIEL	Images of satellite Umbriel
URANUS	Images of Uranus
U_RINGS	Images of the rings of Uranus

In addition there are two catch-all directories containing compressed images:

Directory	Directory Contents
CALIB	Calibration images
OTHER	Images that don't fit in any other category

If there are no images of a target on a particular volume then the target's directory is omitted. If there are more than about 100 images of a target on a volume, the images are further divided into subdirectories based upon their image number. Each image subdirectory has a name of the form CnnnnXXX, where nnnn is the first four digits of the seven-digit image number. All images of the target with image numbers that have those first four digits will appear in the subdirectory.

Each browse image is contained in a file and the browse image files are arranged into directories using the scheme outlined above for compressed images. The only difference is that all of the browse image directories are located under the directory named BROWSE. Within the BROWSE directory you will find, for example, a subdirectory named ARIEL that contains all the browse format images of the satellite Ariel.

Most files on this disk have a label encoded in the Object Description Language (ODL). A file's ODL label is readable by both humans and computers and it provides a formal description of the format and content of the file. For most files the ODL label appears at the beginning of the file All image files have such an embedded ODL label preceding the data in the file. For files where labels can't be easily included, a separate label file is provided that contains the ODL label and a pointer to the file that the label describes. These external label files all have a .LBL file extension. An example of an external label is the file IMGINDEX.LBL in the INDEX directory which contains the ODL label for the index file IMGINDEX.TAB. The LABEL directory contains two files with external ODL labels that describe the format and content of the engineering information that is contained within each image file. For a description of the Object Description Language, see the document file VOLINFO.TXT in the DOCUMENT directory.

Please be aware that there are several problems with the first Voyager Uranus CD-ROM volume. Firstly, 76 images of Uranus were placed into the wrong subdirectory: these images all have image numbers beginning with the digits 2624 and hence they should have been placed into a subdirectory named URANUS.C2624XXX; but due to a juxtaposition of digits they are instead located in the directory URANUS.C2264XXX.. Secondly, the image file C2625405.IMQ should have been placed on Volume 1 but is found on Volume 2. Thirdly, the image file C2449031.IMQ on Volume 1 is in error and a corrected file was placed on Volume 2. Lastly, the IMGINDEX.TAB file on Volume 1 reflects the errors described above. Use the updated IMGINDEX.TAB file found on Volumes 2 or 3.

A. Software for Voyager/CD-ROM Access:

A variety of software exists for accessing VOYAGER/CD-ROM images. If your computer system has a link with SPAN, then it is simple to access this software. The software files are located on the JPLPDS node. If you have a VAX/VMS system, an example copy command would be as follows:

$COPY JPLPDS::DISK$USER1:[CDROM.VAX]READ.ME *

In the example, the READ.ME file in the [CDROM.VAX] directory, would be

copied to the default directory on your system. Software for CD-ROM access is available for VAX/VMS, UNIX, IBM/PC, and Macintosh II computer systems. There is a directory for each supported computer system. In addition, software exists on the CD-ROM in the [SOFTWARE] directory.

If your computer system is not part of SPAN, then the software can be provided to you via magnetic tape or floppy disk. Contact the individuals shown below for a copy of the software:

<div style="display:flex; gap: 2em;">

<u>VAX/VMS or UNIX users contact:</u>
Eric M. Eliason
Branch of Astrogeolgy
U.S. Geological Survey
Flagstaff, Az. 86001
Telephone: (602) 527-7113

<u>IBM/PC or Mac II users contact:</u>
Mike Martin
Mail Stop 233-208
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, Ca. 91103
Telephone: (818) 354-8751

</div>

B. **Software Available for the VAX/VMS Environment:**

Filename/Path	Description
JPLPDS::DISK$USER1:[CDROM.VAX]	This directory contains CD-ROM software pertinent to a VAX/VMS system. The files listed below are contained in this directory.
READ.ME	The file describes contents of the [CDROM.VAX] directory. More information is available on the subroutines and programs for access to CD-ROM files.
VOLINFO.TXT	This file contains the document "Archive of Digital Images from NASA's Voyager 1 and 2 Missions". The document describes the contents of the Voyager CD-ROMs, the CD-ROM directory structure, the file format of full-resolution compressed image files and browse image files, and software contained on the CD-ROMs.
CDROM_UTILITY_SUBROUTINES.COM	The command file creates the CDROMLIB.OLB object module library and source code files for CD-ROM access subroutines. The subroutines created are low-level I/O routines, high-level routines specific to PDS image files, and image decompression routines.

