SHARE and the Origins of Open Source Software: 1953-1972

Thomas Haigh
Leicester, August 16, 2005

Open Source Idea?

- The **basic idea behind open source** is very simple: When programmers can read, redistribute, and modify the source code for a piece of software, the software evolves. People improve it, people adapt it, people fix bugs.

From OpenSource.org homepage

- "Open Source" concept attributed to 1998 meeting, Eric S. Raymond

Structure of Talk

1. Review of canonical accounts of the origins of open source/free software
   - Linus Torvalds and Linux
   - Raymond Stallman and GNU
   - The Hacker Culture and Bell Labs
2. Examination of software projects in the mathematical software field
   - SHARE in the 1950s onward
3. Some preliminary conclusions

1: Origins of Open Source Software – Three Fables

Version 1: Finland, 1991

- Linus Torvalds sends a message to the comp.so.minix newsgroup…
- Linux was project of Linus Torvalds
  - Begun in 1991 as undergrad in Finland
- Now a leading server operating system

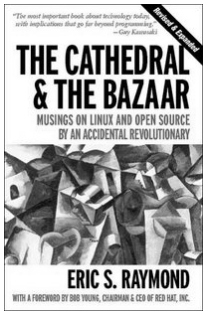
```
From:
torvalds@klaava.Helsinki.FI
(Linus Benedict Torvalds)
Newsgroups: comp.os.minix
Subject: Gcc-1.40 and a
posix-question
Message-ID:
<1991Jul3.100050.9886@klaava
.Helsinki.FI>
Date: 3 Jul 91 10:00:50 GMT

Hello netlanders,
Due to a project I'm working
on (in minix), I'm
interested in the posix
standard definition. Could
somebody please point me to
a (preferably)
machine-readable format of
the latest posix rules? Ftp-
sites would be
nice.
```

Power of the Internet

- Similar recent success for Firefox browser
- The story
  - Genius young programmer starts visionary project
  - Promising but incomplete versions posted on internet attract community of user/developers
  - A virtuous circle leads to exponential growth

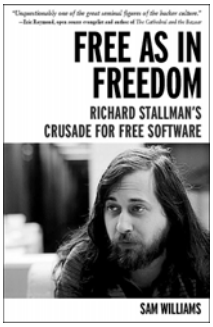
Bazaar Model

- Characteristics include
  - Users as co-developers
    - Projects start with personal problems to solve
    - Users debug systems – "many eyes make bugs shallow"
  - Early and frequent releases
  - High modularization
  - A "benevolent dictator" to lead project



Version 2: MIT, 1983

- Richard Stallman was respected MIT "hacker"
  - Author of EMACS editor
- Since 1984 Stallman Coordinates GNU project
  - GNU is Not Unix (recursive name)
  - Intended to produce open, free version of Unix
- "Free as in speech… not beer"

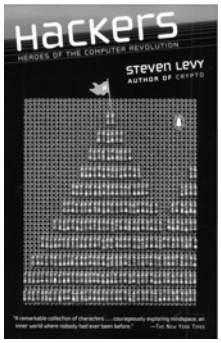


GNU's Free Software Definition

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works, and adapt it to your needs (freedom 1). Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbor (freedom 2).
- The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.

Version 3: Hacker Culture

- Stallman was propagating and defending a tradition going back to the late 1950s at MIT
- Propagated and revitalized by
  - Personal computes
  - Widespread internet access



The Hacker Ethic

- Access to computers… unlimited and total
- All information should be free
- Mistrust authority – promote decentralization
- Hackers should be judged by their hacking…
- You can create beauty and art on a computer
- Computers can change your life for the better

From ch. 2 of Hackers, by Steven Levy,

Summary of 3 Conventional Views

- Stress
  - Hacker culture and ideological commitments
  - Unpaid enthusiast virtuosos
  - Charismatic individuals
  - Novel licensing arrangements
- All about operating systems

A New Origin Story

- Different in all respects
  - Scientific software libraries
  - 1950s to 1970s
  - No concern with licensing arrangements
  - Motivated by pragmatic commercial interests (1950s)
    - Avoidance of duplicated efforts on generic programs
    - Free resources for areas of proprietary interests
  - Motivated by scientific norms (1970s)
    - Free exchange of data
    - Desire for publication
    - Faith in peer review

2: Mathematical Software and Open Source

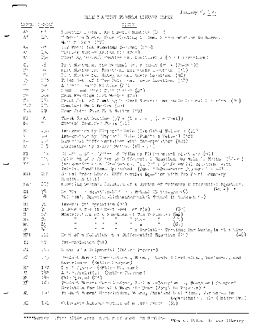
Scientific Computing

- Original function of early machines
  - Harvard Mark I, ENIAC
  - Source of the term “computer”
- Many applications are concerned with modeling natural or man made systems
  - Hydrogen bomb physics
  - Fluid Dynamics of air for aerospace
  - Celestial mechanics for space navigation

Mathematical Libraries

- Produced internally within computer centers
  - First example for EDSAC circa 1950
    - Invented along with subroutine
    - Discussed in 1951 programming text
    - Included Runge-Kutta differential equation routine
  - First US grant to support development may be for ILLIAC
    - Numerical Analysis funding from ONR 1950-1958

