

NCAR Graphics and NCL (1964-2010)

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Introduction

This document, written in February of 2011, outlines the development of the NCAR Graphics package and NCL over the time period 1964 to 2010. Any reference to "present" will mean February of 2011.

NCAR Graphics refers to the package of program libraries that dates to 1964 and, with many additions and augmentations, is still in use. The current documentation for the package exists at <http://ncarg.ucar.edu/>

In the fall of 1995 a locally-developed interpreted language designed specifically for scientific data analysis and visualization was released. This package, known as NCL (the NCAR Command Language) incorporates much of the functionality of the NCAR Graphics libraries; it has been the main focus of development since its initial release. The current documentation for NCL is at <http://ncl.ucar.edu/>. While an attempt is made to integrate any significant additions to the functionality of the NCAR Graphics libraries into NCL, NCL development proceeds independently from NCAR Graphics.

The [Overview](#) section of this document describes the development highlights in a conversational style while the [Timeline](#) section provides details in a list of events ordered by date. The [Software](#) section describes the software in the major releases, much documentation of which is online. The [Release dates](#) section gives a (perhaps overly detailed) summary of all package release dates, some with descriptions of the major developments in the release. Beginning in 2000 workshops were initiated to provide a thorough introduction to the products. The [Workshop locations and dates](#) section is a summary of workshop activity. The [Staff bios](#) section gives brief biographies of most of the people involved in the project over the years. Undoubtedly some names have been overlooked. The [Hardware](#) section lists some of the hardware in use during the time period.

There are many acronyms used in this document. A list of them appears in [Appendix A](#). [Appendix B](#) lists the computing directors and their terms of service. [Appendix C](#) provides a list of all digitized documentation available through the NCAR Library that pertains to NCAR Graphics and NCL. And [Appendix D](#) points to what is in the UCAR Archives that relates to NCAR Graphics and NCL.

For those reading the hardcopy of this, any references to NCAR Technical Notes (of the form NCAR/TN) can be located by going to <http://library.ucar.edu/collections/technotes/> and searching on the tech note number.

Overview

Early days (roughly 1964-1971)

First, a little early background. The National Center for Atmospheric Research (NCAR) was formed in 1960 and by April of 1961 NCAR had purchased its own IBM 1620 computer which was installed on the University Campus in the [HAO](#) building. A computing facility ([CF](#)), was formed within the Atmospheric Technology Division ([ATD](#)) in 1962. The CF was originally housed in the Physical Sciences Research Building (PSRB) on the CU campus near 30th and Marine Streets. [Dr. Glenn Lewis](#) was the first CF director and by the end of 1962, about ten persons were in the CF.

All of this is background to the arrival of [Dave Robertson](#), who is considered to be a founding father of NCAR Graphics. Dave came to NCAR in June of 1963 as the manager of administrative services and moved to the CF in September of 1964 by which time the CF had acquired a [CDC 3600 computer](#) (considered a "supercomputer" at the time). In October of 1964, Dave became involved in his first graphics project, which was to write Fortran subroutine interfaces to access a [Calcomp plotter](#) that the CF had purchased.

Also, in 1964 a [dd-80](#) high speed film recorder had been acquired and attached to the CDC 3600. Dave wrote software, in [assembly language](#), to interface to the dd-80 that could be invoked by users from their [Fortran](#) codes. Dave's main goal in developing the package was to establish easily-produced graphical output as something that should be a part of the services offered by any leading-edge computing facility. His early interface had low-level functions for drawing lines, points, curves, text, backgrounds, and so forth.

Dave also wrote programs for more complicated functionality like drawing XY-plots (which he named IDIOT) and for basic contouring (CALCNT). Also, there was a map-drawing package called SUPMAP that Dave had brought in. This was written about 1963, called SUPERMAP, by R. L. Parker of [UCSD](#) using [outline data generated by Dr. A.V. Hershey](#). This was the beginning of NCAR Graphics, though it was not called that then.

Over the years Dave refined the low-level package and produced detailed documentation. The status of the package in 1971 is described in chapter four of [NCAR/TN-67+IA](#).

In the early 1970s NCAR rented a [CDC GRID](#) (Graphical Interactive Display) to investigate the potential of interactive graphics in atmospheric research. This device was a very early monochrome graphics terminal. It had an attached light pen that could be used for extracting X/Y coordinates from the screen to be used in a running program. Dave developed a language and user interface for this device (see: <http://www.computer.org/portal/web/csdl/doi/10.1109/AFIPS.1973.87>). The GRID was ahead of its time and was expensive to rent. It turned out that not enough projects at the time could justify its use and the device was removed within a couple of years.

Since there was no remote computing in these early days, many scientists came to the Computing

Facility to use it and Dave was able to learn about a lot of the available software from those scientists and what their needs were. Dave continued to have an influence on the package contents until he left NCAR in 1979.

Consolidation and distribution (roughly 1972-1982)

Whereas [Dave Robertson](#) was the main player in the early years, in this era it was [Tom Wright](#) who was the main person to push the package forward. Tom came to the CF in September of 1969 and it was not long before [Dave Robertson](#) became his mentor. Tom's first project was to work on software dashlines with uniform spacings. The hardware dashlines on the [dd-80](#) depended on how fast the electron beam traveled, producing unevenly spaced dashlines using the DASHLN package currently in existence. Tom wrote the DASHCHAR package that provided dashed lines with uniform spacing with the option of line labels.

One thing Tom did was to rewrite Robertson's low-level [assembly language](#) functions in Fortran, isolating machine dependencies in a small set of constants. This was the first step toward making the package portable.

Building upon Robertson's work Tom augmented the collection of graphics functions that Dave had put together. He wrote, or collaborated on, several new utilities: CALCNT was replaced by a suite of contouring functions, CONREC, CONRECQCK, and CONRECSMTH; HAFTONE was added to draw half-tone plots like what you might see in a newspaper (color was not yet available then); ISOSRF and ISOSRFHR were added to draw iso-valued surfaces in three-space, based on Tom's own algorithms; PWRY and PWRZ were added for drawing text at angles and to label axes in three space; SRFACE, a package for drawing functions of two variables was written using a hidden-line algorithm that was Tom's. Tom was not the only programmer active in the early 1970s. [Dori Bundy](#) wrote PWRX, a character drawing package using the stroked fonts created by A.V. Hershey. While at NCAR [Alan Cline](#), a young Ph.D. in mathematics, wrote some of the curve-fitting functions whose functionality would later be a part of the commercial package [Fitpack](#). This package was based on splines under tension and the bulk of its functionality is still distributed as part of NCARG Graphics and NCL. [Jay Chalmers](#) and [Cicely Ridley](#) provided a map drawing package, SUPMAP, that was a great improvement over the old SUPERMAP. Chalmers also worked on the vector drawing package VELVEC. The package as it existed in 1975, which is documented in Chapter 12 of [NCAR/TN-105](#), has formed the core conceptional functionality of the package up until 2010. It was at this time that the package began being commonly referred to as the NCAR Graphics Package.

Another major contribution Tom made was introducing the concept of "metacode" -- a device independent file description format for the storage of 2D graphical elements. This concept was the germ of what became, in 1986, the [ANSI](#) Standard [CGM](#) (Computer Graphics Metafile). Producing metacode from NCAR Graphics allowed for writing device drivers that would translate the metacode to specific hardware devices, simplifying the source-code-to-device-instruction path. The package could be distributed without concern for device dependencies, and writing metacode to device drivers was usually fairly simple.

It was thus Tom who packaged NCAR Graphics and aggressively marketed it, making it one of the premier graphics products of its day. Its public domain status made it quite appealing and it had been implemented at over one thousand sites by the end of the 1970s.

Prior to Tom's leaving in 1979, he was involved in the acquisition of two [Dicomed film cameras](#) capable of producing 16mm, 35mm, and 105mm (fiche) film, in black-and-white only. These cameras would ultimately replace the dd-80 cameras that, at their peak, were producing over a million frames of 35mm film a month.

Fittingly in December of 1977 [David Robertson](#) and [Tom Wright](#) received the annual Scientific and

Technical Achievement award for their development of the NCAR computer graphics software system (NCAR Graphics).

The move toward standards (roughly 1982-1994)

With [Tom Wright](#)'s leaving in 1979 a Graphics Group was formed with [Lofton Henderson](#) as the group head. Initially the group consisted of Lofton, [John Humbrecht](#), and [Fred Clare](#). Although never officially a member of the group in the 1980s, [Dave Kennison](#) (of whom more later), was very active in the area.

The first order of business for the Graphics Group was to bring the Dicomed cameras online and this happened in May of 1982. The dd-80 cameras were retired a couple of months later.

Lofton's main contribution was to base NCAR Graphics on National Standards: the [GKS](#) (Graphical Kernel System) replaced the old SPP (System Plot Package); all codes were converted to Fortran 77; and the Computer Graphics Metafile ([CGM](#)) was adopted for device-independent 2D graphics file storage. GKS offered new functionality such as filled areas, a coherent color model, and a generic raster function. Lofton actually sat on the CGM committee. All higher level Fortran utilities were converted to the new interfaces, including a [System Plot Package Simulator](#), [SPPS](#) (coded by [Dave Kennison](#)).

At the time of Lofton's departure in 1986 the standards conversion effort was still in beta release. John Humbrecht's departure a few months later led to some pretty lean times for the group, now headed by [Bob Lackman](#). The task of completing the GKS code and the CGM metafile translator (originally written by John Humbrecht), as well as keeping the distribution going, fell to Fred Clare.

The situation was complicated by the fact that, just prior to the GKS-based package going out the door, [NSF](#) decided to remove the package from the public domain. This time period was most confusing and is treated in more detail in the [Release Dates](#) section of this document. Suffice it to say that the package was released in August of 1986 as Version 1.0 and it marked the first time NCAR charged for the software and manuals. During the time that the copyright issues were being sorted out, distribution was suspended starting in December of 1986 and continuing until Version 2.0 was released in November of 1987.

By the end of 1987 the dust had finally settled over the copyright issues and distribution had resumed. Within the next six months two strong new people were hired--[Don Middleton](#) and [John Clyne](#). John supported and developed his C version of the CGM translator that had been developed when he was part of a student collaboration in the previous year. John also wrote an interactive interface to the CGM as well as metafile manipulation package. John's extensions and support for the C translator were of such a quality that it ultimately replaced the earlier Fortran translator. John also supplied direct output to the [X11 windowing system](#).

By the time that Don Middleton came on board it was clear that we were moving to be a predominately [UNIX](#) shop and Don's first task was to tailor NCAR Graphics for a UNIX environment. He succeeded on this in short order and was nominated for the Technical Support Award for development of a UNIX-specific version of the NCAR Graphics package. By the release of Version 3.0 in 1990 the package would auto-install on most UNIX systems. Don and John were instrumental in writing a package to display raster images in an X window. In a reorganization in 1994, Don would become the head of the Scientific Visualization Group.

As a historical comment on the GKS and CGM standards it should be said that they did not pan out quite as hoped and expected. With regard to GKS the original thinking was that it would become so popular that vendors would supply implementations in the same way that they supplied Fortran or C compilers. While some vendors did implement GKS packages, it never became the industry standard hoped for. As for the CGM, it was initially popular, and remains an exchange medium among many commercial companies, but with the advent of Postscript in 1984 its popularity came to totally eclipse

that of the CGM, in part due to its great font technology and its adoption as a de facto standard for printers.

Throughout the years [Dave Kennison](#) continued to work on expanding and improving the NCAR Graphics Fortran libraries, following his own muse it should be pointed out. While his contributions do not fit neatly into the time frame of this section, this is as good a time as any to remark on them. Dave's fingerprints are on most every piece of the Fortran graphics library, he wrote or revised most of the graphics application software: [Autograph](#) (XY-plotting), [Conpack](#) (contouring), [Softfill](#) (software area fill), [Ezmap](#) (map drawing), Ezmapa (color fill of maps), [Plotchar](#) (character plotting), [Isosrf](#) (iso surfaces), [Polypack](#) (polygon manipulation), [Dashpack](#) (dash lines), [Tdpack](#) (3d plotting), [Conpackt](#) (contouring on triangular meshes), [Vaspackt](#) (vectors and streamlines on triangular meshes), [Stitle](#) (scrolled movie titling). He implemented high-resolution outline data in EZMAP. Dave also produced detailed documentation for all of his software. Safe to say that Dave is responsible for much of what is in the Fortran functionality of NCAR Graphics, without which there would have been no NCL. This provides a good segue to the next era.

NCL (roughly 1994-present)

In response to user comments that the package was getting to be behind the times and difficult to use there was a decision to be made as to whether to press on with local development or move to purchase and support for commercial products. [Bob Lackman](#) decided to continue to pursue local development and, as a consequence, set the package on the path it would follow to the present. The goal was to develop an interpreted, high-level language designed specifically for scientific data processing and visualization, with the potential for a [GUI](#). To this end Ethan Alpert was hired to investigate this development. Ethan had just come off of an [SVG](#) collaborative project with four students from the computer science department at the University of Colorado; the project had been to develop a data visualization environment, so Ethan seemed well qualified to lead the effort to bring NCAR Graphics into a new era.

In short order Ethan was joined by [Jeff Boote](#), another person who had been hired at the end of a student collaboration project that was concerned with developing an interactive color editor. Jeff's background gave him superior skills in [X Window](#) programming as well as [UNIX](#) tools and user interfaces. After a year or so [Dave Brown](#) came on board and joined the team subsequent to writing the [Vectors](#) package for drawing 2D vector component arrays. These three guys formed the team responsible for producing the initial design and coding of the NCAR Command Language (NCL) which remains the flagship product to the current time. Version 4.0.0 was the first release that contained NCL; this was in September, 1995 concurrent with the second User Graphics Conference held at NCAR.

The object oriented interfaces released in Version 4.0.0 were found by many users to be difficult to understand and use. In order to provide a more user friendly interface, a collection of functions and procedures was provided in 1999 primarily written by Mary Haley. Initially these functions were documented in a manual called "GSUN - Getting Started Using NCL." The essential chapter of the manual was a collection of examples showing how to produce sample plots with single calls. The collection of the functions in this manual continue to be present in the functions available in NCL; these are the gsn_xxxx functions. The GSUN manual is available at http://ncl.ucar.edu/Document/Manuals/Getting_Started/.

With the departure of Ethan and Jeff in 2002, the maintenance and development of NCL fell mainly to Mary Haley and Dave Brown. While Mary handles the bulk of the consulting load the project has benefited greatly from the work of [Dennis Shea](#) and [Adam Phillips](#), both members of [CGD](#), the Climate and Global Dynamics division. As scientists Dennis and Adam have been particularly valuable in consulting on scientific issues. But they have made contributions other contributions as well. Dennis wrote the initial Fortran version of the [Streamlines](#) package for drawing streamlines and Adam

redesigned the [NCL home page](#) that is current. Both Dennis and Adam contribute large chunks of essentially pro bono time far exceeding their official commitments.

A significant outreach and education effort was begun in 2000 with the offering of training workshops. As of the current writing (February, 2011) there have been 50 of these multi-day seminars given both locally and at United States and foreign universities, as well as around the world. Initially it was Dennis Shea and [Sylvia Murphy](#) who conducted these workshops, but in recent years it has been Mary Haley, Dennis and Dave Brown. It is felt that these workshops have contributed greatly to the ever-increasing user base of NCL. For details on the locations and dates of the workshops see the [Workshop locations and dates](#) section of this document.

By the early 2000s it was seen that [Python](#) was becoming an increasingly popular language and investigating what value Python might have for NCL was considered worthwhile. Fred Clare used Python to create several animations after which he and Mary Haley undertook creating a Python interface to much of NCL's functionality. This product was called [PyNGL](#) and its first beta release was in late 2004; Version 1.0.0 came out in the summer of 2006. Dave Brown undertook writing an I/O module for the package and this ultimately became the separately maintained package [PyNIO](#). These packages became open source in 2008. The PyNGL home page is <http://www.pyngl.ucar.edu/> and the PyNIO home page is <http://www.pyngl.ucar.edu/Nio.shtml>.

Sometime in 2006 members of [VETS](#) began thinking about how to address some of the most frequent user requests, such as importing graphic images, an increased color palette (from the 256 color limit), transparency, and a stable [PNG](#) output driver. Since the open source [cairo graphics package](#) (which had been being developed since the early 2000s) offered all of this functionality, in 2008 Fred Clare began looking into providing a cairo backend for NCAR Graphics/NCL. By early 2009 he had implemented a beta version of this for NCAR Graphics. Shortly thereafter, upon Fred's retirement, [Rick Brownrigg](#) took over the cairo development and in April, 2010 a cairo-based PNG driver was released as part of the NCL package.