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B. **Software Available for the VAX/VMS Environment** (continued...)

Filename/Path	Description
CDROM_TAE_UTILITY_PROGRAMS.COM	The command file creates the utility programs CDDIR, CDTYPE, and CDCOPY. CDDIR obtains directory listings of a CDROM, CDTYPE types ASCII CDROM files, and CDCOPY copies a CDROM file to a magnetic disk file. These programs run under the TAE user interface.
CDROM_VMS_UTILITY_PROGRAMS.COM	Command file containing CDDIR, CDTYPE, and CDCOPY. These programs have the same function as the ones shown above, only they do not require the TAE user interface.
CDROM_PICS_PROGRAMS.COM	The command file builds the CD2PICS program. For groups which utilize the PICS image processing system, CD2PICS will convert a CD-ROM image file to the PICS format. PICS must be on your system in order to execute this command file.
CDROM_VICAR_PROGRAMS.COM	The command file builds the program for converting a CD-ROM image file to the VICAR format. VICAR must be on your system in order to execute this command file.

C. **Software Available for the UNIX Environment:**

Filename/Path	Description
JPLPDS::DISK$USER1:[CDROM.UNIX]	This directory contains CD-ROM software pertinent to the UNIX environment.
READ.ME	General information file describing contents of the [CDROM.UNIX] directory.
CDIO.SHAR	Software which provides an interface with ISO 9660 volume and directory standard. The software assumes your UNIX system has a device driver for a CD-ROM drive.

D. Software Available for the IBM/PC Environment:

Filename/Path   Description

JPLPDS::DISK$USER1:[CDROM.IBMPC]   This directory contains utility software
                                       and programs for access to a CD-ROM.
                                       Consult the **READ.ME** file in this
                                       directory for additional information. The
                                       software in this directory assumes you
                                       have purchased the MS/DOS extension for
                                       assess to CD-ROM disks containing ISO
                                       9660 volume and directory standard.

JPLPDS::DISK$USER1:[IMDISP.IBMPC]   This directory contains the source code
                                       for an image display program which reads
                                       an image from a CD-ROM file and displays
                                       it on a display terminal. Consult the
                                       READ.ME file in this .directory for
                                       additional information.

E. **Software Available for the Macintosh II Environment:**

Filename/Path   Description

JPLPDS::DISK$USER1:[CDROM.MACII]   This directory contains utility software
                                       and programs for access to a CD-ROM.
                                       Consult the **READ.ME** file in this
                                       directory for additional information.

JPLPDS::DISK$USER1:[IMDISP.MACII]   This directory contains the executable
                                       files for Pixelpusher, an image display
                                       program developed by MIPL. Consult the
                                       READ.ME file in this directory for
                                       additional information.

F. **Software Stored on the VOYAGER/CDROM Disks:**
In addition to the software available on the PDS VAX and SUN computer,
each VOYAGER/CDROM contains a [SOFTWARE] directory. This directory
contains access and image decompression software. Consult the
[SOFTWARE]SOFTINFO.TXT file for a description of the directory
contents.

III. CD-ROM TECHNOLOGY SUMMARY

CD-ROM is based on the highly successful CD audio technology developed by Philips and Sony in the early 1980's. The CD-ROM disk uses the same basic data storage format as a CD audio disk. CD audio stores an hour of 16-bit digitized audio sampled at 44.1 kHz in two channels (stereo) on a .7 ounce, 120-mm (4.72-inch) polycarbonate plastic disk.