Subroutine library 1955 →



Early Needs

- Initially: very basic assembly language subroutines
  - Multiplication, square root, binary to decimal, floating point simulation, etc.
- FORTRAN (1956) covers basics, but plenty of challenges left
  - Each computer center is likely to need routines for
    - Linear algebra and matrix manipulation
    - Ordinary and Partial Differential Equation solvers
    - Special and Elementary functions
    - Curve fitting and least squares
    - Fast Fourier Transformation

Mathematic Challenges

- Mathematical techniques largely independent of disciplinary boundaries
- Most solutions are numerical using approximation techniques
  - As opposed to symbolic
- Computer opens many new possibilities
  - Computers thousands of times faster
  - Exposes limitations of existing mathematical methods

Issues - Mathematical

- Different numerical approximations suited to different problems
  - May be very slow
  - May give meaningless or inaccurate result
    - Problems may be under very specific conditions
- Newer, better methods may be more complex or highly specialized
  - Package in software for easy consumption
  - Disseminate formerly tacit knowledge between sites

2a: SHARE and Mathematical Software

IBM 701/704/709

- Large, "first generation" machines of 1950s
  - Worth approximately $2 million
- Designed for technical computation
  - Early users dominated by Southern California aerospace firms
  - Cold war context
- Many employees for each computer installation

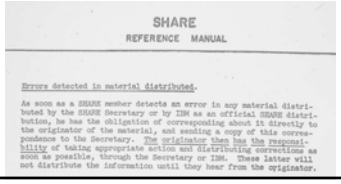
704 at LLNL, 1956

SHARE IBM User Group

- SHARE founded 1956
  - Cooperative group for users of large IBM computers
    - Discussions begin among IBM 701 users
    - SHARE represents "large" IBM scientific machine users
    - Representatives from each installation (52 by end of 1956)
  - Intended to "share" programs, expertise, experiences and best practices
    - Lobbying of IBM to alter machines or policies

SHARE Software Library

- Routines contributed by user sites
  - Reproduction and catalog handled by IBM
  - Classification scheme developed to organize
  - Contributors responsible for maintenance
- List posted of routines devised & desired



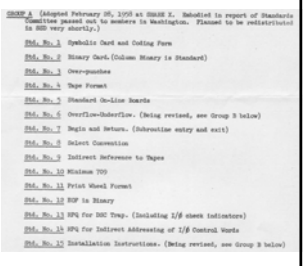
SHARE
REFERENCE MANUAL

Errors detected in material distributed.

As soon as a SHARE member detects an error in any material distributed by the SHARE Secretary or by IBM as an official SHARE distribution, he has the obligation of corresponding about it directly to the originator of the material, and sending a copy of this correspondence to the Secretary. The originator then has the responsibility of taking appropriate action and distributing corrections as soon as possible, through the Secretary or IBM. These latter will not distribute the information until they hear from the originator.

SHARE Practices

- Standardization needed to share code and practices
- Standardize machine configuration
  - Setting of switches, control panels, etc
- Standardize system software
  - Assembler and utility programs (not supplied by IBM)
  - Leads to big project to create "Share Operating System"



GROUP A (Adopted February 26, 1958 at SHARE X. Submitted in report of Standards Committee passed out to members in Washington. Planned to be redistributed in SHD very shortly.)

Std. No. 1 Symbolic Card and Coding Form
Std. No. 2 Binary Card (Column Binary is Standard)
Std. No. 3 Over-punches
Std. No. 4 Tape Format
Std. No. 5 Standard On-Line Boards
Std. No. 6 Overflow-Underflow. (Being revised, see Group B below)
Std. No. 7 Begin and Return. (Subroutine entry and exit)
Std. No. 8 Select Convention
Std. No. 9 Indirect Reference to Tapes
Std. No. 10 Minimum 709
Std. No. 11 Print Wheel Format
Std. No. 12 BCF in Binary
Std. No. 13 BPQ for BAC Trap. (Including I/O check indicators)
Std. No. 14 BPQ for Indirect Addressing of I/O Control Words
Std. No. 15 Installation Instructions. (Being revised, see Group B below)

SSD

- Mechanism for communication between meetings
  - Mailing of large bundles of assorted materials
    - Committee reports
    - Drafts for comments
    - Letters, inquiries and responses
      - Including bug reports
- Also microfilms of source code for programs

Packaging of Mathematics

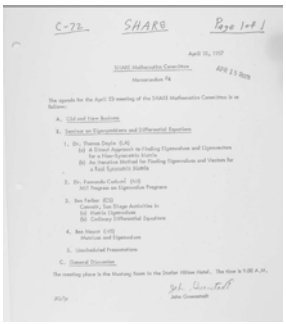
- Many routines are for mathematical functions
  - Substantial duplication and overlap in contributed routines
  - Quality issues
- Importance of tacit knowledge
  - Limits use, causes support issues
  - "Black boxing" of mathematical procedures