In the last decade NCL has seen a rapid rise in popularity. It has been distributed to sites world-wide to university, commercial, and government organizations. Here is a breakdown by number of downloads and system type for the one month of January, 2011:

Total number of NCL downloads (2011-01):	1426
Total number of NCL source downloads:	375
Total number of NCL precompiled binary downloads (2011-01):	1051
Breakdown by type of binary	
linux	783
cygwin	118
macos	130
aix	18
sunos	2

In 2005 [David Brown](#), [David Kennison](#), [Dennis Shea](#), [Fred Clare](#), [Mary Haley](#), [Richard Grubin](#), and [Sylvia Murphy](#) received the UCAR Scientific and Technical Advancement award for the development of the NCAR Command Language.

Timeline

This section contains a timeline of dates related to the NCAR Graphics and the NCL software packages. Since other sections of this document give details on staff, release dates, and NCL workshops, those items are not listed here unless they have special significance. Some dates of general importance to CF/SCD/CISL are included. Several items in this list duplicate entries in other sections. Much of this

timeline is based on notes from [Dick Valent](#).

- 02/??/1959 *Preliminary Plans for a National Institute for Atmospheric Research* (the so-called "Blue Book") presented to the National Science Foundation by the University Committee for Atmospheric Research. This document details the initial structure of what was to become NCAR. Of particular note is the need for a high-end Computing Facility. This book is available in the NCAR Mesa Library and is also offered online by the library.
- 07/18/1960 NCAR was officially formed. A valuable resource for UCAR history in the early days is: *The University Corporation for Atmospheric Research and the National Center for Atmospheric Research 1960-1970: An Institutional History* by Elisabeth Lynn Hallgren, March 1974. This book is available from the NCAR Mesa Library.
- ??/??/1960 [Glenn Lewis](#) (Ph.D. New York University, 1960) arrives to head the NCAR Computing Facility.
- 06/17/1963 [Dave Robertson](#), future founder of NCAR Graphics arrives as manager of administrative services.
- 11/??/1963 The [Control Data 3600](#) was delivered in November, 1963, and installed in an unfinished Colorado University building being constructed at 3215 Marine Street. It was to this building that the CF moved late in 1963. The CDC 3600 had 32,700 48-bit words of memory (less than 50,000kb). It supported a FORTRAN 66 compiler and an [assembly language](#) assembler called ASCENT.
- 09/??/1964 [Dave Robertson](#) moves to the Computing Facility.
- ??/??/1964 The [dd-80](#) 35mm film device arrived. Initially it was attached to the CDC 3600 at the 30th Street location.
- 01/??/1965 A [CDC 6600](#) was delivered to the 30th street location. (Staff Notes No. 48, May 18, 1967).
- 12/??/1965 The CDC 6600 was moved to the Mesa Lab. (see Staff Notes No. 48, May 18, 1967). The 6600 system was documented in the September 1966 Computing Facility Manual.
- ??/??/1966 Mesa Lab construction completed at a cost of \$5.5M.
- 08/01/1967 Dr. A.V. Hershey publishes his technical report on what would become known as the Hershey fonts. (ref: <http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=AD0662398>)
- 09/22/1969 [Tom Wright](#), ultimately considered as co-creator of the NCAR Graphics Package, arrives.
- 10/05/70 [Dave Kennison](#), responsible for contributing much of the Fortran codes in the NCAR Graphics package, arrives.
- 04/??/1970 The Computing Facility acquired a [Bendix Datagrid Digitizer](#), enabling data presented in a graphic form to be translated

into digital XY coordinates which are recorded on a magnetic tape compatible with the CDC 6600 and later [CDC 7600](#) computers. A limited keyboard enabled the operator to record other information such as data related to identification and orientation, isopleth values, and instructions for subsequent processing. Main hardware components: electronics unit, datagrid table and cursor, tape recorder, keyboard and floating control unit, and display unit.

- 09/??/1970 [Alan Cline](#), future author of the curve-fitting package [Fitpack](#), arrives.
- 11/03/1970 [GRID](#) (Graphic Remote Interactive Display) presentation given. This device was a very early monochrome graphics terminal. It had an attached light pen that could be used for extracting X/Y coordinates from the screen to be used in a running program. One use was to find suitable initial values for algorithms to find local minima of a 2D surface. The User Manual is advertised in NCAR Computing Facility Notes April 4 issue #1. SCD rented this at considerable expense.
- 07/??/1971 The [CDC 7600](#) installed, augmenting CDC 6600 already in place. A second [dd-80](#) is in place with one now attached to the CDC 6600 and one attached to the CDC 7600.
- 03/??/1972 [Alan Cline](#) completes coding of his KURV package for interpolation of parameterized functions in two space using splines under tension. The functionality of this package, made available to SCD, would ultimately be contained in the expanded commercial product [Fitpack](#).
- 07/??/1972 [Alan Cline](#) completes coding of his QURV package for interpolation of parameterized functions in three space using splines under tension. The functionality of this package, made available to SCD, would ultimately be contained in the expanded commercial product [Fitpack](#).
- 09/??/1972 The NCAR CF Notes #5 announced a modern version of the dd-80, for a three-month evaluation. It was the Singer-Link MS-5000 Microfilm Recorder featuring about ten times the resolution, fine line widths, better drift control, and much better linearity than the dd-80. This device was never integrated into the computing environment.
- 10/??/1972 ARPANET (the Advanced Research Projects Agency Network) was demonstrated, including e-mail.
- ??/??/1972 [Cray Research Institute](#) was founded by [Seymour Cray](#).
- 06/??/1973 Graphics contour routine CONREC announced by [Tom Wright](#). (NCAR CF Notes #14)
- 08/??/1973 [Alan Cline](#) completes coding of his CURV package for splines under tension interpolation of functions of one variable. The functionality of this package, made available to SCD, would ultimately be contained in the expanded commercial product [Fitpack](#).
- 01/11/1973 [Lofton Henderson](#) arrives. Lofton would be the first group head for the NCAR Graphics Group when it was formed in 1979.

03/06/1974 The MODCOMP II computer arrived (a small minicomputer). It provided remote job entry (RJE) for university users.

06/??/1974 MIT, Colorado State University, Scripps, [HAO](#) begin using the remote job entry facilities.

0?/??/1974 Many limited-functionality terminals arrive on the scene for access to NCAR's RJE (remote job entry) functionality. These terminals were monochrome devices with text-only capabilities.

??/??/1975 [RFP](#) issued for the CDC 7600 replacement, resulting in an order for CRAY-1A.

11/21/1975 The Front End Technical Design Working Group formed in CF with the mission to study possible configurations for a front end computer system that would provide a sophisticated interface (with terminals) between users and the mass storage system, the CDC 7600, and the fifth generation computer which CF proposes acquiring. (Newsletter Vol 3 #4 April 1976) Working group members were Gary Aitken, Greg Eitzen, Don Morris, [Dave Robertson](#) (chair) and [Tom Wright](#).

??/??/1976 CRAY Research delivers the first CRAY-1A at the Los Alamos National Laboratory.

??/??/1976 The CF moves away from a "programmer pool" (i.e. direct support for scientists) to support groups working internally.

03/10/1976 The Front End Technical Design Working Group issued its Final Report. The group recommended acquisition of a distributed front end rather than the centralized system originally envisioned. A distributed system would comprise a number of satellite computers, each capable of supporting up to 30 terminals, which would communicate with the batch-processing main frames via a "switching" machine that would be transparent to users. One satellite was already in existence -- the ModComp II that provided a front end for the RJE (Remote Job Entry) system. RJE now serves about 35 terminals at university and government laboratories across the country. University users will still be able to use RJE, but a distributed front end might enable users with appropriate equipment to interact with a satellite computer located at the NCAR CF.

??/??/1977 SCD acquires two DEC PDP-11/70 computers running Berkeley [Unix](#) as the first step to distributed computing. These systems provided an internal e-mail facility.

05/??/1977 The CDC 6600 leaves due to the obsolescence of its peripherals and a declining user base).

07/??/1977 The C1 (CRAY-1 Serial 3) arrives, weighing 5.25 tons. It has one million 64-bit words of memory, and approximately 40 billion bits of high-speed disk storage (twice the amount of disk on the CDC 7600). "We expect the CRAY-1 to be five times faster than the Control Data 7600 on our estimated job mix" says SCD director Stu Patterson.

10/27/1977 NCAR signs a contract with the [Dicomed](#) corporation for purchase of two Dicomed film recorders, one to produce 105mm microfiche and the other to produce 16mm and 35mm film. Delivery date is set for April, 1978. Two new Digital Equipment Corporation PDP 11/34 computers will drive the cameras.
(ref: Staff Notes Vol. 12, No. 44, 4-Nov-1977)

03/??/1978 Early use of interactive graphics terminals in the Numerical Weather Prediction (NWP) Section.

03/??/1978 In anticipation of the arrival of the new [Dicomed](#) film cameras a new film processor was installed in the film room. The new processor can process 16mm, 35mm, and 105mm film. It was estimated that the old processor had produced more than 87 million frames of 35mm film in its nearly thirteen years of service.
(ref: Staff Notes Vol. 13, No. 11, 17-Mar-1978)

07/17/1978 The Dicomed cameras (as well as the DEC PDP 11/34 computer to drive them) arrived. Acceptance testing begun.

08/??/1978 The Dicomed cameras passed initial acceptance tests and were running off-line by way of creating 9-track tapes. The [dd-80](#) camera would run on-line until 07/01/1982. The cameras produce 16mm, 35mm, and 105mm (fiche) film in black-and-white only.
(ref: Staff Notes Vol. 13, No. 37, 15-Sep-1978)

04/06/1979 [Tom Wright](#) goes to ISSCO (a San Diego graphics software firm).

03/??/1979 The CF gets two DEC 11/70's for staff use (first interactive systems).

09/13/1979 [Dave Robertson](#) leaves CF to form Robertson Software.

02/??/1980 [SCD](#) Director [Walter Macintyre](#) begins a push for an Input/Output Satellite Computer "to make scientific computing available to the researcher." This [IOS](#) computer was later selected as the IBM 4341 in March of 1981. Its main uses were job editing, submitting Cray jobs and receiving output.

10/01/1980 The Computing Facility (CF) moved from [ATD](#) and given divisional status, renamed as the Scientific Computing Division (SCD).

03/??/1981 The IBM 4341 #1 was delivered.

04/??/1982 SCD acquires the commercial product [Fitpack](#) for \$500. [Fitpack](#) offers extensive functions for interpolations using splines under tension. [Fitpack](#) contains over 100 functions and represents a substantial expansion over the functionality [Alan Cline](#) wrote when he was in SCD in the early 1970s.

05/24/1982 SCD acquired, for evaluation, an IBM Personal Computer with 128 kb of memory and two 160 kb floppy diskette drives. The machine did have a Fortran compiler, but it took over ten minutes to compile a typical 1000-line program. Ultimately it was found that the DOS operating system was cumbersome and

the machine did not offer any advantages to the existing development environment.

- 05/??/1982 The [Dicomed](#) film recorders come online.
(ref: Staff Notes Vol. 17, No. 19, 14-May-1982)
- ??/??/1982 [UNIX](#) was chosen as the operations system for the Cray-2; this was a first for supercomputing operating systems.
- 07/01/1982 The [dd-80](#) film camera is retired, having been replaced by the Dicomed cameras which came online in May.
- 12/??/1982 The CRAY Serial 14 arrives.
- 04/08/1983 SCD retires the CDC 7600.
- 07/??/1983 A second IBM 4341 delivered.
- 04/??/1984 First announcement of e-mail available for remote sites using UNIX systems using the [USENET](#) UNIX-to-UNIX copy network (uucp). Mentioned in the article "UNIX Network Mail" in April 1984 issue of The Record (Vol. 5 #4, pp 6-7).
- 04/01/1985 The new table-driven [metacode](#) translator for [CGM](#) is released on the IBM 4341 computers. This translator accepts the earlier SCD-specific metafiles as well as CGM.
("The Record", Volume 6, Number 4).
- 05/??/1985 [NSFNET](#) connects the five computer centers and NCAR. First external e-mail.
- 05/10/1985 Purchase order prepared for two Tektronix 4017 color terminals at \$6,000 per each.
- ??/??/1986 SCD acquires a Pyramid (Unix) front-end to eventually replace the (DEC) PDP 11/70's sa & sb. Lou Jones wrote a device driver for it, so it can communicate with the mass store.
- 04/??/1986 NCAR Graphics chosen to be the initial version of the SLATEC (Sandia, Los Alamos, Air Force Weapons Lab Technical Exchange Committee) common graphics library. This was to be the seed for a community effort, but after several years of meetings at the various labs the effort was abandoned in 1995, primarily due to lack of any overall authority to enforce desired project goals.
- 04/??/1986 Ten SCD staff members terminated in layoffs, including Graphic Group Head [Lofton Henderson](#), who will not leave until June. [Bob Lackman](#) assumes the Graphics Group Head position.
- 06/??/1986 The [CALCOMP](#) Data Plotter and the [Bendix Data Grid](#) are decommissioned.
- 07/??/1986 A user IBM 4381 installed (the 4341s would later be decommissioned).
- 07/??/1986 The card reader on 4341 was decommissioned. NCAR was one of the last institutions to retire its card punches and readers.

08/01/1986 Version 1.0 of NCAR Graphics released. For details, see the [Release dates](#) section of this document.
This is the first release when charging was initiated: \$200 for the software and \$100 for the manuals.

10/??/1986 A CRAY XMP/48 arrives to replace CRAY-1A Serial 14 ([COS](#)); CRAY-1A Serial 14 scheduled for disconnection October 1.

10/??/1986 The first Sun workstations acquired by SCD were the pair of Sun-2s.

06/??/1987 A Sun-3/280 acquired (4 MIPS), later upgraded to a Sun-4/280.

11/??/1987 Version 2.00 of NCAR Graphics released, after a release hiatus of ten months. This is the first officially copyrighted version. For details, see the [Release dates](#) section of this document. Charging for the package begins.

12/??/1987 A purchase order issued to purchase a color [Dicomed](#) graphics system and a purchase order for a color processor is prepared.
(ref: *The Record* Vol. 8, No. 12, December, 1987)

??/??/1988 [PHIGS](#) (Programmer's Hierarchical Interactive Graphics System) becomes an [ANSI/ISO](#) standard. PHIGS was designed in the 1980s with the idea of its being a natural extension of [GKS](#) for 3D graphics. Consideration was given to supporting this within SCD, but the complexity of its implementation and use was ultimately deemed beyond the capabilities of the staff to support. [OpenGL](#) became the de facto 3D standard in the 1990s as PHIGS faded into disuse.

05/27/1988 Memo from the UCAR Foundation stating, "Effective today UCAR Foundation has signed a license agreement with SCO, Inc. for the development and distribution of a commercial software product based on NCAR Graphics." SCO ultimately became Centera, Inc.; this collaboration was to last for only about two years.

11/??/1988 [Don Middleton](#) nominated for the Technical Support Award for development of a UNIX-specific version of the NCAR Graphics package.

12/??/1988 The color Dicomed cameras and film processors are in place and opened for "friendly users." These cameras are driven by a Sun/UNIX workstation running SUDOOS (the Sun/UNIX Dicomed Online Operating System, written by Lou Jones). The color cameras accept only the [ANSI](#) Standard [CGM](#) metafiles, whereas the black-and-white cameras accept only pre-CGM metafiles.
(ref: *SCD Computing News* Vol. 9, No. 12, December, 1988)

??/??/1989 Initial [CGM](#)-->[X11](#) translation added to ctrans (by [John Clyne](#)).

03/??/1989 [UNICOS](#) XMP/18 arrives.

01/??/1990 Version 3.00 of NCAR Graphics released. Had UNIX support. For details, see the [Release dates](#) section of this document.

01/10/1990 CRAY XMP-48 decommissioned. Cray Operating system (COS)

entirely replaced by the CRAY UNIX operating system (UNICOS).

- 04/??/1990 A second [Dicomed](#) color film camera and another fiche camera arrive.
- 05/??/1990 Development of the Fortran CGM translator (ftrans) is frozen with the idea that the C version (ctrans) will become the primary CGM translator.
- 05/21/1990 CRAY YMP8/864 arrives.
- 06/??/1990 The manufacturer of SCD's online film recorders has changed the recommended form of its name from "DICOMED" to "Dicomed."
- 07/??/1990 The use of pre-CGM metafiles is phased out. A document *Converting Pre-GKS NCAR Graphics to NCAR Graphics, Version 3.00* is published.
- 11/??/1990 SCD begins Visualization Lab development under [Don Middleton](#).
- ??/??/1991 [X11](#) workstation added to GKS (direct output to an X11 window and not metafile translation). Would not be in the public release until Version 3.2.
- 03/12/1991 The rasview package that draws raster imagery to an X window added.
- 11/??/1991 SCD officially opens Visualization Lab under [Don Middleton](#).
- 01/??/1992 First release of [OpenGL](#), a graphics standard for 2D and 3D graphics developed by [SGI](#).
- 03/31/1992 User IBM 4381 decommissioned.
- 06/18-19/92 First NCAR Graphics User Conference. There 120 users as well as 27 staff members in attendance.
- 10/21/1992 Start of the ncarg-talk mail support group (ncarg-talk@ucar.edu). Details at <http://ncarg.ucar.edu/ncarg-talk/>.
- ??/??/1993 [VTK](#) (the Visualization Toolkit) created for rendering 3D Graphics. With the founding of the company [Kitware](#) in 1998, VTK has gained much popularity. [OpenGL](#) commands can be used with VTK. The Python interface to VTK has been used by SCD staff to produce several animations.
- 04/??/1993 [NCSA](#) releases [Mosaic](#) browser (Marc Andreessen).
- 09/??/1993 NCSA's mosaic browser being used in SCD.
- ??/??/1994 A [Postscript](#) workstation (direct output to Postscript and not via metafile translation) added to [GKS](#). Would be released in Version 4.0.0.
- ??/??/1994 Scientific Visualization Group re-organized. Don Middleton is Visualization Group Head.
- 02/??/1994 CRAY EL92 arrives, used for library and operating system testing.