In fact, CD-ROM data blocks are identified by minute, second and sector number, following the audio format. Information is recorded on a three-mile spiral of small pits in a plastic substrate from the inner to outer radius of the disk. The surface is coated with a reflective metal layer (usually aluminum), which is then coated with a protective lacquer. Tracks are made up of .6 micron pits with a depth of .12 microns spaced at 1.6 microns (20,000 tracks per disk). The tracks are read with a gallium-arsenide laser beam, which must track the small spiral despite recording irregularities in horizontal and vertical directions which are hundreds of times the size of the track.

Each raw data block contains 2,352 bytes of information, with 304 bytes used for housekeeping and error correction and 2,048 (2K) containing user data. Each data block is called a sector, and 75 sectors are stored per second. Since the nominal playing time of a CD disk is 60 minutes, the data storage capacity is 75 sectors per second * 60 seconds per minute * 60 minutes or 270,000 sectors. Thus the nominal storage capacity of a single CD-ROM disk is 540,000 kilobytes, which can be safely extended to 675,000 kilobytes by recording 75 minutes of data on a disk.

In order to maximize the storage capacity of CD disks a constant linear velocity (CLV) recording format is used. This means that the player changes speed (slows down) as it reads from the inside to the outside of the disk, to maintain a constant flow of data under the read mechanism at a speed of 1.2 meters per second. This is in contrast to most magnetic disk drives which use constant angular velocity (CAV) storage, where the information density is greater on the inner tracks than the outer tracks. While the use of CLV recording increases the storage capacity of CD-ROM disks, it reduces access time, since the disk must change speeds as it moves to different positions on the disk radius. The strategy for locating a recorded data block is also more complicated than with constant angular velocity recording technology.

As a result the average access time of CD-ROM drives is between 400 ms and 1 s, and the maximum data transfer rate to the host computer is 150 kilobytes per second. These rates are approximately an order of magnitude slower than magnetic disks, although in practice, throughput is roughly 75 percent of magnetic disk rates. Therefore, the access mechanisms to disk directories and data must be customized for CD-ROM in order to provide acceptable performance.

The data recording format for compact disk includes cross-interleaved Reed-Solomon (CIRC) coding which provides a bit error rate (ber) of 10-9. CD-ROM disks also provide a Layered ECC which results in a ber (if used) of 10-12. This corresponds to one block error in reading 2,000 disks.

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The development of a standard logical format for recording data files on CD-ROM disks was taken on by a group of CD-ROM applications developers, hardware vendors and computer vendors. The proposed standard resulting from this effort is called the High Sierra format. This format was submitted to the International Standards Organization (ISO) for consideration and approved on October 5, 1987, with the standard formally published and supported by the industry in April 1988 (ISO 9660, "Information processing-Volume and file structure of CD-ROM for information processing"). The logical format standard supports a hierarchical file structure optimized for read-only use. A shortened version of the CD-ROM directory (the path table) is stored in the host computer's RAM, allowing access to the directory entry for a data file with only one seek, greatly improving performance (Note: this is possible only if directory sizes are kept to about 40 files per directory).

Other standards specify the physical recording format of CD-ROM (ECMA/TC31/88/1, "Data Interchange On Read-only 120-mm Optical Data Disks (CD-ROM)"), and the specification for audio recording on compact disk (IEC908, "Compact disk digital audio system."). The level of standardization achieved in a fairly short time with CD-ROM makes it likely that it will become one of the most transportable storage media ever developed.

CD-ROM disk replicas are mass-produced, unlike magnetic replicas which must generally be made on a one-at-a-time basis. This reduces the cost per replica to a fraction of the cost of magnetic replicas (currently $2 to $4 per replica). As a rule-of-thumb, CD-ROM becomes more cost effective than magnetic tape when 10 or more copies are required.

CD-ROM disks are resistant to all normal operational threats. The storage life of CD-ROM disks is rated at 10 years, and many industry experts expect 40 years to be a reasonable life, making them excellent for archival products. In 4 years of testing, the PDS has encountered only one unreadable disk, caused by a scratch covering the primary volume descriptor record. No read errors have been reported by the recipients of nearly five-hundred PDS CD-ROMs.