SHARE Labor

- Installation reps are senior figures
  - Responsible for design and specification
  - Commit employees of their firms to develop code
- Economy of effort in developing generic routines
  - Driven by economics – save time and money
  - No proprietary advantage in cosine routine

SHARE Structure

- Committees to manage particular projects
  - Mathematical software is one important area
  - Subcommittees for particular projects



SHARE and the Four Freedoms

- Freedom to run – YES
- Freedom to study and adapt source code - YES
- Freedom to redistribute – YES
  - Pretty much all 704/9/90 were members
- Freedom to improve and release to the public – YES

Similarities in Practices

- Ad-hoc collaboration groups for specific projects
  - Some effort at modular code architecture
- Mechanisms to share and respond to bug reports
- Standards for coding and configuration to facilitate collaboration
- Open circulation of proposals and design documents
  - "Indoctrination" into culture

Challenges to SHARE

- Problems develop in open source model
- See Akera – "The Limits of Voluntarism", T&C, 2001
  - Following problems with the "SHARE Operating System" project the writing of system software migrates to IBM
- But mathematical software largely doesn't
  - SHARE is main distribution mechanism until early 1970s
    - Large labs rely on own code libraries

What Happened Next

You might expect

- Triumph of commercial software
- Big picture
  - IBM puts much more effort into software from mid-1960s
  - Emergence of independent market for packaged software in early 1970s
- But not quite the story here

Three Successors in 1970s

- Computer drives rapid development in numerical analysis as mathematical discipline
- Successful models emerge for
  1. Peer-reviewed program publication
     1. Share Numerical Analysis Project
     2. ACM Transactions on Mathematical Software
  2. Specialized free packages from expert teams
     1. EISPACK
     2. LINPACK, etc
  3. Commercial software libraries
     1. NAG
     2. IMSL

SHARE Numerical Analysis Project

- Attempt in 1960s to peer review mathematical routines
  - Volunteer committee with IBM support
  - Limited success
    - Reviewing standards lacking and commitment uneven
  - Too many routines to review

Peer Review of Programs

- Common idea within this community
  - Simple application of scientific journal processes
- Submitted routines are evaluated for
  - Quality of documentation
  - Novelty and superiority over existing ones
  - Performance
  - Mathematical stability
- Two or three independent expert opinions solicited
  - Response is either
    - Accept
    - Reject
    - Revise and Resubmit
- Contrast with Raymond's open source model

ACM TOMs

- Transactions on Mathematical Software
- Publication venue for peer reviewed mathematical software
  - Started 1975 by John Rice
  - Program source code distributed via microfiche, card and tape
- Surprisingly successful

EISPACK

- Computes eigenvalues and eigenvectors of matrices
  - Released 1972
  - Standard routines in this area for a decade
- Project performed at Argonne National Lab
  - Dozens of specialized packages produced within the labs during this era
- Many other “PACKS” follow
  - LINPACK, LAPACK, MUDPACK, FISHPACK, FUNPACK

EISPACK Development Methodology

- Very small team of contributors
  - Remains small for LINPACK follow-on project
- Debugging mostly done in small groups
  - Prior to release
  - Don’t expect much insight from ordinary users
    - No expectation of code fix submission
  - Relationships cultivated with computer center staff
    - Create closed network of test sites
- Three major releases
  - Cycle repeated

SSP

- First formal and supported numerical library from IBM
  - Bundled with IBM 360 series
    - Developed in IBM Boeblingen circa 1965?
    - Successor packages are sold commercially in 1970s. PL-Math, SL-Math
- SHARE people express quality concerns
- Never particularly successful
  - Main manager later founds commercial IMSL library company

NAG & IMSL

- Comprehensive, commercial libraries
  - Both launched around 1972
  - Rapidly ported to multiple platforms
  - Numerical and statistical coverage
- Sold on annual subscription basis
  - Documented
  - Supported
  - Tested

Blend of academic and commercial

- Much crossover within community
  - Academic backgrounds of founders
  - Advisory boards of academics
- Blending of Commercial and Open
  - LINPACK and EISPACK code used in commercial libraries
  - Most NAG code is initially contributed by academics and external groups
  - Some NAG/IMSL contribution back into free projects

3: Ponderings

Commercial Origins of Open Source Practices in 1950s

- To recap, by 1956 we already have
  - All formal characteristics of "free" software
  - Many practices of modern open source development
- But not the ideology of free software
  - Seen as pragmatic, economically driven sharing

Shows need for Separation of Ideology and Practice

- Open source practices are older, more widespread than open source movement, so…
  - How important is the ideology?
  - Is selective use open source by big firms (IBM etc) the exception or the rule?
- How important are scientific norms to open source practices?
  - Publication and sharing of data
  - Goes back to 17th century gentlemen

Importance of Scientific Norms in Mathematical Software in 1970s

- Same authors contribute code to open and commercial libraries
  - Though many express general idea that software should be freely available
    - Especially if publicly funded
- Scientists & mathematicians want to publish
  - Pragmatic desire to get code to users
  - Cultural norm of free sharing of results
  - Hard to get tenure or credit without reviewed publication