12/??/1994 Users begin using the [Netscape browser](#) in place of Mosaic.

01/??/1995 Due to cost considerations SCD shuts down the film room in favor of outsourcing the film processing. However, this option proved more expensive than expected, and local processing was resumed after five months until the decommissioning of the [Dicomed](#) cameras in 1997 (see below).

09/??/1995 Version 4.0.0 of NCAR Graphics released. First to contain NCL. For details, see the [Release dates](#) section of this document.

09/10-13/95 Second (and last) NCAR Graphics User Conference introducing Version 4.0. Over seventy participants.

09/??/1997 Because of budgetary constraints, minimal usage, and the advent of personal workstations, the [Dicomed](#) cameras are decommissioned and the film processing room is shut down. Prior to the final shutdown there was recognition that the cost/benefit ratio of the resource was higher than desired, since fewer and fewer people were using it. In an earlier attempt to control costs, the local film room processing was closed down in 1995 and the film was outsourced for commercial processing. However, after five months of this experiment it was discovered that this was more expensive than expected and local processing was resumed until the final shutdown. For details on the decommissioning of the [TAGS](#) resource, see <http://www.cisl.ucar.edu/zine/97/fall/text/3.tags.html>.

12/??/1997 [Ethan Alpert](#) becomes group head of the The Scientific Visualization Group (SVG), replacing [Bob Lackman](#) who retired in September.

01/21/1998 Core functions of [Fitpack](#) added to NCAR Graphics.

02/??/1999 GSUN (Getting Started Using Ncl) published. Describes a simpler interface to NCL functionality. See: <http://www.cisl.ucar.edu/zine/99/spring/text/2.gsun.html> and http://ncl.ucar.edu/Document/Manuals/Getting_Started/.

10/15/1999 Core functions of [Fitpack](#) added to NCL.

12/??/1999 [VETS](#) (Visualization and Enabling Technologies Section) formed headed by [Don Middleton](#). It subsumes all of the previous Scientific Visualization Group.

02/07-11/2000 First NCL Workshop taught by [Sylvia Murphy](#) and [Dennis Shea](#). For details on workshop dates and sites, see the [Workshop locations and dates](#) section of this document.

05/??/2000 NCAR Graphics (not NCL or the [HLUs](#)) put under the [GNU General Public License](#). This made NCAR Graphics free for the general public, ending the charging that had begun with Version 1.0 in 1986.

11/??/2000 The [NCAR Visualization Lab](#) will be moving from room [ML](#) 19G to a new larger space in the Mesa Lab first basement. This will have more state-of-the-art equipment.

- 10/09/2001 The [NCAR Visualization Lab](#) officially opens. It is equipped with the [Access Grid](#) (its first usage was the week after the September 11 terrorist attacks on the East Coast. SCD used the Access Grid to host a meeting because air travel was still restricted.)
- 02/02/2004 Alpha release of [PyNGL](#) (a Python Interface to much of the graphics functionality of NCL). This product was developed by members of [VETS](#).
- 11/xx/2004 SCD (Scientific Computing Division is incorporated into CISL (Computational and Information Systems Laboratory) along with [IMAGE](#).
See <http://www.nar.ucar.edu/2005/orgchart.html> for the 2005 organization chart.
- 11/??/2004 Direct [PDF](#) output driver added to NCL and GKS.
- 12/??/2005 The NCL team wins Technical Achievement Award and Vislab wins Education & Outreach award. NCL team includes [David Brown](#), [Fred Clare](#), [Rick Grubin](#), [Mary Haley](#), [David Kennison](#), [Sylvia Murphy](#), and [Dennis Shea](#).
- 11/06/2007 NCL Version 5.0.0 released. First version that contains both NCL and NCAR Graphics, also under a new open source license.
- 12/10-11/07 First Scientific Python Class hosted in Vislab

Software

This section hits on the highlights of the software in the package by capturing snapshots at various times ordered sequentially by date. Most of what is mentioned is on-line for anyone wanting to delve deeper.

1964-1967

In this time frame [Dave Robertson](#) wrote a group of routines in [assembly language](#) used to form primitive plotter instructions. Only the most basic routines for scaling and plotting line segments, character strings, and annotated axes were included in this group. This group of low-level functions was known as the NSPP (the NCAR System Plot Package). Dave also wrote programs for more complicated functionality like drawing XY-plots (which he named IDIOT), for basic contouring (CALCNT). Also, there was a map-drawing package called SUPMAP that Dave had brought in. This was written about 1963, called SUPERMAP, by R. L. Parker of [UCSD](#) using outline data generated by Dr. A.V. Hershey. IDIOT eventually became AUTOGRAPH, discussed elsewhere in the archive. This package was available on card deck for duplication. This early package ran on the CDC 3600 and CDC 7600 computers with output disposed online to the dd-80 cameras.

Details on the early package contents be found in Chapter 4 of [NCAR/TN-67+IA](#).

1971

The only differences between the 1971 codes and Robertson's original package, discussed above, were the additions of a package HIST for drawing histograms, a package SOLIDS for drawing surface plots of 2D data, and STRMLN for drawing streamlines.

This original STRMLN had been started by [Bob Lackman](#) and then completed by [Rich Helgason](#). This version was later replaced with a complete re-write by [Dennis Shea](#). SOLIDS was based on a

[JACM](#) article (Volume 15 Issue 2, April 1968) by Kubert, Szabo, and Giulieri. No record of who wrote SOLIDS.

1975 The NCAR Software Support Library

The reference for the graphics from this is Chapter 12 in [NCAR/TN-105+IA](#). Since 1971 (see above) HIST had disappeared and its history lost. STRMLN was also dropped and SOLIDS had been rewritten by [Tom Wright](#) based on his algorithm published in:

"A Two Space Solution to the Hidden Line Problem for Plotting a Function of Two Variables." [IEEE Transactions on Computers](#), pp 28-33, January 1973.

This package was called SRFACE. STRMLN was not mentioned in the 1975 documentation. By 1975 the System Plot Package had been re-written in Fortran and several new higher level packages had been added: AUTOGRAPH (a replacement for IDIOT), a suite of contouring packages (to replace CALCNT), a suite of functions for drawing dashed lines, some text plotting functions, VELVCT for drawing vectors, functions for drawing iso-valued surfaces, and a function for creating movies called SCROLL. At this time much of the core functionality of the package, that would last into 2011, had been established, however basic. But this is a bit like comparing a Model-T Ford to a 2011 model.

1981 January, An Introduction to the SCD Graphics System

The reference for this is [NCAR/TN-161+IA](#). This document details the functional capabilities available at the time.

1981 January, The System Plot Package

The reference for this is [NCAR/TN-162+IA](#). This manual contains a detailed description of the System Plot Package which at this time was a package of Fortran routines at the low level of drawing points, basic text, lines, backgrounds, curves. Scaling facilities were also available.

1981 February, The Graphics System Implementer's Guide

The reference for this is [NCAR/TN-165+IA](#). It contains detailed instructions on how to install the package.

1981 February, The SCD Graphics Utilities

The reference for this is [NCAR-TN-166+IA](#). This manual contains detailed descriptions of all of the higher-level Fortran utilities in the NCAR Graphics Package. Among the new utilities since 1975 were: CONRAQ, for contouring on randomly-spaced datasets; EZMAP an updated version of SUPMAP for world map projections; THREED, for drawing lines in three space; WINDOW, provided clipping to a specified rectangle; new version of STRMLN coded by [Dennis Shea](#) based on a 1977 article by Thomas Whittaker.

1981 June, Selection of papers

The reference for this is [NCAR/TN-174+IA](#). This is a selection of reference papers. Its contents are:

A Guide to Making Movies at NCAR

Written by [Fred Clare](#) and [David Kennison](#) this document is meant to complement the paper, "The Production of Scientific Films Using a Digital Computer and Optical Output Device" written earlier by T. Wright, J.C.H. Mungall, A.C. Vastano, and R.E. Whitaker (a copy of the latter is in the UCAR Archives).

A Portable Device-independent Fortran Graphics System

Written by [Lofton Henderson](#), this describes the portability efforts made in the previous decade and has an interesting figure showing the NCAR Network Configuration as of December, 1979. This paper was originally prepared for and published in the Proceedings of the Digital Equipment Computer User's Society (DECUS), April 1980.

Generating and Plotting Graphics Text at NCAR

Written by [Fred Clare](#) this discusses utilities for generating characters and character plotting on the [dd-80](#) and on the [Dicomed](#). Of some historical interest in that it documents the dd-80 hardware characters.

PRFILM

Written in 1978 this describes the Fortran routing PRFILM that was callable from user CRAY-1 programs, for sending disk records to film.

PRSIM

This article discusses printer simulation on the [Dicomed](#) film cameras, particularly on 105mm microfiche where it was possible to get 270 pages on a single fiche card.

[RJE](#) graphics

Written by [Fred Clare](#) and [Lofton Henderson](#) this article discusses the (then) new capability of allowing a user to receive graphics instructions directly at his or her site and display the results on a local graphics device. Prior to this capability a user had to submit a remote job to one of the NCAR mainframe computers and have the output mailed to him. Hard to imagine anyone with such patience from the perspective of 2011.

MC2DD80B

Describes the function that ran on the CDC 7600 that could be invoked to translate [metacode](#) to the [dd-80](#) cameras (this was usually called automatically for jobs run on the 7600 or the CRAY-1 that disposed graphics to the dd-80 cameras.

Film production

Brief description of the procedures for producing movies.

Using [metacode](#)

Describes the concept of metacode and the role it plays in NCAR Graphics. This relates to the locally-developed metacode format prior to the adoption of the ANSI Standard CGM later in the 1980s.

Using the [Dicomed](#) off-line

Describes how to use the Dicomed cameras when they were running in off-line mode, prior to their coming online in May of 1982.

1986 The NCAR GKS-compatible Graphics System

The reference for this is [NCAR/TN-267+IA](#). This was a major release representing several person-years of development. It effected a conversion to base the package on the [ANSI/ISO](#) Graphical Kernel System (GKS) Standard. The package also produced the ANSI Standard [GCM](#) metafile and was released with a table-driven CGM translator; it provided tables for driving any one of many common output devices. Filling in a table for a new device was usually not difficult. Along with all of the other efforts, all code was made compliant with the Fortran 77 Standard. In short, this release was the culmination of several years of planning and implementation to convert to national standards. The adoption of GKS provided new functionality of long-standing request, such as producing raster images, solid fill areas, and a coherent color model. It had been in beta release for over a year.

The release of this package had a somewhat checkered history since it was released at the very time that [NSF](#) was moving to copyrighting the NCAR Graphics software. See the [Release dates](#) section of this document for details. This release ultimately constituted Version 1.0 of the package.

1987 NCAR Graphics User's Guide, Version 2.00

The reference for this is [NCAR/TN-283+IA](#). This is a more fleshed-out version than the 1986 version. It contains a lengthy introduction giving an overview of the package and a brief history. Also contained is a chapter on how to convert from a previous version of the package to this GKS-based version. There is a chapter on the System Plot Package Simulator ([SPPS](#)) the interfaces to the higher level utilities are detailed. Examples, with source code, are given. All code in this package was copyrighted by UCAR.

1987 NCAR Graphics Installer's Guide : Version 2.00

The reference for this is [NCAR/TN-284+IA](#). This manual was to be used by an experienced programmer in the initial installation of the NCAR Graphics package.

1989 NCAR Graphics Guide to New Utilities, Version 3.00

The reference for this is [NCAR/TN-341+STR](#). This manual emphasized producing color graphics. There is a particularly interesting section on beautiful plots produced from real scientific applications. There were sections on color, contouring, area fill, movies, text, labels, and legends. The new package [CONPACK](#) was introduced as a replacement for the old packages CONREC, CONRECQCK, CONRECSPR, CONRAN, CONRAQ, and CONRAS; the package [PLOTCHAR](#) was introduced as a replacement for PWRITX, PWRITY, PWRIT, and WTSTR; [GFLASH](#) was provided as new to the GKS-based package as a replacement for the FLASH package in pre-GKS versions; [STITLE](#) was provided as new to the GKS-based package as a replacement for

1990 NCAR Graphics Generic Package Installer's Guide, Version 3.00a

The reference for this is [NCAR/TN-342+STR](#). This gives details on installing the package, concentrating on [metafile](#) translation.

1993 Version 3.2 released on July 27

There is no digitized source for this release. It contained much new functionality added since the 3.00 release, among which were:

- C bindings for all user entry points.
- Eleven new filled fonts accessible from [PLOTCHAR](#).
- A direct [X11](#) output driver (bypassing the metafile translations step).
- ictrans, an interactive interface to [CGM](#) files (written in 1991).
- Inverse mapping projections in [Ezmap](#).
- rasview--a raster file previewer package for the [X Window System](#) (written in 1991).
- All source files put under [CVS](#) version control.
- [Polypack](#)--a set of routines allowing polygons to be manipulated in various ways.
- A video output option for ctrans (the C [CGM](#) translator).
- The "ncargex" script was added allowing for easy generation of examples.
- The "ncargf77" script was added allowing for compiling and loading of user Fortran codes.
- The "ncargcc" script was added allowing for compiling and loading of user C codes.

1995 Version 4.0, released in August

This is the first release to contain the new object oriented programmatic interface to the NCAR Graphics functionality, called the HLUs. More importantly it was the first release of the interpreted language NCL which was to become the flagship product until the present. The old Fortran/C interface, known as "NCAR Graphics," was maintained as a separate package from this time until the two packages were merged in Version 5.0 in November of 2007. A reference for the 4.0 release of NCAR Graphics (not NCL) is the [NCAR Graphics Fundamentals](#) manual.

With the advent of online documentation it seems that the ability to capture a snapshot of NCAR Graphics or NCL at a particular time has been lost. For anyone really interested complete documentation, with an online interface, is contained on the NCAR Graphics 4.1.1 disk in the UCAR archives. This has documentation for both NCAR Graphics and NCL.

The 4.0 release came out at the same time as the NCAR Graphics User Conference in 1995.

The major components of Version 4 were:

- The Low Level Utilities (LLUs) -- these are the Fortran utilities in NCAR Graphics that used to be called the high level utilities.
 - [Conpack](#), [Ezmap](#), [Autograph](#), etc.
 - The System Plot Package Simulator ([SPPS](#)).
 - The NCAR GKS package.

- New online documentation.
- The High Level Utilities ([HLUs](#)) -- this was a new object-oriented interface to the LLUs.
 - Applications
 - Data input
 - Workstation output
 - Overlays
 - Annotations
 - Transformations
- The NCAR Command Language (NCL) -- a new interpreted language interface to all functionality.
 - Interpreted language
 - Command line mode or batch script mode
 - Data input/export, support for [netCDF](#), [HDF](#), binary, and ASCII files.

New in 4.0 were:

- ng4ex -- script for easy generation of HLU and NCL examples.
- nhlf77 -- links user Fortran codes with the HLU libraries.
- nhlcc -- links user C codes with the HLU libraries.
- A direct to Postscript driver, eliminating the [metafile](#) translation step.
- [WMAP](#), A weather map package containing all the symbols for drawing weather maps and station model data.

1999 Getting Started Using NCL, released in February

The object oriented interfaces released in Version 4.0 were found by many users to be difficult to understand and use. In order to provide a more user friendly interface, a collection of functions and procedures was provided, documented in a manual called "GSUN - Getting Started Using NCL." The essential chapter of the manual was a collection of examples showing how to produce sample plots with single calls. The collection of the functions in this manual continue to be present in the functions available in NCL; these are the gsn_xxxx functions. The GSUN manual is available at http://ncl.ucar.edu/Document/Manuals/Getting_Started/.

2004 [PyNGL](#) released in February

PyNGL is a Python interface to the core functionality of NCL. Documentation for PyNGL is at <http://www.pyngl.ucar.edu/>.

2006 [PyNIO](#) released as a separate package in July

PyNIO is a Python package that allows read and/or write access to a variety of data formats using an interface modeled on [netCDF](#). PyNIO was formerly part of the PyNGL package as the Nio module. Documentation for PyNIO is at <http://www.pyngl.ucar.edu/Nio.shtml>.