CD-ROMs are a manufactured media. User data is supplied to a vendor on magnetic tape for disk mastering and replication. Generally, a pre-mastering process is also required, which adds the information needed to build the CD-ROM logical structure (VTOC, directories, etc.) to the user data. The cost of these processes can range from $1,300 to $10,000 depending on the complexity of the user data structure and the amount of assistance required by the user in the data preparation and premastering processes. The cost of a mastering plant is between $5 and $25 million. Recording devices for single unit or low-volume disk production have recently become available for about $100K with blank disks priced at $100 each.

Appendix A: CD-ROM Vendors.

Drives for IBM PC's and compatibles:

AMDEK 1901 Zanker Road San Jose, Ca 95112 408-436-8570	Laserdek 2000 ($995) stand-alone, I/F supports up to 4 drives. Laserdek 1000 ($895) half-height.
ATARI Corp. 1196 Borregas Ave. Sunnyvale, Ca 94086 408-745-2000	CDAR500 ($599) Atari ST and IBM PC versions available.
Hitachi 401 West Artesia Blvd. Compton, Ca 90220 800-262-1502	CDR1503S ($889) Standalone drive. CDR3600 ($869) Half-height internal drive.
Laser Magnetic Storage 4425 ArrowsWest Drive Colorado Springs, CO 80907, 303-593-4269	CM121 ($820) RS442 serial I/F. CM131 ($1130) SCSI I/F.
Laser Optical Technology 10 Victor Square Suite 600 Scotts Valley, CA 95066 408-438-7400	LD CD-ROM drive ($1595), drive with SCSI interface, audio output.
NEC Home Elec. 1255 Michael Drive Wood Dale, IL 60191 312-860-9500	CDR77 ($999) stand alone drive with SCSI interface. CDR80 ($899) half-height internal drive.
Panasonic 1 Panasonic Way Secaucus, NJ 07094 201-392-4602	SQ-D1 ($999) half-height internal with Panasonic interface. SQ-D101 ($1149) Stand-alone drive with Panasonic or SCSI I/F.
Pioneer Communications Opt. Memory Prod. Div. Sherbrooke Plaza, NJ 07458-1827 201-327-6400	CD Changer ($1200) Stand-alone drive with SCSI I/F. Holds 6 disks, up to 7 drives can be connected to I/F card. Available in October, 1989.

Drives for IBM PC's and compatibles: (continued...)

Reference Technology 700 Flatiron Parkway Boulder, Co 80301 303-449-4157	Clasix 500 ($890) Sony Drive.
SONY 1 Sony Drive Park Ridge, NJ 17656 201-930-7071	CDU-510 ($895) half-height internal. CDU-7101 ($1095) stand-alone drive with Sony interface.
TOSHIBA 9740 Irvine Blvd. Irvine, CA 92718 714-583-3117	XM-3201 A1-PCF ($1150). Stand- alone drive, for PC or PS/2.

CD-ROM Drives for other Computers:

Apple Computer 20525 Mariani Ave. Cupertino, Ca 95014 408-973-6144	CD SC ($1199) Stand-alone unit connects to SCSI port. Ask for ISO drivers when purchasing this unit.
Delta Microsystems. 5039 Preston Avenue Livermore, Ca 94550 415-449-6881	SS600C Provides drive, interface and software for Sun Minicomputers.
Digital Equipment Corp 333 South St. Shrewsbury, Ma 01545 617-841-3776	RRD50-QA ($1200) Obsolete, but may be able to get a bargain ($500). RRD40- ($2800) New model, no details yet.
TOSHIBA Ron Haglund 9740 Irvine Blvd. Irvine, CA 92718 714-583-3117	XM-3201 A1 MAC stand-alone with I/F. Special drivers provided for ISO support.
Delta Microsystems. 5039 Preston Avenue Livermore, Ca 94550 415-449-6881	SS600C Provides drive, interface and software for Sun Minicomputers.
Workstation Solutions 2123 Yorkshire Court Woodstock, Ga 30188 404-924-9260	OFS-CD ($2450) For Apollo work- stations. (DN3 and DN4 machines) SCSI I/F. ISO software support.