2007 Version 5.0.0, November

Some of the main things added since the 4.0.0 release were:

- NCAR Graphics and NCL merged in the 5.0.0 release.
- Package contents released as open source.
- [GRIB](#) reader added.
- Several interpolation functions added in the [ngmath library](#).
- Many new color tables, dozens of new functions and bug fixes.
- A user e-mail list, [ncl-talk](#) (in 2000).
- New histogram function.
- Curly vectors added to the [Vectors](#) package.
- Mac OS [X](#) distribution.
- Direct [PDF](#) driver (2003).
- Mini reference manual.
- Functions for [WRF](#) support.

2011 Version 6.0.0, February

Some of the main things about the 6.0.0 release:

- New map outlines like the provinces of China, states of Brazil, India, and Australia.
- Support for [Shapefiles](#).
- [PNG](#) output.
- Support for variables greater than or equal to 2 GB in size.

The current full documentation for NCL is at: <http://ncl.ucar.edu/>. The current full documentation for NCAR Graphics is at: <http://ncarg.ucar.edu/>.

Release dates

Below is a summary of the public availability of the packages:

[NCAR Graphics](#)

[NCL](#)

[PyNGL](#)

[PyNIO](#)

Also mentioned are some basic milestones.

Details on releases of NCAR Graphics and NCL subsequent to September 1999 can be found at

<http://ncarg.ucar.edu/whatsnew.html>

and

http://ncl.ucar.edu/prev_releases.shtml respectively.

Details on all PyNGL and PyNIO releases can be found at <http://www.pyngl.ucar.edu/whatsnew.shtml>.

1964-1967

During this time period [Dave Robertson](#) wrote a group of routines in [assembly language](#) used to form primitive plotter instructions. Only the most basic routines for scaling and plotting line segments, character strings, and annotated axes were included in this group. This group of low-level functions was known as the NSPP (the NCAR System Plot Package). Dave also wrote programs for more complicated functionality like drawing XY-plots (which he named IDIOT) and for basic contouring (CALCNT). IDIOT eventually became AUTOGRAPH, discussed elsewhere in the archive. This package was available on card deck for duplication.

1968-1971

Under the direction of [Tom Wright](#) the portable NSPP (NCAR System Plot Package) was produced. This package was a Fortran implementation of the [assembly language](#) routines written by [Dave Robertson](#). Tom also assembled higher level Fortran functions created by himself and from scientific codes written by SCD staff and externally-written codes. This collection was an early effort to organize the package into a cohesive product. Most programs were still submitted via punched cards in this era and the package continued to be available on card decks for duplication.

1971-1977

During this period the package was in the public domain. It was part of the wider collection of routines known as the NCCL (NCAR Software Support Library). For an overview of the package contents in this era, see [NCAR/TN-105+IA](#). During this period [Tom Wright](#) made the package more portable and promoted its distribution within and outside of NCAR. In 1977 Tom visited [CSIRO](#) in Australia at the invitation of John O'Callaghan. Tom distributed the package to CSIRO via 9-track tape. This is considered the first distribution outside of the United States.

In December of 1977 [David Robertson](#) and [Tom Wright](#) received the annual Scientific and Technical Achievement award for their development of the NCAR computer graphics software system (NCAR Graphics).

1978-1985

In this time frame between 80 and 200 packages were being distributed per year on 9-track tape. The package had no official release numbers assigned in this era.

1985

July 30

First beta release of the [GKS](#)-based package. This was the result of several years of effort to convert the package to National standards: GKS, the ANSI Graphical Kernel System graphics standard; [CGM](#), the [ANSI](#) Computer Graphics Metafile Standard; Fortran 77, the ANSI 1977 Fortran standard.

September 30

Second beta release of the GKS-based package.

December 13

Third beta release of the GKS-based package.

1986

July 21

The notice below was sent to beta sites saying that in accordance with recent NSF guidelines, the package would no longer be in the public domain.

Under new guidelines from the NSF, this NCAR software package is not in the public domain. Distribution by NCAR does not include the right of the recipient or the user to distribute or use this software for commercial purposes. Commercial distribution is permitted only under agreement with NCAR.

August 1

Version numbers began. This release was known as "Version 1.0". The start date for the release of Version 1.0 is documented in the December 1, 1986 edition of the SCD newsletter "The Record." The package was shipped with the same message as above. See the user manual for this release at: [NCAR/TN-267+IA](#). This is the first release when charging was initiated: \$200 for the software and \$100 for the manuals.

December

It was announced in the December, 1986, issue of the SCD Newsletter, "The Record" that SCD would be suspending distribution of Release 1.0 until Release 2 would become available in 1987.

1987

April

SCD was still not distributing the graphics package, but NCAR's Meso-scale Research Section (MRS) was distributing its [VMS](#) version of the for \$200.00.

July

Notice was given in the July, 1987, edition of the newsletter "The Record" that all software and documentation of NCAR Graphics would be copyrighted. All recipients of Version 1.0 were shipped a copyrighted replacement, called Version 1.00 and asked to return Version 1.0.

November

Distribution was resumed with Release 2.00 which had UCAR copyright notices inserted in all software (official notice of the UCAR copyright was given in the July, 1987, edition of "The Record"). An extensive hard-copy manual was part of this release which can be seen at: [NCAR/TN-283+IA](#). A pricing structure for the software and the manuals was in place for this release.

1988, August

First release of a [UNIX](#) specific package, developed by [Don Middleton](#).

1989

January 12

Version 2.01 released.

May 10

Version 2.01 released.

June 16

Version 2.03 released

1990, January

Release 3.00 announced. This package would auto-install on many [UNIX](#) systems, and would install on most any UNIX system with minor mods. [Don Middleton](#) was the main developer for conversion of the package to run on UNIX machines. An extensive hard-copy manual was part of this release, see: [NCAR/TN-341+STR](#).

1991

March

Release 3.01 announced. Included a filter for converting pre-[CGM metafiles](#) to CGM. Provided color [Postscript](#) via a Postscript graphcap. Contained a background/foreground color setting utility for Postscript. The "rasview" package was added to the distribution; this package displays raster imagery from a file into an [X window](#).

April

Version 3.1.0 (new version numbering) released. This version was a UNIX-specific version. The generic version number stayed at 3.0. All subsequent version numbers for NCAR Graphics refer to the UNIX version.

June

Version 3.1.1 released.

June 16

Version 3.1.2 released.

1992

April

Version 3.1.3 released.

June

Version 3.1.3a released (corrected problems in Version 3.1.3).

1993, July 20

Version 3.2.0 released for [UNIX](#) computers. Generic and [VMS](#) ports were not available for Version 3.2 and beyond, only the UNIX version. Version 3.2 contained the new filled fonts as well as C language bindings for all user entry points. Also the direct [X11](#) and Postscript drivers.

1994, June

Version 3.2.1 released.

1995

September

The name "NCAR Graphics," was granted as a trademark by the U.S. Patent and Trademark office.

September

Version 4.0.0 released. This major release was the first to contain NCL (the NCAR Command Language) and the [HLUs](#) (High Level Utilities). The main developer of NCL was [Ethan Alpert](#); the developers of the HLUs were Ethan, [Jeff Boote](#), and [Dave Brown](#). From this date until version 5.0.0 was released in November of 2007, the classic NCAR Graphics programmatic

subroutine library was maintained as a separate package from the NCL package and the version numbers went their separate ways until Version 5.0.0 in November of 2007 when the two packages were combined into a single fully open source package.

1996, June

NCAR Graphics [UNIX](#) Version 4.0.1 released.

1998, August

NCAR Graphics [UNIX](#) Version 4.1.0 released.

1999

May

NCAR Graphics [UNIX](#) Version 4.1.1 released.

September 29

NCL Version 4.2.0a005 released. Shgrid interpolates 3D data. [GRIB](#) reader updated.

November 2

NCL Version 4.2.0a006 released. Date functions added.

December 6

NCL Version 4.2.0a007 released. Date functions added.

2000

January 18

NCL Version 4.2.0a008 released. Date functions added.

June 12

NCL Version 4.2.0a009 released. New functions and procedures.

July 31

NCL Version 4.2.0a010 released.

August

NCAR Graphics Version 4.2.0 released. This was released under the [GNU General Public License](#). Details on all subsequent releases of NCAR Graphics can be found at: <http://ncarg.ucar.edu/whatsnew.html>. Details on NCL releases can be found at: http://ncl.ucar.edu/prev_releases.shtml

August 28

NCL Version 4.2.0a011 released. [ncl-talk](#) mail group announced.

September

NCAR Graphics UNIX Version 4.2.1 released. Climate divisions added to [Ezmap](#).

October 30

NCL Version 4.2.0a012 released. Date functions added.

November 8

NCL Version 4.2.0a013 released. pop_remap added.

2001

January 2

NCL Version 4.2.0a014 released. [ngmath](#) functions accept multi-dimensional input.

February 14

NCL Version 4.2.0a015 released. New colormaps.

March 16

NCL Version 4.2.0a016 released. dsgrid2 and dsgrid3 added.

April 2

NCL Version 4.2.0a017 released. [gsn_histogram](#) added.

May 14

NCL Version 4.2.0a018 released. Date functions added.

June 12

NCL Version 4.2.0a019 released. [grid2triple](#) and [wavelet](#) added.

July 24

NCL Version 4.2.0a020 released. Date functions added.

September

NCAR Graphics UNIX Version 4.2.2 released. Improvements for [Linux](#) implementations.

September 24

NCL Version 4.2.0a021 released. Date functions added.

November

NCAR Graphics UNIX Version 4.2.3 released. Improvements for [RedHat Linux](#) 7.1 implementations.

November 28

NCL Version 4.2.0a022 released. Mention that curly vectors have been available in [Vectors](#) since 4.2.0a019.

2002

February 14

NCL Version 4.2.0a023 released. Access to high resolution coastline data added; [wmstnm](#) added for plotting station model data.

May 13

NCL Version 4.2.0a024 released. A download was added for the Mac OSX operating system.

July

NCAR Graphics UNIX Version 4.3.0 released. High resolution coastlines added to [Ezmap](#); curly vectors added to [Vectors](#); improvements for Cygwin implementations.

September 16

NCL Version 4.2.0a025 released. Can run NCL a file name input, without "<".

September 24

NCL Version 4.2.0a026 released. Bug fix for [Vectors](#) bug.

November

NCAR Graphics UNIX Version 4.3.1 released. More improvements for [Linux](#) support.

December 30

NCL Version 4.2.0a027 released. Date functions added.

2003

March 31

NCL Version 4.2.0a028 released. [PDF](#) driver added.

July 1

NCL Version 4.2.0a029 released. NCL mini reference manual available.

July 1

NCL Version 4.2.0a030 released. Bug fixes for 4.2.0a029. available.

2004

January 2

NCL Version 4.2.0a031 released. [GRIB](#) reader update and bug fix.

September 19

First beta release (Version 0.1.0b1) of [PyNGL](#), a Python language interface to NCL functionality.

October 18

[PyNGL](#) Version 0.1.1b1 released. New examples; documentation update.

November

NCAR Graphics UNIX Version 4.4.0 released. PDF driver. Contouring on non-uniform grids (Conpackt). IFTRAN added to the distribution.

December 6

NCL Version 4.2.0a032 released. OPeNDAP enabled; new [GRIB](#) tables; [wmbarb](#) added for drawing wind barbs over maps.

December 8

[PyNGL](#) Version 0.1.1b3 released. Bug fixes; new resources.

December 10

[PyNGL](#) Version 0.1.1b4 released. Bug fix.

December 12

[PyNGL](#) Version 0.1.1b5 released. New examples; works with Python 2.4. update.

2005

January 12

[PyNGL](#) Version 0.1.1b6 released for internal testing only, not publicly released.

February

NCAR Graphics UNIX Version 4.4.1 released. Ezmap supports rotated Mercator projections.

March 17

[PyNGL](#) Version 0.1.1b7 released. New functions; new examples.

September 22

[PyNGL](#) Version 0.1.1b8 Module Nio added to allow read and/or write access to a variety of data formats ([netCDF](#), [GRIB1](#), HDF4, HDF-EOS2, [CGM](#) History tape) using an interface modeled on netCDF. This module would be split into a separate package call [PyNIO](#) in 2006.

December

[David Brown](#), [David Kennison](#), [Dennis Shea](#), [Fred Clare](#), [Mary Haley](#), [Richard Grubin](#), [Sylvia Murphy](#) win the UCAR Technical Achievement Award for the development of the NCAR Command Language (NCL).

2006

January 23

NCL Version 4.2.0a033 released. NCL mini reference manual available.

July 12

[PyNGL/PyNIO](#) Version 1.0.0 released. The Nio module is now independently maintained as the [PyNIO](#) package. Website redesigned. Supports NumPy 0.9.8. More examples.

September 26

NCL Version 4.2.0a034 released. New [GRIB](#) conversion function's.

November 9

[PyNGL/PyNIO](#) Version 1.1.0 released. Supports both NumPy 1.0 and Numeric 24.

2007

May 1

NCL Version 4.3.0 released. New [GRIB2](#) reader; changes to [GRIB1](#) reader; new color tables.

June

NCAR Graphics [UNIX](#) Version 4.4.2 released. Vector and streamlines added for triangular meshes ([Vaspackt](#)).

July 23

[PyNGL/PyNIO](#) Version 1.2.0 released. [NumPy](#) default array module.

August 10

NCL Version 4.3.1 released. Partial support for [netCDF](#) 4; functions added to support [WRF](#).

November 6

NCL Version 5.0.0 released. With this release the NCAR Graphics package was flagged as release 5.0.0 and combined with the NCL distribution, which was also noted as 5.0.0. This was the first official open source release. All future distributions have NCL and NCAR Graphics at the same version number and are referred to as NCL releases. New map databases added; state/province outlines for Australia, Brazil, China, and India added; ice shelves of Antarctica added.

2008, August 18

[PyNGL/PyNIO](#) Version 1.3.0b1 released. PyNGL and PyNIO now separate packages. This is the first open source version of the two packages. Many new features.

2009

March 4

NCL Version 5.1.0 released. New map projections and map outline databases; new color tables.

June

NCL Version 5.1.1 released. [Shapefiles](#) supported.

2010

April 1

[PyNGL](#) Version 1.3.0b4 released. [PNG](#) output supported.

April 1

[PyNIO](#) Version 1.3.0b5 released. Builds with Python 2.6. OPeNDAP supported.

April 14

NCL Version 5.2.0 released. Beta [cairo](#)-based functionality with [PNG](#) driver released.

July 26

NCL Version 5.2.1 released. Long-standing bug in [Areas](#) fixed.

August 16

[PyNIO](#) Version 1.4.0 released. Installation of NCL no longer required.

August 22

[PyNGL](#) Version 1.3.1 released. New functions, resources, and examples.

Staff bios

This information was compiled in January, 2011 by [Fred Clare](#), with help from [Dick Valent](#), [Dave Kennison](#), [Tom Wright](#), [Mary Haley](#), and [Dave Robertson](#).

Jeanne Adams (??/??/1961 - 12/??/1981, 11/??/1984 - ??/??/1997)

Head of user services for many years. Taught Fortran classes on a one-on-one basis to new hires in the early days, including some future members working on NCAR Graphics. Chairman of the [ANSI](#) Fortran committee through its development of Fortran 77 and Fortran 90. For more on Jeanne, see <http://www.ucar.edu/communications/staffnotes/0705/adams.shtml>. [deceased 2007]

Akash Agrawal (02/22/2002 - 01/30/2003)

Student assistant. Worked with Mary Haley

Ethan Alpert (06/xx/1991 - 08/02/2002)



One of the co-developers of the object-oriented [HLU](#)s (High Level Utilities) and NCL (the NCAR Command Language, see <http://ncl.ucar.edu/>). Ethan came to the Scientific Visualization Group after having participated in a collaborative project between SVG and students from the University of Colorado Department of computer science in the academic year 1990-1991. This project was "GLOVE: GLObal Visualization Environment" and Ethan utilized his experience from the GLOVE project in his code development for SVG. Ethan served as group head of the Scientific Visualization Group from December, 1997 until he left NCAR. Ethan went on to be a Senior Software Engineer at DigitalGlobe.

Dan Anderson (07/07/1970 - 04/02/2004)

Dan's only direct involvement with the graphics software was to rewrite [Dave Robertson's](#) XY-plotting package (called IDIOT), calling it AUTOGRAPH. [Dave Kennison](#) ultimately rewrote his [Autograph](#) from scratch while retaining the name.

Ed Ash (01/09/1984 - 08/03/1986)

Student assistant. Worked with [Fred Clare](#) on GKS testing and examples.

Diane Bernier (04/28/2003 - 10/02/2006)

SVG (Scientific Visualization Group) administrative assistant.

Brian Bevirt (04/20/1988 - present)

Worked on documentation.

Jeff Boote (05/22/1990 - 03/15/2002)



One of the co-designers (with [Ethan Alpert](#)) and implementers of the [HLU](#)s and NCL. Jeff came to NCAR after his participation in an [SVG](#) collaborative effort with a student project with the Computer Science Department of the University of Colorado. This project was "XCOED: X Window System Color Editor" and Jeff used his experiences with this project in his NCAR work. Jeff made significant contributions to the internal file maintenance and update procedures. After leaving NCAR Jeff went to work for Internet2 where he became Assistant Director, Research and Development, Architecture and Performance.

David Brown (09/14/1992 - present)



Dave came to [SCD](#) from doing contract work for CSC (Computer Science Corporation) and Henderson Software. Dave has been involved in almost all aspects of the graphics project. Early on he worked with the co-developers ([Ethan Alpert](#) and [Jeff Boote](#)) of NCL and, when they left, became the primary expert on that code. Dave has worked on enhancing some Fortran utilities and wrote the [Vectors](#) package. He developed and maintains [PyNIO](#), a stand-alone python code that accesses the I/O capabilities of NCL. Through his work on data I/O Dave has acquired expert knowledge of the [GRIB](#), [HDF](#), and [netCDF](#) data formats. He incorporated most of the lower level Fortran functions into NCL. In 2005 Dave shared the UCAR Technical Advancement Award for the development of the NCL.

Rick Brownrigg (12/01/2008 - present)

Rick got his Ph.D. in Computer Science from the University of Kansas in 2005. Rick came to NCAR from working on NASA's WorldWind team. He took over the [cairo](#) drivers when he came on board. He added new workstation types which involved getting into the guts of the GKS code. He is a frequent responder to the [ncl-talk](#) mail group questions. He fixed a long-time vexing bug in the [Areas](#) package. Rick Shared the National Aeronautics and Space Administration Software of the Year award in 2009 for work he had done prior to joining [CISL](#).

Cindy Bruyere (09/04/2001 - present)

A member of the Mesoscale & Microscale Meteorology (MMM) Division. Cindy is a native of South Africa where she earned a master's degree in meteorology from the University of Pretoria. She has worked with Mary Haley on developing NCL functionality specific to supporting the WRF (Weather Research and Forecast) model. See <http://www.ucar.edu/communications/staffnotes/0302/visitors.html> for more on Cindy.

Mary Buck (03/25/1974 - 03/15/2000)

Keypunch operator in the old days. Helped with NCAR Graphics orders later.

Dori Bundy (xx/xx/1969 - xx/xx/1972)

While working for Roy Jenne, Dori became interested in graphics and worked with [Dave Robertson](#) in 1970 to write PWRX, the first use at NCAR of the stroked fonts developed by Dr. A. V. Hershey in 1967 at the U.S. Naval Weapons Lab. (ref: <http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=AD0662398>). Dori has said, "I did this on Saturday and Sundays, as Roy wouldn't give Dave any of my paid time." In that era full-time male employees at NCAR and their wives were covered 100% by NCAR health insurance, but for full-time female employees their husbands were only 50% covered. Dori was responsible for getting NCAR to change the policy to 100% coverage. Many of the things that are later taken for granted were fought for. After leaving NCAR, Dori worked for NASA, then at Columbia University,

and finally at Princeton University working for the [DOE Plasma Physics Lab](#) (PPPL) where she was Head of Computing and Technology.

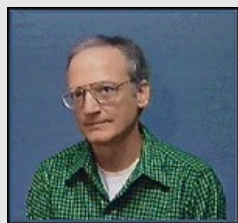
Lee Carter (05/20/1991 - 02/02/1996)

Lee started in SCD as a student working in the consulting group. He then moved to the graphics project where he worked on documentation, consulting, and distribution. He left NCAR to do entrepreneurial work with his brother.

Jay Chalmers (12/01/1969 - 11/16/1985)

Jay was in the Computing Facility from 1969 to 1979 and then, since he was doing a lot of work for scientists at the High Altitude Observatory ([HAO](#)), he transferred to that division in March of 1979. Jay wrote the original version of the package called EZMAP (a world map drawing package). This was based on earlier work by [Dave Robertson](#) (who had brought in a package called SUPERMAP) and work by [Cicely Ridley](#). Ultimately [Dave Kennison](#) took Jay's code and rewrote most of it to produce the NCAR Graphics version of [Ezmap](#). Jay was noted for being able to optimize codes, particularly for specific machines. He optimized the the byte-packing function SBYTES using extensive vectorization features. From NCAR Jay went to work for Karl-Heinz Winkler at the Los Alamos National Laboratory and the University of Illinois. He commuted from Boulder to Los Alamos and Champaign/Urbana. [deceased, 1993]

Fred Clare (09/02/1969 - 05/16/2008)



Fred came to SCD as a student assistant while working on his Ph.D. in pure math at the University of Colorado. He knew nothing about programming and learned Fortran from [Jeanne Adams](#). As a student he worked directly with scientists, primarily with Bob Dickinson and John Geisler. When becoming full time in 1973 he worked in the GCM (General Circulation Model) group with Jerry Browning and Akira Kasahara. He worked with Dave Williamson on normal modes. He began working on NCAR Graphics in 1979. He completed implementations and testing of the standards conversions in the 1980s ([GKS](#), [CGM](#)) after [Lofton Henderson](#) and [John Humbrecht](#) left. He shepherded the project through some lean times in the late 1980s (distribution, consulting, bug fixes, documentation, etc.) Produced direct Postscript and [PDF](#) drivers. Wrote [WMAP](#), a weather map package. Added filled fonts and [WMO](#) weather symbol fonts. Produced the [ngmath](#) package of mathematical interpolation functions. Worked with [Mary Haley](#) to produce the Python interface to NCL graphics functionality called [PyNGL](#). Worked on a couple of animations for Warren Washington using PyNGL/PyNIO. Implemented an initial interface to [cairo graphics](#). After Fred retired, [Rick Brownrigg](#) continued Fred's initiative to exploit the interface to cairo graphics to address long-standing user requests such as adding new workstation types and transparency. Shared the UCAR Technical Advancement Award in 2005 for the development of the NCAR Command Language. Worked as a casual employee until April of 2011.

Alan Cline (09/xx/1970 - 09/xx/1973)



Alan came to [SCD](#) as a young Ph.D. mathematician from the University of Michigan. He specialized in linear algebra, applying it to curve fitting, and in particular using splines under tension. Alan did consulting to the scientific staff. A major achievement was to have written, while in SCD, some of the core functions of what was to become the commercial [Fitpack](#) curve fitting package. Alan was in charge of designing a template for test routines, and overseeing the implementation of these. Alan went from SCD to the computer science department of the University of Texas where he became a tenured professor.

John Clyne (05/26/1988 - present)



Before coming to [SCD](#) John was a member of a three person team of computer science students at the University of Colorado working with SCD staff on a senior project. That project was to rewrite our [metafile](#) translator (which was in Fortran) in C. The project was completed in May of 1988 at which time John came on board



in SCD. His main efforts at the beginning were to enhance and maintain the translator. John wrote a metafile editing application ([med](#)), an interactive metafile display tool ([idt](#)), and raster manipulation functions. He also became proficient in [X Window](#) programming. John was active in establishing the Visualization Lab and has been a lead programmer in developing [VAPOR](#) (a Visualization and Analysis Platform for Ocean, Atmosphere, and Solar Researchers). VAPOR provides an interactive 3D visualization environment that runs on most [UNIX](#) and Microsoft Windows systems equipped with modern 3D graphics cards.

Donna Converse (06/08/1984 - xx/xx/1988)

Student assistant. Worked with [Fred Clare](#) and [John Humbrecht](#) on [CGM](#) translator issues. Helped Fred spin up to take over the Fortran CGM translator after John quit in September of 1986. After 1986 helped with the package distributions and implementations. Left to join the MIT X Consortium. See: <http://www.netads.com/~meo/pubsntalks/iX/xtc95/donnac.html>. Donna went on to co-author several books on the [X Window System](#).

Dee Copelan (08/xx/1986 - 09/xx/1987)

Head of the User Services Section which is where the Graphics Group resided at the time.

Susan Cross (07/27/1987 - present)

Worked on the design and set-up for NCAR Graphics booths at conferences. At present, she is responsible for the gathering and transport of the graphics booth materials. She is a super-admin in coordinating registration and arrangements for a number of [CISL](#)-related meetings and conferences. She shared the 2005 UCAR Education and Outreach award with other team members, in recognition of this work.

Ed Davis (08/??/1966 - ??/??/????)

Worked in the film processing room in the days of [dd-80](#) film output. Maintained the microfilm/microfiche readers. [deceased]

Margaret Drake (??/1962 - 07/08/1989)

Was a programmer in the [CF](#) from 1962 through 1967. Served as acting director and deputy director for much of her career. Was briefly a member of the Graphics Group before her retirement. [Deceased, December 27, 1990 in Mexico]

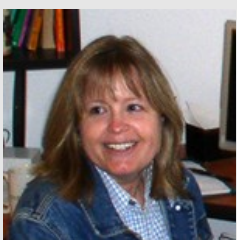
Sandy Walker Fuller (11/13/1967 - 11/17/1998)

Did some early work on the character plotting package PWRITX (precursor to [Plotchar](#)). Sandy had a colorful personality in the style of Joan Rivers. [deceased 1985]

Richard Grubin (10/08/2002 - 06/09/2008)

Worked on NCL consulting and installation. Won a 2005 SCD Special achievement award for installation of software on SCD's [Linux](#) cluster systems. In 2005, shared the UCAR Technical Advancement Award for the development of the NCAR Command Language.

Mary Haley (06/12/1991 - present)



Mary got her undergraduate degree from New Mexico Tech in Socorro. She came to NCAR after working at Mission Research Corporation in Albuquerque. Her first tasks in SCD were graphics consulting and distribution. Mary has gone on to have been essential in the development and success of NCL--she has been the NCL project leader for many years. She is a master of incorporating Fortran and C codes into NCL. She wrote a suite of user-friendly functions ([GSUN](#)) to address the difficulties users were having with the object-oriented code in the initial NCL release; many consider that she saved NCL from failure by writing that interface. These interface functions are the gsn_xxxxx functions in the current release (see: <http://ncl.ucar.edu/>). She has overseen several dozen official distribution releases of NCL, NCAR Graphics, [PyNGL](#), and [PyNIO](#), tailored to about two dozen varieties of [Linux](#), [UNIX](#), and [Cygwin](#) for PCs. She answers most of the questions coming into the ncl-talk, ncarg-talk, pyngl-talk mail groups (running over 200/month in 2011). She

shared the UCAR Technical Advancement Award in 2005 for the development of the NCAR Command Language (in fact she supplied the necessary energy and paperwork required for this award). In addition, in collaboration with [Dennis Shea](#) (and sometimes [David Brown](#)) Mary has conducted over fifty multi-day NCL workshops all over the U.S. and in several countries, as well as presented at numerous conferences. See the entry for [Dennis Shea](#) for more details on the workshops. Mary's organizational skills and work ethic are unparalleled; her unofficial title of "Supreme Goddess of NCL" is well deserved.

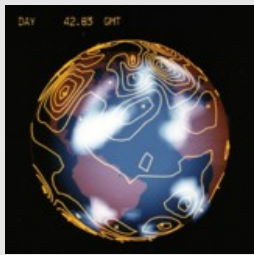
Ken Hansen (10/18/1967 - 10/03/1997)

Started in the computer operations section, then worked with [Bob Lackman](#) on GENPRO (GENeral PROcessor), then became a full time consultant who was responsible for graphics questions.
[deceased 2006]

Esther Harrold (??/??/???? - 08/02/1991)

Student assistant.

Richard Helgason (06/xx/1968 - 05/xx/1973)



Rich was an early power user. Around 1970 he produced a color movie that had contours drawn over a globe, with clouds (plot at left). This was way ahead of its time. Since there was no color film camera available the colors were produced in post-processing by using different color filters. The clouds were then put on by drawing some "X" characters and having the film operator put them out of focus. Perhaps one of Rich's most significant contributions was in encouraging his friend [Dave Kennison](#) to come to NCAR. Rich went on to get his Ph.D. in operations research and become a tenured professor at Southern Methodist University.

Lofton Henderson (01/11/1973 - 06/19/1986)



Started out working on GENPRO (the GENeral PROcessor) but within a few years began working with [Tom Wright](#) on graphics. In September through December of 1976 Lofton accompanied NCAR scientist Melvin Shapiro to Oslo, Norway to work on post-processing of Mel's modeling efforts. When [Tom Wright](#) left NCAR in 1979, Lofton was made the head of the newly-formed Graphics Group. Lofton's main contribution was to base NCAR Graphics on National Standards. The GKS (Graphical Kernel System) replaced the old SPP (System Plot Package). All codes were converted to Fortran 77. The Computer Graphics Metafile (CGM) was adopted for device-independent 2D graphics file storage. Lofton sat on the CGM committee. All higher level Fortran utilities were converted to the new interfaces. At the time of Lofton's departure the implementation was still in beta release. Lofton, along with [John Humbrecht](#), was also instrumental in bringing the [Dicomed](#) film/fiche cameras online. Lofton went on to form his own software company, Henderson Software. He also co-authored two books on the CGM.

Lynn Hermanson (02/12/1996 - 07/25/1996)

Student assistant.

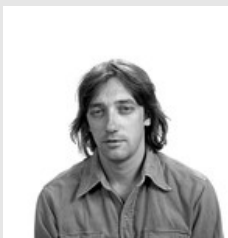
Darryl Holley (09/??/1975 - 05/xx/1994)

Darryl worked in the systems section. He was responsible for producing text and graphics on the high-speed Xerox laser printers as an alternative to producing fiche or film.

Wei Huang (12/11/2008 - present)

Wei came into the [VETS](#) section in 2008 from the [CISL](#) consulting office where he was hired in 2005. Before that, he worked in [MMM](#) developing the WRF 4D-VAR package. He has worked closely with [Dave Brown](#) on NCL issues, in particular datatype conversion functions. He holds master's degrees in both Atmospheric Science 1991 and later Computer Science, the latter from the University of Colorado. Wei responds to many ncarg-talk newsgroup questions and is a determined bug fixer. He has also been involved in the conversion to 64-bit addressing effort.

John Humbrecht (09/22/1980 - 09/11/1986)



John wrote the initial version of Conraq, a package for drawing contours on irregularly spaced grids. He was involved in the standardization effort to convert the package to be based on the [GKS](#) and [CGM](#) standards. He wrote a beta version of a CGM translator in Fortran, known as "ftrans." He came up with the idea of having ftrans be table driven by providing compact device descriptions in "Graphcaps" and font descriptions in "Fontcaps." John did work to get NCAR

Graphics plots to display on early color workstations. John went on to form his own consulting company.

Lou Jones (12/??/1980 - 05/06/1988)

Lou did a lot of work on the NCAR local network, for example: he wrote the driver for the Pyramid server that was the general server for SCD, replacing the DEC 11/70's. With respect to NCAR Graphics Lou was instrumental in writing SUDOOS (the Sun/UNIX [Dicomed](#) Online Operating System) in 1988. This operating system, and Sun computers, replaced the much slower RSX-11M system running on the DEC 11/70s. Lou was also involved with developing NRIF (the NCAR Raster Image Format). Lou left to work at the Pasteur Institute in Paris, France.

David Kennison (10/5/1970 - 02/06/2009)



Dave initially took over the GCM (General Circulation Model) processors. He took over maintenance and development for FRED, a Fortran editor that provided many coding conveniences; later assumed responsibility for maintenance and development of IFTRAN, a Fortran pre-processor that implemented structured programming concepts, conditional compilation, and so forth. Dave wrote most of his programs in IFTRAN. Dave participated in benchmarking efforts for the

replacement of the [CDC 7600](#). On loan to the Systems Section he rewrote the system editor for the 7600, in [assembly language](#). Dave also served several years in the consulting office. Dave's fingerprints are on most every piece of the lower level Fortran graphics library, he wrote or revised most of the graphics application software: [Autograph](#) (XY-plotting), [Conpack](#) (contouring), [Softfill](#) (software area fill), [Ezmap](#) (map drawing), Ezmapa (color fill of maps), [Plotchar](#) (character plotting), [Isosurface](#) (iso surfaces), [Polypack](#) (polygon manipulation), [Dashpack](#) (dash lines), [Tdpack](#) (3d plotting), [Conpackt](#) (contouring on triangular meshes), [Vaspackt](#) (vectors and streamlines on triangular meshes). He implemented high-resolution outline data in [Ezmap](#). Dave also produced detailed documentation for all of his software. Safe to say that Dave is responsible for much of what is in the Fortran functionality of NCAR Graphics, without which there would have been no NCL. Dave Shared the UCAR Technical Advancement Award in 2005 for the development of the NCAR Command Language. Over the years Dave climbed Longs Peak (elevation 14,259 ft.) more than 100 times; he also climbed Mt. Kilimanjaro.