IBM PC Networks which support CD-ROM drives:

Online Computer Sys. 20251 Century Blvd. Germantown, Md. 20874 301-428-3700	Opti-Net. Software which supports IBM token ring, PC Net, Novell and other NETBIOS compatible networks.
Meridian Data, Inc. 4450 Capitola Rd. Suite 101 Capitola, Ca 95010 408-476-5858	CD NET. Network server can be configured with 1 to 4 drives. Supports NETBIOS, Token Ring and ARCNET networks.

CD-ROM Hardware and Software Retailers:

Bureau of Elec. Publ. 18 Louisburg Sq. Dpt K Verona, NJ 07044 301-428-3700	Large selection of CD-ROM drives, titles and accessories for PC and Macintosh.
Compact Disk Products 223 E 85th St. New York, NY 10028 212-737-8400	CD-ROM drives, large selection of PC and Macintosh software.

CD-ROM References

Buddine, L., Young, E., "The Brady Guide to CD-ROM." New York, NY, Brady Books.

Lambert, S.; Ropiequet, S., "CD-ROM, The New Papyrus." Redmond, Wn., Microsoft Press.

Lambert, S., Ropiequet, S., "CD-ROM, Optical Publishing." Redmond, Wn., Microsoft Press.

Oberlin, S., Cox, J., "Microsoft CD-ROM Yearbook." Redmond, Wn., Microsoft Press.

Scientific Disk Producers

NASA Planetary Data System, Jet Propulsion Laboratory. PDS Science Sampler, Uranus Sampler, Voyagers to the outer planets. Mike Martin (JPLPDS::MMARTIN).

Space Telescope Science Institute (STSci). Space Telescope Guide Star Catalog and images. Brian McLean (MCLEAN@SCIVAX.STSCI.EDU).

National Geophysical Data Center (NGDC). Geophysical data sets with selection and display software. Carl Abston.

National Snow and Ice Data Center (NSIDC). SMMR data from Nimbus-7. Claire Hanson (KRYOS::HANSON).

NASA Ocean Data System, Jet Propulsion Laboratory. West Coast Time Series (Nimbus-7) pigment concentration. Elizabeth Smith (STANS::EAS).

US Geological Survey National Mapping Center. USGS test disk, Gloria Sonar disk, Joint Earth Science disks. Jerry McFaul.

Bureau of Land Management (BLM). Joint Earth Science disks (aerial photos and radar). Dave Traudt.

University of Washington. Meterology disk and GALE disk. Cliff Mass.

National Earthquake Information Center. Seismic event logs. Madeline - Zirbes.

Astronomy Data Center (ADC), Goddard Space Flight Center. Collection of Star Catalogs. Lee Brotzman (CHAMP::BROTZMAN).

International Halley Watch (IHW). Multidisciplinary data sets from comet studies. Michael Aronsson, Ed Grayzeck (CHAMP::GRAYZECK).

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Overview of CD-ROM Workshop

Dan Klinglesmith III

NASA/LASP

Large Scale Phenomenon Network/International Halley Watch

CD-ROMs AS AN ARCHIVE TOOL

Their time has come and it is now!
　　400 titles out
　　30 scientific titles
　　　easily will double each year

Small, cheap, affordable
　　small insitutions
　　individuals

They work because of the efforts put into standards
　　ISO 9960
　　ieee 754
　　sgml
　　cdxa
　　etc.

The producers of CD's MUST

Test their data and disc to death
make effort to standardize
follow Sawyer's guidelines
　　I felt no major reaction, yea or nea

Common features of CD's

Image data is both

           compressed   -- saves space
           browsed   -- quick look access

the more indices the better
Documentation on disc
Software on disc
Everybody is doing it differently

PROBLEMS

Data formats
        floating point standards
        ASCII versus binary
        FITS versus PDS versus ???
Drives are cheap. Drivers are not available
How to distribute the scientific data to amatuer scientist
What is the best way to do pre-mastering
        Here at NSSDC
        Commercially
        Your own computer system