Bob Lackman (2/5/1968 - 10/03/1997)



Bob's major effort, prior to his becoming the head of the Graphics Group upon [Lofton Henderson](#)'s leaving in 1986, was the development of GENPRO, a general scientific data processor (see: [NCAR/TN-209+IA](#)). Bob's tenure as manager saw the completion of the standardization effort and the original development of the [HLU](#)s (high level utilities) and NCL. Also, development and support for [UNIX](#) specific implementations were effected during Bob's time. Early on in Bob's tenure

as group head there was a decision to be made as to whether to freeze the package and move to purchasing and supporting commercial graphics products, or to continue local development. Bob's decision was to move on with local development which resulted in the development of the NCAR Command Language (NCL), first released in 1995. In that sense, Bob set the direction for the project for almost twenty years (at the time of this writing in 2011).

Lynda Lester (06/04/1990 - 11/06/2006)

Lynda was a writer/editor in the Digital Information Group. Over the years Lynda worked with

members of VETS (the Visualization and Enabling Technology Section) to write many articles on graphics for The "SCD Computing News," and [The SCDzine](#). A typical example of Lynda's work relevant to the graphics project can be seen at:

<http://www.cisl.ucar.edu/news/04/fotoweeek/1015.pyngl.html>.

Rich Loft (??/??/1988 - present)

Director of Technology Development for the Computational and Information Systems Laboratory (CISL) at NCAR. He pushed the two-dimensional [FFTPACK](#) routines which are in the NCL distribution.

Tania Loftus (01/xx/1984 - ??/??/1986)

Student assistant. Worked with [Fred Clare](#) on [GKS](#) testing.

Jacque Marshall (06/21/1989 - 07/09/2002)

Did artwork for online and hard-copy documentation.

Don Middleton (11/09/1987 - present)



Don received a master's degree from Louisiana State University in electrical engineering and was working in the LSU Electrical and Computer Engineering Department prior to coming to NCAR. Don's first major contribution was to tailor NCAR Graphics to work on [UNIX](#) systems. The first version of this was released in 1990. Don gave a talk "Video and workstation animation" at the 1992 Graphics Conference at NCAR; this reflected his interest in providing facilities for producing and viewing animations. He had begun work on developing a visualization laboratory at NCAR in 1990 and the Visualization Lab was officially opened in 1991. In 1994 Don became the group head of the Scientific Visualization Group (SVG) and then, in 1999, the Visualization and Enabling Technologies Section (VETS) was formed and headed by Don. Don is internationally recognized as an expert in computer visualization, having given many presentations at conferences and published articles in journals like *AI Magazine* and *Parallel Computing*. Don has a wide variety of interests centering on the frontiers of managing, preserving, and analyzing large, complex earth system datasets and communication using advanced visual technologies. As of 2010 he is serving in a [PI](#) or co-PI capacity on a number of projects, including: the Earth System Grid, the Earth System Curator, the Virtual Solar Terrestrial Observatory, the North American Regional Climate Change Assessment Program, the Cooperative Arctic Data and Information Service, and NCAR's Cyberinfrastructure Strategic Initiative. He recently completed a term on a National Research Council committee for NEES/NEESGrid and Earthquake Engineering and was a contributing author for the new publication, The Visualization Handbook. Don shared the 2005 UCAR Education and Outreach award with Darin Oman, Dianne Bernier, Joey Mendoza, [John Clyne](#), [Susan Cross](#), and [Tim Scheitlin](#) for their work in the Visualization Lab.

Adrianne Middleton-Link (07/09/1987 - 03/xx/1995)

Adrianne was heavily involved in documentation and training. She taught a thorough three day class on NCAR Graphics prior to the NCAR Graphics Conference in the summer of 1992. In 1993 she published the [LLU Contouring and Mapping Tutorial](#) that employed a tutorial approach for beginning users. She was a co-author of [NCAR Graphics Fundamentals](#). Adrianne became a causal employee in March of 1995, but did no work for NCAR Graphics in that capacity. She was hired in the fall of 1998 to work with Warren Washington to make [IPCC](#) runs, This has turned into long-term employment continuing into the present (2011).

Rob Montgomery (06/xx/1988 - 08/13/1990)

Student assistant. Worked on examples, debugging, and documentation. Later went to NOAA, then to [HAO](#). See: <http://www.ucar.edu/communications/staffnotes/9509/farewell.html>. [deceased 2010]

Laura Morreale (02/01/1988 - 10/11/2003)

Laura handled orders during the time the package was being sold. She and [Mary Buck](#) handled the physical distributions and well as all the accounting.

Sylvia Murphy (01/xx/1999 - 02/18/2005)

Before Sylvia's transfer from [CGD](#) to [SCD/CISL](#) in 1999, she worked with [Dennis Shea](#) to develop and present NCL training seminars (for more on this, see the entry for [Dennis Shea](#)). Sylvia designed the original home page for NCL. In 2005 she shared the UCAR Technical Advancement Award for the development of the NCAR Command Language.

Alan Norton (10/01/2008 - present)

Alan got his Ph.D. from Princeton. Before coming to [CISL](#) he had done work on fractals with Benoit Mandelbrot himself, having created figures for two of Mandelbrot's books. He was the [SIGGRAPH](#) 2003 Web Graphics Chair. He has worked with [John Clyne](#) on [VAPOR](#) (a Visualization and Analysis Platform for Ocean, Atmosphere, and Solar Researchers). Alan has worked on providing functionality for importing NCL output into VAPOR.

Adam Phillips (01/04/2000 - present)

As a member of [CGD](#) (Climate and Global Dynamics) division, Adam has made significant contributions to NCL, particularly in consulting on scientific issues, but general consulting as well. On his own time he redesigned and implemented the NCL home page (<http://ncl.ucar.edu/>). For more information on the collaboration between [VETS](#) and [CGD](#), see the entry for [Dennis Shea](#).

Juliana Rew (08/30/1976 - 05/xx/2010)

Edited manuals. Juli was head of the SCD Documentation group, then responsible for production of NCAR Graphics manuals. She did testing on NCAR Graphics routines.

Russ Rew (??/??/1970 - 03/31/1986)

Was the head of the Software and Libraries Group starting in 1978. NCAR Graphics development was in that Group until later in the year when the NCAR Graphics Group was formed with [Lofton Henderson](#) as group head.

Cicely Ridley (09/23/1968 - 03/03/2000)

Cicely worked most of her time at NCAR collaborating with Ray Roble of [HAO](#). Her main contribution to NCAR Graphics was an early rewrite of the SUPERMAP package (a global map drawing utility) that [Dave Robertson](#) had acquired. Cicely provided the projections. Cicely's version, called SUPMAP, was the primary map drawing functionality in NCAR Graphics until [Dave Kennison](#) produced [Ezmap](#) in 1985. Cicely won the UCAR Technical Support Award for her work on NCAR upper-atmosphere general circulation models.

Tammy Rittner (??/??/???? - ??/??/2003)

SVG (Scientific Visualization Group) administrative assistant.

Andy Robertson (11/06/1967 - 07/07/1995)

As Head of Graphics Operations Andy was in charge of film processing during the [Dicomed](#) era. He helped with many experiments during the period in which the Dicomed cameras were installed and brought into production.

Dave Robertson (06/17/1963 - 09/13/1979)



Dave was a geologist working in the mining industry in Missouri before coming to NCAR. His first job at NCAR was as Manager of Administrative Services. He joined the [CF](#) in 1964 and his first graphics project in that year was to write a Fortran interface to produce 200 bpi 7-track tapes to drive the [CALCOMP](#) plotter. In the early 1970s NCAR rented a CDC [GRID](#) (Graphical Interactive Display) to investigate the potential of interactive graphics in atmospheric research. Dave developed a language and user interface for this device (see: <http://www.computer.org/portal/web/csdl/doi/10.1109/AFIPS.1973.87>).

In 1965 Dave wrote a suite of low-level graphics functions (drawing points, curves, text, plot backgrounds, and so forth) in assembly language. These functions were an interface to the CDC [dd-80](#) film camera that was attached to the [CDC 3600](#). In perhaps his most significant contribution to computer graphics at NCAR Dave collected some higher level functions, written in Fortran, to interface to his lower-level assembly language functions. In that collection were functions for drawing contours, doing world map projections, drawing graphs, producing text in many fonts, drawing streamline plots, drawing two dimensional surfaces, and for drawing iso-surfaces. Most of the codes were collected from outside of NCAR and integrated by Dave into what came to be known as "The NCAR Graphics Package." The utility for drawing XY-plots (which was named IDIOT) Dave wrote himself. This later evolved into [Autograph](#). In some ways Dave can be viewed as the father of NCAR Graphics.

In 1975 Dave chaired the working group on selecting a new front-end computer--they chose [UNIX](#) as the operating system which early on set us on that path. Dave brought in a world map plotting function called SUPERMAP. This was written about 1963 by R. L. Parker of [UCSD](#) using outline data generated by Dr. A.V. Hershey. As an example of how that package has evolved over the years, [Cicely Ridley](#) improved SUPERMAP for use at NCAR, creating SUPMAP; then Jay Chalmers improved on that and created EZMAP; then [Dave Kennison](#) took that and produced the [Ezmap](#) that is still part of the NCAR Graphics Fortran suite; then [Dave Brown](#) integrated that into NCL, with augmentations.

Later [Tom Wright](#) would come along and augment the graphics package, write Fortran interfaces in place of the assembly language code, and create a portable distributable package. In 1977 Dave and Tom shared the UCAR Technical Advancement Award for the development of NCAR Graphics.

Tim Scheitlin (06/05/1989 - present)

Tim got his undergraduate degree in computer science at Iowa State University, during which time he was a summer intern with Cray Research. Before coming to NCAR Tim worked as a software engineer with Hewlett-Packard in Fort Collins. Before coming into the graphics project, Tim worked in NCAR's [CGD](#) division. Tim's primary interest as a software engineer in [CISL](#) has been the display of scientific data, specializing in developing visualizations at the request of NCAR scientists. Tim works with staff members in the [CISL](#) Visualization Lab to display his animations, some of which are in 3-D. Tim has had one of his images appear in Scientific American. To create his animations Tim relies heavily on NCL and the [Vis5D](#) package, as well as writing his own code. Tim also uses the Visualization Lab for presentations to a variety of visitors such as researchers, schoolchildren, politicians, policymakers, journalists, and foreign ambassadors. In addition to Tim's graphics work he took on the responsibility of becoming the assistant manager of the Visualization and Enabling Technologies Section (VETS) in 2003. Tim shared the 2005 UCAR Education and Outreach award with [Don Middleton](#), Darin Oman, Dianne Bernier, Joey Mendoza, [John Clyne](#), and [Susan Cross](#) and for their work in the Visualization Lab.

Connie Sholl (09/25/1991 - 06/11/1992)

Student assistant.

Dennis Shea (04/11/1972 - present)



Although a member of [CGD](#) (Climate and Global Dynamics) division, Dennis has made significant contributions to NCAR Graphics and NCL, in particular in the area of consulting on technical scientific issues. Since NCL was chosen in 1996 as the officially designated support package for the [CCSM](#) (the Community Climate System Model) there has been a close relation between [VETS](#) staff and [CGD](#). Over the years several [CGD](#) staff (notably [Sylvia Murphy](#), Dennis, and [Adam Phillips](#)) have officially or unofficially (on their own time) worked on NCL related projects. The level of support from the [CGD](#) people has exceeded their official commitments. Working from initial training lectures prepared by Dennis, he and Sylvia Murphy expanded those into a multi-day seminar that

they gave at several sites, the first one being in February, 2000 at the Mesa Lab. In recent years [Mary Haley](#) has taken Sylvia's place and the training workshops have been given over forty times in the years 2000-2010. [Dave Brown](#) has also helped out on many of the recent workshops. Many of the workshops have been local, but visits have been made to many universities as well, such as UCLA, UCSC, Purdue, UW-Madison. Other U.S. institutions have been visited as well, such as Scripps Institute, the National Ocean Service, and the Stennis Space Center. Several foreign sites have also been visited, such as Max Planck Institute in Germany, the APEC Climate Center in Busan, Korea, and the Eurasia Institute of Earth Sciences in Istanbul, Turkey. The workshops have been a major factor in the success of NCL. In 2005 Dennis shared the UCAR Technical Advancement Award for the development of the NCL.

Scott Snodgrass (09/16/1996 - 09/22/1998)

Student assistant.

Susan Smith (07/13/1988 - 11/01/1988)

Writer/Editor, worked on graphics documentation.

Ed Stautler (01/18/1994 - 06/22/1995)

Student assistant.

Mark Stevens (09/15/1997 - 11/06/2007)

Mark was a Ph.D. meteorologist in [CGD](#) who was in charge of the [CCSM](#) post processor and, in that capacity, became an NCL power user who made many helpful suggestions.

John Szajgin (10/xx/1986 - xx/xx/1987)

Worked on implementing low level graphics functions on the IBM 4341. SCD Documentation Project leader. Worked on documentation of the first GKS release of NCAR Graphics.

Paul Swarztrauber (01/09/1963 - 10/xx/2004)

Paul was a mathematician in CF/SCD/CISL. Paul used NCAR Graphics to produce many interesting plots for his publications. For a bio, see:

<http://www.ucar.edu/communications/staffnotes/0410/swarztrauber.html>.

Robert Ubelmessenger (06/??/1977 - 09/??/1978)

Student assistant. Worked with [Tom Wright](#). Did some work on PWRITX and the DASH package. Robert was a German citizen and from NCAR went to Munich where he worked for CRAY Research, and then on to be Managing Director of SGI, Germany.

Fred Walden (07/01/1965 - 11/21/1980)

Was in charge of film development for output from the [dd-80](#) film device. In the late 1960s, he pioneered a method of creating color movies from black-and-white microfilm by carefully splicing pieces of the microfilm and adding false color.

Jennifer (Tobyne) Williamson (02/22/2006 - present)

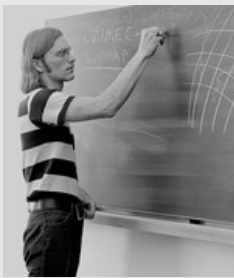
Administrative assistant for the Technical Development Division.

Dick Valent (06/??/1970 - present)



A good part of the [Timeline](#) in this document was taken from an informal timeline that Dick had kept over the years. Dick received his Ph.D. in mathematics from the University of Colorado in 1974. Dick has been in charge of the software math libraries and has always been involved with user services, serving in the consulting office for many years and was the head of the Consulting Services Group before moving to casual status in 2007. Outside of his role as a consultant Dick has never been directly involved in computer graphics. He had said he started keeping a journal of significant events since people were always asking when something happened and nobody could ever remember.

Tom Wright (09/22/1969 - 04/06/1979)



Tom came to the [CF](#) as a student assistant while working on his undergraduate degree in computer science at the University of Colorado. Early on [Dave Robertson](#) took Tom under his wing and encouraged his work on graphics. Tom's first project was to work on software dashlines with uniform spacings. The hardware dashlines on the [dd-80](#) depended on how fast the electron beam traveled, producing unevenly spaced dashlines.

Tom was soon building upon work of Dave to augment the collection of graphics functions that Dave had put together. In the 1970s Tom made some major contributions. One thing he did was to rewrite Robertson's low-level assembly language functions in Fortran, isolating machine dependencies in a small set of constants. Using this Tom assembled a collection of functions that was made part of a portable package that could be distributed. This was the beginning of what came to be known as the NCAR Graphics Package.

Another major contribution Tom made was introducing the concept of "[metacode](#)" -- a device independent file description format for the storage of 2D graphical elements. This concept was the germ of what became, in 1986, the [ANSI](#) Standard CGM (Computer Graphics Metafile). Producing metacode from NCAR Graphics allowed for writing device drivers that would translate the metacode to specific hardware devices, simplifying the source-code-to-device-instruction path. The package could be distributed without concern for device dependencies, and writing metacode to device drivers was usually fairly simple. It was thus Tom who packaged NCAR Graphics and aggressively marketed it, making it one of the premier graphics products in its day. Tom took the package to the Los Alamos National Lab in the early 1970s which was the first off-site distribution. The public domain status of the package (until the mid-1980s) contributed to its appeal.

In addition, Tom also wrote original graphics codes and published many articles in journals like *Computer Graphics* and the *IEEE Transactions on Computers* on topics ranging from visible surface drawing to portable character generation. He also made several presentations at [SIGGRAPH](#) conferences. In 1977 Tom went to [CSIRO](#) in Australia and installed the package there. While [Lofton Henderson](#) installed the package in Oslo in 1976, it was in support of his [PI](#) Mel Shapiro, so Tom's visit to CSIRO is probably the first public installation of NCAR Graphics outside the United States. Tom rightly deserves to be known as a co-founder of NCAR Graphics, with [Dave Robertson](#). In 1977 Dave and Tom shared the UCAR Technical Advancement Award for the development of NCAR Graphics. Tom's hiring represented a philosophical change from hiring and training simply smart people to hiring people with computing experience. When Tom left NCAR he went to work for ISSCO, a commercial graphics software company.

David Younghans (07/05/1995 - 01/12/1996)

Student assistant.

Workshop locations and dates

Starting in February of 2000 NCL workshops were initiated to provide a thorough introduction to the product. The workshops are tailored to researchers in the earth sciences who are interesting in learning how to use NCL to analyze their data. Most of the workshops have been held in Boulder, but there have been several visits to Universities and research organizations both foreign and domestic. The workshops usually run for four days and are conducted by two knowledgeable staff members. A typical workshop schedule can be found at: <http://ncl.ucar.edu/Training/Workshops/schedule.shtml>. Staff members who have conducted these workshop over the years are: [Mary Haley](#), [Dennis Shea](#), [Sylvia Murphy](#), and [Dave Brown](#). Here is a summary of workshop activity through 2010:

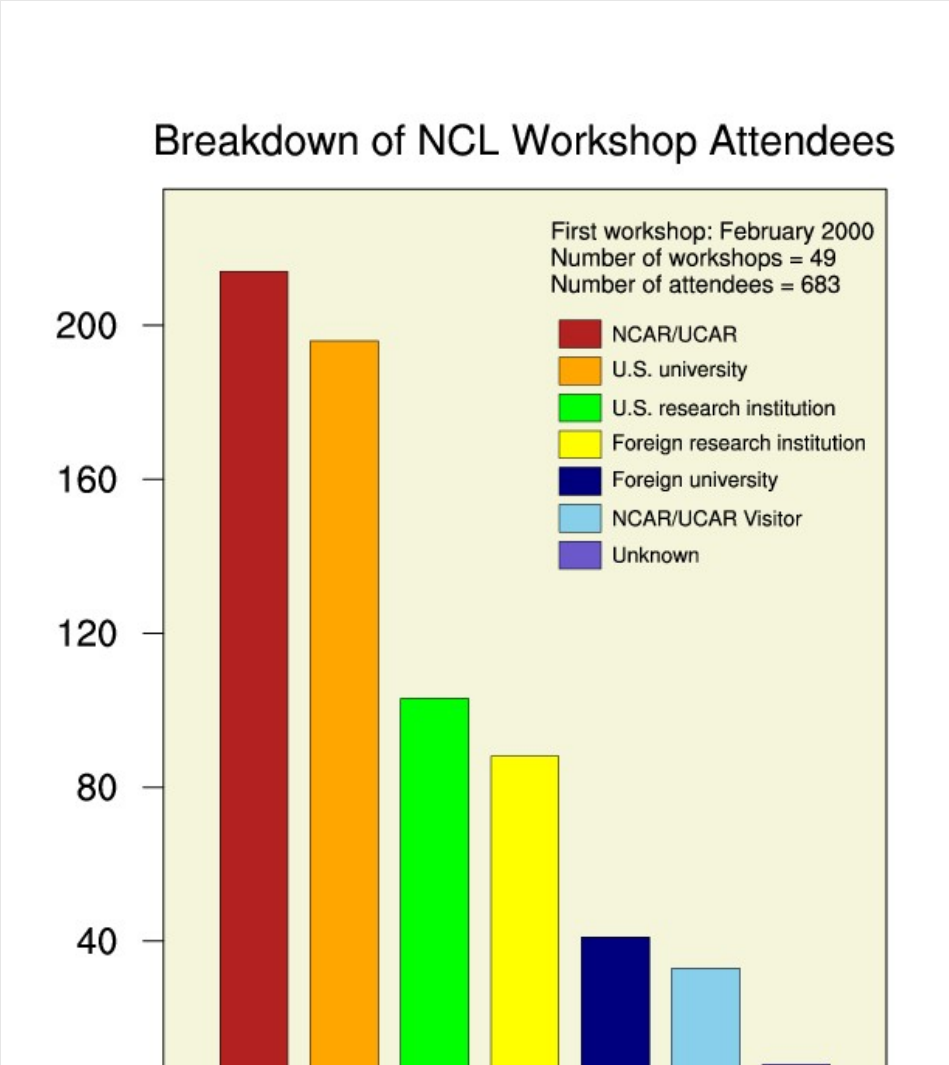
First workshop: February 2000
Last workshop: September 2010
Total # of workshops: 49
Total # of students: 683

and here is a detailed list of the workshop dates and locations:

14-17 Sep 2010	University of California, Irvine
30 Aug-03 Sep 2010	Center for Climate Systems Modeling, Zurich, Switzerland
20-23 Jul 2010	CG1 at UCAR Center Green Facility, Boulder CO
26-29 Jan 2010	CG1 at UCAR Center Green Facility, Boulder CO
12-15 Oct 2009	Max Planck Institute for Meteorology in Hamburg, Germany
06-09 Oct 2009	Max Planck Institute for Meteorology in Hamburg, Germany
14-17 Jul 2009	CTTC at UCAR Center Green Facility, Boulder CO
24-27 Feb 2009	Scripps Institution of Oceanography in La Jolla, California
10-13 Feb 2009	CTTC at UCAR Center Green Facility, Boulder CO
08-12 Dec 2008	Max Planck Institute for Meteorology in Hamburg, Germany
14-17 Oct 2008	CTTC at UCAR Center Green Facility, Boulder CO
25-29 Aug 2008	University of Madison-Wisconsin
04-06 Aug 2008	Vislab at NCAR Mesa Lab Facility, Boulder CO
08-11 Jul 2008	CTTC at UCAR Center Green Facility, Boulder CO
03-07 Mar 2008	Eurasia Institute of Earth Sciences in Istanbul, Turkey
08-11 Jan 2008	CTTC at UCAR Center Green Facility, Boulder CO
10-13 Jul 2007	CTTC at UCAR Center Green Facility, Boulder CO
13-16 Mar 2007	CTTC at UCAR Center Green Facility, Boulder CO
11-14 Dec 2006	APEC Climate Center in Busan, Korea
03-06 Oct 2006	CTTC at UCAR Center Green Facility, Boulder CO
27-30 Jun 2006	CTTC at UCAR Center Green Facility, Boulder CO
19-21 Apr 2006	National Ocean Service, Silver Springs MD
04-07 Apr 2006	CTTC at UCAR Center Green Facility, Boulder CO
14-17 Feb 2006	CTTC at UCAR Center Green Facility, Boulder CO
09-12 Nov 2004	CTTC at UCAR Center Green Facility, Boulder CO
13-16 Jul 2004	CTTC at UCAR Center Green Facility, Boulder CO
25-28 May 2004	CTTC at UCAR Center Green Facility, Boulder CO
02-05 Mar 2004	National Ocean Service, Silver Springs MD
10-13 Feb 2004	CTTC at UCAR Center Green Facility, Boulder CO
16-19 Dec 2003	Stennis Space Center, MS
04-07 Nov 2003	Purdue University, IN

29 Sep - 2 Oct 2003	CTTC at UCAR Center Green Facility, Boulder CO
14-17 Jul 2003	CTTC at UCAR Center Green Facility, Boulder CO
12-15 May 2003	CTTC at UCAR Center Green Facility, Boulder CO
14-18 Apr 2003	University of Fairbanks, Alaska
10-12 Feb 2003	CTTC UCAR Pearl Street Facility, Boulder CO
06-08 Jan 2003	University of California, Los Angeles
29-31 Oct 2002	CTTC UCAR Pearl Street Facility, Boulder CO
16-18 Jul 2002	CTTC UCAR Pearl Street Facility, Boulder CO
5-7 March 2002	CTTC UCAR Pearl Street Facility, Boulder CO
14-16 May 2002	CTTC UCAR Pearl Street Facility, Boulder CO
10-12 Dec 2001	CTTC UCAR Pearl Street Facility, Boulder CO
12-14 Jun 2001	NCAR ML
15-17 May 2001	NCAR ML
03-05 Apr 2001	NCAR ML
13-15 Feb 2001	University of California, Santa Cruz
03-05 Jan 2001	University of California, Los Angeles
13-16 Nov 2000	NCAR ML (for internal CCSM users)
07-11 Feb 2000	NCAR ML (for university users)

Here is a summary chart of workshop activity through 2010:





Hardware

Control Data 3600 (1964-1969)



The Control Data 3600 was delivered in November, 1963, and installed in an unfinished Colorado University building being near 30th and Marine streets. It was to this building that the [CF](#) moved late in 1963. At that time the operating system was not ready and it was not until early 1964 that the machine was opened for users. The CDC 3600 had 32,700 48-bit words of memory (less than 50,000kb). It supported a FORTRAN 66 compiler and an assembler called ASCENT. In 1964 a [Data Display dd-80](#) film recorder was attached to the 3600. In 1965 [Dave Robertson](#) wrote a suite of low-level graphics functions (drawing points, curves, text, plot backgrounds, and so forth) in ASCENT. These functions were an interface to the CDC dd-80 film camera and provide the first interface for producing graphics output at NCAR.

Data Display dd-80 (1964-1982)



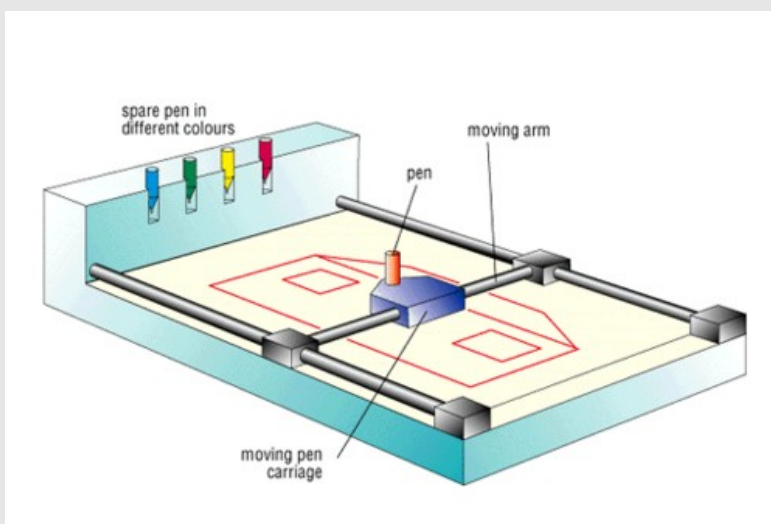
This was the workhorse film output device from the time it was installed in 1964 until it was replaced with the [Dicomed](#) cameras in 1982. Initially being attached to the [CDC 3600](#) in 1964, it was later attached to the [CDC 6600](#) and the [CDC 7600](#). At its peak it was producing over one million frames per month. It was a monochrome device, but the film technician Fred Walden was able, with significant effort and skill, to produce color images by carefully splicing pieces of the black-and-white microfilm and adding false color. For details on the dd-80, see: <http://www.computer-history.info/Page4.dir/pages/DD.80.dir/index.html>.

CDC6600 (1965-1977)



The Control Data 6600 was delivered to the 30th street location in January of 1965 and moved to the Mesa site in December of that year, even before the building had been officially completed. (ref: Staff Notes No. 48, May 18, 1967). Full documentation for the 6600 was made available in the September 1966 Computing Facility Manual. The 6600 remained in operation at NCAR until May of 1977. With performance of about 1 [MFLOP](#), it remained the world's fastest computer from 1964-1969. During its time in the Computing Facility it was the primary source of producing graphics output. The NCAR Graphics package matured considerably during the era of the 6600, with augmented functionality and enhanced portability. Output was still directed to the [dd-80](#) as graphics terminals were not commonly available at NCAR until the late 1970s.

Calcomp flatbed plotter (1964-1986)



The Computing Facility had an early Calcomp flatbed plotter looking essentially like the schematic picture above, except that it accepted three colored pens instead of the one pictured. One of [Dave Robertson](#)'s first graphics projects in 1964 was to provide a Fortran interface to the Calcomp plotter. The plotter was driven by instructions stored on a 7-track 200bpi tape and was quite slow. Due to

low usage, maintenance considerations, obsolete hardware, and the advent of ink-jet printers, the plotter was retired in 1986. It was not until Version 2.00 of the package in the mid-1980s that the color scheme of specifying global color, as was appropriate for the calcomp, was replaced with the [GKS](#) concept of specifying color tables and associating colors with graphical elements.

Bendix datagrid (1970-1986)

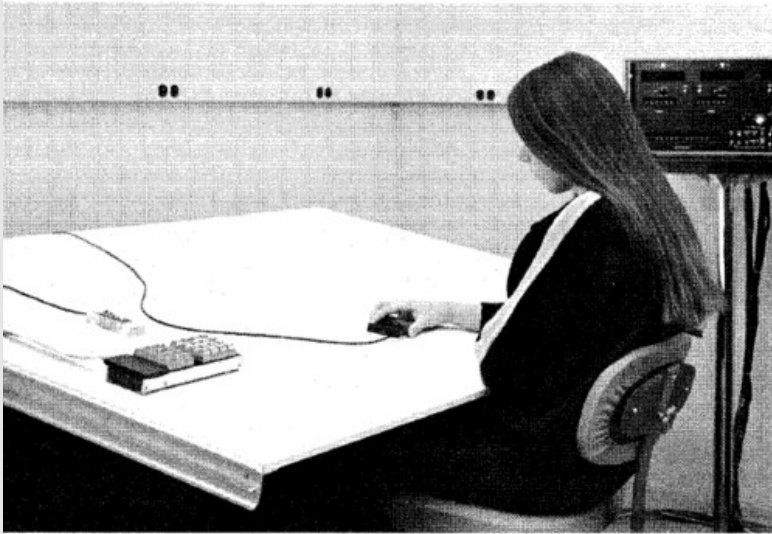


Fig. (1.1) The NCAR Datagrid system.

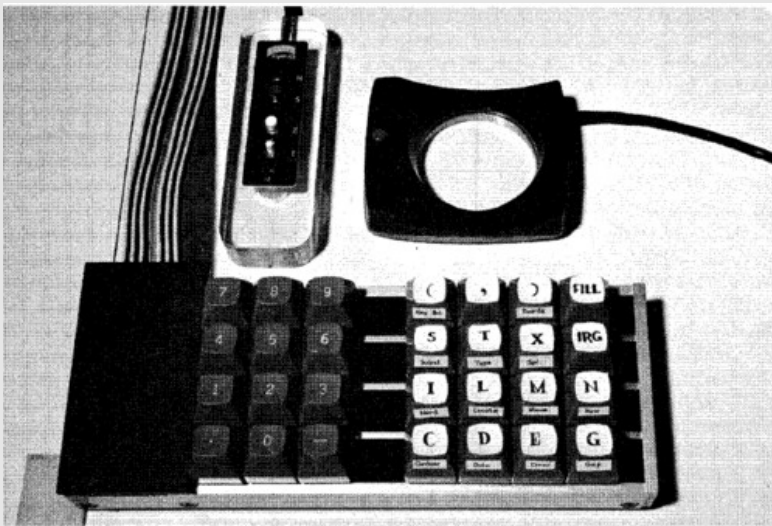
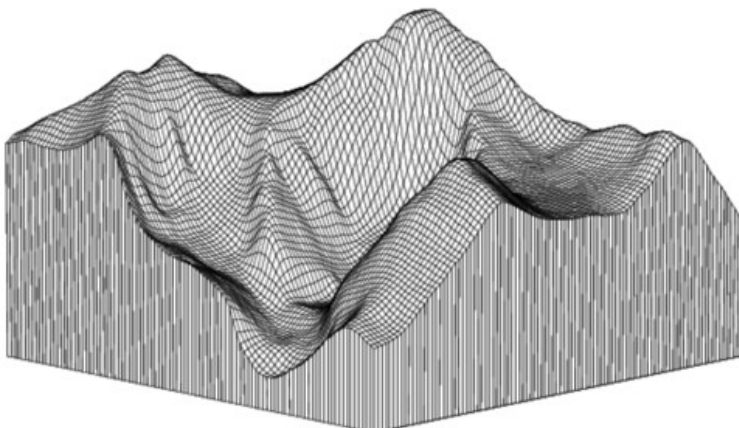


Fig. (1.2) Floating control panel, cursor and keyboard.

Longs Peak relief using SRFACE



In April of 1970 the Computing Facility acquired a Bendix Datagrid Digitizer, enabling data

presented in a graphic form to be translated into digital XY coordinates which were recorded on a magnetic tape compatible with the CDC 6600 and later 7600 computers. A limited keyboard enabled the operator to record other information such as data related to identification and orientation, isopleth values, and instructions for subsequent processing. The main hardware components were an electronics unit, a datagrid table and cursor, a tape recorder, a keyboard and floating control unit, and a display unit. This was a popular device until it was superseded by other more sophisticated and less cumbersome hardware arrived on the scene. One early fun project had [Tom Wright](#) and Bill Briggs digitizing elevation data for the long's peak area in Rocky Mountain Park, the result shown above. Also, working from large [USGS](#) maps [Dave Kennison](#) used the digitizer to create the political and state outlines for the [Ezmap](#) package.

CDC7600 (1971-1983)



In the era of the Control Data 7600 many changes occurred in graphics production and how users viewed them. When the machine came in graphics were still being sent to the [dd-80](#) film recorder and distributed to the users on film reels that were then viewed on film readers. This time frame saw the advent of graphics terminals, the [Dicomed](#) film/fiche recorders replacing the dd-80, the arrival of a CRAY-1 in July of 1977, the rise of the use of the device-independent graphics storage format known as [metacode](#). However, the Control Data 7600 (and later the CRAY-1) were still central to producing graphics using the NCAR Graphics Package.

CRAY-1A (1977-1989)



The CRAY-1A was perhaps the last supercomputer at NCAR where NCAR Graphics was a primary generator of graphic output. By the time the CRAY was decommissioned the [Dicomed](#) cameras had been decommissioned, minicomputers and personal workstations had arrived on the scene, along with network connections. While the supercomputers continued to produce vast quantities of output

data, more and more graphical data analysis has been done on local systems. And, as personal workstations continued to become more and more powerful, more and more work was shifted to them. Many current laptops (2011) have single processing speeds over ten times the speed of a CRAY-1, not to mention their huge memory and disk sizes in comparison. In the 1960s and 1970s NCAR Graphics was a premier product for 2D vector graphics, but in later years other commercial and open source products arrived on the scene and NCAR Graphics was not the only game in town. However NCAR Graphics and its evolutionary child NCL are still popular products. For example, in 2010 there were 4000 unique downloads of NCL. NCL continues to be installed and supported on NCAR computers and is used on the supercomputers.

Dicomed film recorders (1978-1997)



Two black-and-white Dicomed film recorders were purchased in 1978 to replace the aging [dd-80](#) cameras. These recorders could produce 35mm, 16mm, and 105mm (fiche) film. Their film output was at a 4096x4096 resolution, compared to the 1024x1024 resolution of the dd-80. Text output to fiche using hardware characters was blindingly fast. In 1988 the black-and-white cameras were supplemented with a color camera that could produce 35mm and 16mm film. The production of 35mm color slides was popular as well as producing 16mm color movies. The original cameras were driven by a [DEC PDP-11/34 computer](#). The support computers were upgraded over the years to a PDP-11/84, and Sun-1 and Sun-4 computers. Due to budgetary constraints, minimal usage, and the advent of personal workstations, the Dicomed cameras were decommissioned and the film processing room was shut down in September of 1997. The Dicomed Corporation went out of business in 1999.

Control Data GRID (Graphical Interactive Display) (1970-197?)





The Control Data GRID (similar to the device in the above image) was an early version of a terminal that could be connected to a computer. In late 1970 the Computing Facility rented one of these devices from Control Data as an experiment to see if it would be useful to NCAR Scientists. It was a monochrome device that had a light pen attached that could be used to extract XY coordinates from the screen. The device was attached to the Computing Facility's [Control Data 6600](#) computer and [Dave Robertson](#) wrote a Fortran interface for it. Bob Gammill gave lectures on its usage in November of 1970. One user used the device to select initial guesses for an interactive method of solving complex equations. The rental fees were quite high and ultimately it was felt that the cost/benefit ratio was too high and the rental was terminated. For a complete exposition of the implementation, see the article by Robertson and Gammill at: <http://www.computer.org/portal/web/csdl/doi/10.1109/AFIPS.1973.87>.

Text only terminals



With the advent of remote job entry in the 1970s there was a proliferation of text only terminals. These terminals were monochrome and typically showed 24 rows of 80-character lines. Considering subsequent developments and inflation these terminals were surprisingly pricey, most of them selling in excess of \$1,000. The Lear-Siegler ADM-3A pictured above was a popular terminal at NCAR. These terminals were also used for many years to communicate with multi-user minicomputers like the [DEC PDP-11/70s](#).

Monochrome graphics terminals





Not happy with just text-only terminals in the late 1970s there was growing demand for terminals that could display graphics output. One of better terminals in this category was the HP2648a (pictured above). These were still monochrome devices, but had a microprocessor-based architecture with function keys that could be programmed. SCD purchased several of these for staff who were involved with graphics development. Even though these were advertised as low cost for the functionality, the retail price ran \$5,500. From the perspective of what is available for that price now, the cost seems staggeringly high. For details on this particular terminal see: <http://www.hpl.hp.com/hpjournal/pdfs/IssuePDFs/1978-01.pdf>. Such graphics terminals were popular throughout the late 1970s through the mid-1980s, when reasonably priced color graphics terminals arrived.

High-end (read "expensive") interactive graphics terminals were installed at NCAR at this time. For example the Numerical Weather Prediction (NWP) Section installed a Zentec graphics system. See: <http://nldr.library.ucar.edu/repository/assets/staffnotes/asset-000-000-000-610.pdf>.

Color graphics terminals



AAP's Climate Section has a new Ramtek graphics terminal for displaying weather data in color. John Humbrecht (SCD, left) is working with Climate Section Head Warren Washington on software for the system. (Photo by Robert Bumpas.)

There was a time in the early to mid-1980s when there was increasing demand for color graphics output. The image above comes from 1983 and indicates that the first color terminals at NCAR came in around that time. These terminals were CRT based and were pretty expensive. For example, the popular Tektronix 4107 came out in 1983 and was originally priced at \$8950 (ref: <http://www.computerhistory.org/collections/accession/102627517>). The AED 512 (Advanced Electronic Design) was another popular early color terminal--it had 256 colors and a 512x512 resolution, but it had problems when displaying text. NCAR Graphics software could support incrementally set global red, green, or blue values prior to the release of Version 2.00 in 1986, when color tables were introduced. In the late 1980s the price of color graphics terminals came down dramatically and were more common.

Early workstations, Postscript laser printers (1985-1990)

This time frame saw the emergence of the computing environment for NCAR graphics programmers that would last for the next two decades: network-connected desktop computers with color displays

running a [UNIX](#)-flavored operating system with [X windows](#).

In the mid 1980s SCD purchased two [Apollo](#) color workstations. These were put in a common area and were used for testing installations and color software. The systems were running the [Aegis](#) operating system, which was UNIX-like. For reasons lost to SCD history, these workstations never caught on.

Also in the mid-1980s, Sun computers were placed for use in a common area. These machines were quite popular and evolved to be the workstation of choice until Apple came out with its UNIX operating system, Mac OS X, in 2002.



By the late 1980s most programmers had Sun workstations on their desktops running SunOS, based on Berkeley UNIX. The image above is that of a Sun-3 in use in SCD in late 1988. These workstations were compatible with the Sun minicomputers that programmers had been using by way of attached terminals.

Also during this time frame there was interest in the early MacIntosh computers (like the one in the image below), primarily for their interactive drawing programs like Canvas, MacPaint, and later Photoshop.



There were several approaches to trying to use the features of the early Macs with NCAR Graphics. One was to import [CGM](#) files into the Macs by way of converting CGM to the Mac PICT format it used for graphic images. There were several commercial products for doing this; these were analyzed and reviewed in the November, 1990 issue (vol. 11, no. 10) of the "SCD Computing News." Another approach was to write graphics instructions to an IBM 3270 emulator running on a Mac (this would also work for IBM PCs that had an [EGA](#) card). Also, Roy Mendelssohn of the [Pacific Fisheries Environmental Lab](#) implemented NCAR Graphics on a Mac in 1990 and was willing to distribute this product. This product was never distributed, supported, nor consulted on by SCD.

Postscript printers came on the scene at this time with the release of the Apple LaserWriter. Postscript printers would go on to become dominant and were useful in printing out NCAR Graphics plots. Surprisingly, until late in 1990, SCD did not have a color printer available for common use; SCD acquired a TEK4693D at that time.

Internet, laptops, whatever works (1991-present)



The compute power, memory sizes, and disk space of modern computers, even laptops like the one pictured above, make the early computers such as the CDC 6600 "supercomputer" look like toys. And the Internet has revolutionized documentation, collaboration, and access to information.

With the advances in compute power and information access mentioned above, since the late 1980s the ways of generating and viewing computer graphics has gone in many directions. Some people are still using graphics terminals connected to compute servers, many are using desktop computers of varying power. Mixing and matching is common. For example some will generate data on supercomputers, then do the data analysis on personal workstations. Perhaps the most popular scenario among graphics developers in [CISL](#), since the release of the UNIX-based Mac OS X operating system in 2002, is to use a Mac laptop, sometimes connected to external keyboard and large monitor, for much of their work. Merging and editing graphics from many sources is common. Someone may use NCL to generate a plot, edit that in Photoshop, then overlay that onto a plot generated by a commercial product.

Postscript, [PDF](#), and [PNG](#) have become the dominant graphics file formats, eclipsing the [CGM](#). Color laser printers are commonly available in the division, and color ink-jet printers and color scanners for home use are inexpensive.

Sophisticated open source products for 3D visualization, like [Vapor](#) (developed in CISL) and [VTK](#), are now available.

This is an era of choosing whatever works from a multitude of possibilities.

Acknowledgments

The principal author of this document up through 2010 was [Fred Clare](#). Particular acknowledgment for that work through 2010 is due [Dick Valent](#) for his help with the Timeline and other research activities. Many others helped with clarifications, discussions, and dates. Among this group are: [Dave Kennison](#), [Tom Wright](#), [Mary Haley](#), and [Dave Robertson](#).

Fred's work was prepared strictly out of personal interest and in no way represented an officially sanctioned or commissioned history. Much care was taken as to accuracy, but without doubt errors remain.

Appendices

Appendix A -- Acronyms and definitions

Many acronyms are used throughout this document. For reference, here is a list:

[ANSI](#)

The American National Standards Institute.

[ATD](#)

The Atmospheric Technology Division of NCAR prior to the reorganization in the 2000s.

[cairo graphics](#)

An open source a 2D graphics library with support for multiple output devices.

[CCSM](#)

The Community Climate System Model.

CF

The NCAR Computing Facility that was a facility in the Atmospheric Technology Division from late 1963 until October 1, 1980 when it obtained divisional status and became known as the Scientific Computing Division.

CISL

NCAR's Computational and Information Systems Laboratory

[CGD](#)

The Climate & Global Dynamics Division of UCAR.

[CGM](#)

The Computer Graphics Metafile. This is an [ANSI](#) standard file format for storage of 2D vector graphics, raster graphics, and text.

COS

Cray Operating System

[CSIRO](#)

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency.

[CVS](#)

The "Concurrent Versions System," a version control system for files under development.

[Cygwin](#)

A Linux-like environment for Microsoft Windows.

[FTPACK](#)

A package of Fortran subprograms for the fast Fourier transform of periodic and other symmetric sequences.

[Fitpack](#)

A package of over 100 functions for curve and surface fitting using splines under tension. A set of core functions for this package (ten in number) was written by Alan Cline when he was in SCD in the early 1970s.

[GRIB \(GRIdded Binary\)](#)

A data format used in meteorology to store historical and forecast weather data.

GUI

Graphical User Interface

[GKS](#)

The Graphical Kernel System (GKS) was the first ANSI standard for low-level computer graphics, published in 1985.

HAO

The High Altitude Observatory Division of UCAR. In the original organization.

[HLU](#)

The High Level Utilities--a library of tools that provide an object-oriented programming interface to NCAR Graphics functionality.

[IPCC](#)

The Intergovernmental Panel on Climate Change

ISO

The International Standards Organization

IOS

Input/Output Satellite.

[JACM](#)

Journal of the Association of Computing Machinery.

metacode or metafile

A device independent file description format for the storage of 2D graphical elements

[Linux](#)

A family of open source Unix-like computer operating systems.

[NCSA](#)

The National Center for Supercomputing Applications.

ML

The NCAR Mesa Lab.

MFLOP

Million FLoating point OPerations per Second.

[MMM](#)

UCAR's Mesoscale & Microscale Meteorology Division

[PNG](#)

Portable Network Graphics

RFP

Request for Proposal.

RJE

Remote Job Entry.

SCD

The NCAR Scientific Computing Division. SCD was created out of the [Computing Facility](#) on October 1, 1980 and was absorbed into the Computational Information Systems Laboratory (CISL) in November, 2004.

Shapefiles

A geospatial vector data format for geographic information systems.

SVG

The Scientific Visualization Group.

[NSF](#)

The National Science Foundation.

[PDF](#)

The Portable Document Format created by Adobe Systems, Inc.

PI

Principal Investigator

[SIGGRAPH](#)

The Association for Computing Machinery's Special Interest Group on Computer Graphics and Interactive Techniques.

TAGS

The Text and Graphics System that was comprised of the Dicommed film cameras and the high-volume Xerox laser printers.

[UNIX](#)

A multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs.

[USGS](#)

The United States Geological Survey.

[VETS](#)

The Visualization and Enabling Technologies Section.

VMS

The Virtual Memory System operating system that ran on DEC VAX machines.

[WMO](#)

The World Meteorological Organization.

[WRF](#)

The Weather Research & Forecasting Model.

[X11](#)

A computer software system and network protocol that provides a basis for graphical user interfaces (GUI) for networked computers.

Appendix B -- Director list

The sequence of directors of NCAR computing in the organizational structures known over the years as:

- The Computing Facility (CF) in the Atmospheric and Technology Division from 1962 to September 30, 1989.
- The Scientific Computing Division (SCD) from October 1, 1980 to November, 2004.
- The Computational Information Systems Laboratory (CISL) from November, 2004 to the present.

Directors:

Glenn Edwin Lewis	Ph.D. New York University, 1960	??/1962 - 11/1967
John Gary	Ph.D. University of Michigan, 1957	11/1967 - 07/1969
Ted Hildebrandt	Ph.D. University of Michigan, 1956	08/1969 - 04/1973
Paul Swarztrauber	Ph.D. University of Colorado, 1970	04/1973 - 11/1973 (acting)
Stu Patterson	Ph.D. Johns Hopkins, 1966	11/1973 - 05/1979
Walter Macintyre	Ph.D. University of Glasgow, Scotland	04/1980 - 04/1986
Margaret Drake	B.S. Regis College, Weston, Massachusetts	05/1986 - 04/1987 (acting)
Bill Buzbee	Ph.D. University of New Mexico	04/1987 - 9/1998
Al Kellie	University of Alberta, Canada	12/1998 - present

Appendix C -- NCAR Library online resources

Here is a list of documents relating to NCAR Graphics that have been digitized and placed online by the [NCAR Library](#).

1. 6600/7600 Primer, J C Adams, 1974 [NCAR/TN-62+IA](#)
2. Library Routines Manual, J C Adams, P A Rotar, 1971, [NCAR/TN-67+IA](#)
3. Ascent Reference Manual, J C Adams and P A Rotar, 1972 [NCAR/TN-89+STR](#)
4. NCAR Software Support Library, Roland A. Sweet Editor, 1975, [NCAR/TN-105+IA](#)
5. Efficient FORTRAN Subprograms for the Solution of Elliptic Partial Differential Equations, Paul Swarztrauber and Roland Sweet, 1975, [NCAR/TN-109+IA](#)
6. Data Sets for Meteorological Research, Roy L Jenne, 1975, [NCAR/TN-111+IA](#)
7. An introduction to the SCD Graphics System, Gregory R. McArthur and Lofton R. Henderson, 1981, [NCAR/TN-161+IA](#)
8. The System Plot Package, Lofton Henderson, 1981, [NCAR/TN-162+IA](#)
9. The Graphics System Implementer's Guide, Gregory R McArthur, 1981, [NCAR/TN-165+IA](#)
0. The SCD Graphics Utilities, Gregory R. McArthur, 1981, [NCAR/TN-166+IA](#)
1. Planning for the 1980s/ Proceedings of the First Annual Computer Users Conference, Linda Besen, 1981, [NCAR/TN-169+Proc](#)
2. Selected User Reference Papers, Gregory R McArthur, 1981, [NCAR/TN-174+IA](#)
3. The NCAR GKS-compatible Graphics System, Fred Clare, Lofton Henderson, Stu Henderson, Barbara Horner-Miller, John Humbrecht, Dave Kennison, 1986, [NCAR/TN-267+IA](#)
4. NCAR graphics user's guide: Version 2.00, Fred Clare, 1987, [NCAR/TN-283+IA](#)
5. NCAR Graphics installer's guide: Version 2.00, Fred Clare, 1987, [NCAR/TN-284+IA](#)
6. The Evolution of Supercomputing at NCAR, P Rotar, 1989, [NCAR monograph](#)
7. NCAR Graphics Guide to New Utilities: Version 3.00, Fred Clare and Dave Kennison, 1989, [NCAR/TN-341+STR](#)
8. NCAR Graphics Generic Package Installer's Guide/ Version 3.00a, Fred Clare, 1990, [NCAR/TN-342+STR](#)
9. Survey of NCAR User Needs for Visualization Tools, Ray George and Bob Lackman, 1990, [NCAR/TN-354+STR](#)

Appendix D -- UCAR archive's

The UCAR archives room contains materials relevant to various historical developments within UCAR. The boxes in the archives relevant to NCAR Graphics and NCL contain memos, manuals, artifacts, photos, reports, user documents, student projects, and other materials of interest.
