

A Look Back: 57 Years of Scientific Computing

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1950 – 1955

- **Mathematics student at University of Wrocław and University of Warsaw**
- **High school mathematics teacher**

1955 – 1958

**Technical University of Warsaw
Assistant professor (mathematics)**

- **Teaching**
- **Collaboration with engineers**

1956

**Department of Computing
Institute of Mathematics
Polish Academy of Sciences**

Solving $Ax=b$ on accounting machines

- **Paper cards**
- **Tabulator for additions**
- **Multiplier for multiplications**
- **Sorter for paper cards**
- **Reproducer**
- **Electrical calculator**

See: L.J. Comrie et al., The application of Hollerith equipment to an agricultural investigation, J. Roy. Statist. Soc. Suppl. 4(2), 210-224 (1937).

1957

- **Digital Electronic Computer XYZ**
 - 512 words, one word = 36 bits
 - 100 operations per second
 - binary system
 - fixed-point arithmetic
 - input / output on paper cards
 - machine language programming
- **Asked to organize a computing center**

1957 – 1959

- **Digital Electronic Computer XYZ**
 - **Library of basic (sub)programs**
 - **No numerical library**
- **Requirement: Make money!**
 - $Ax = b$
 - **Several important research and industrial problems**

1959 – 1961

**Department of Mathematics
Technical University of Warsaw**

- **A new computing group**
- **Collaboration with**
 - **technical scientists**
 - **industry**
- **Lectures and seminars**

1959 – 1961 (cont.)

- **Digital Electronic Computer EMC-1**
 - **Negative-base system!**
 - **(Z. Pawlak and A. Wakulicz)**
 - **See: Donald E. Knuth,**
The Art of Computer Programming,
Vol. 2, p. 171.
- **“A History of Computing in the Twentieth Century”,** edited by **N. Metropolis,**
J. Howlett and Gian-Carlo Rota, **Academic Press, 1980**

1959 – 1961 (cont.)

- **Subroutine library for UMC-1**
- **Hydraulical and meteorological simulation by linear modelling**
- **Ship construction (96 hours)**
- **Geodesic computations**
- **Other engineering problems**

1961 – 1965

Military Technical University

- Promoted to captain
- Organized a computing center based on Russian Computer URAL-2
 - Core, 2048 words
 - Two drums, 8192 words each
 - Hardware floating point
 - Octal system
 - Input on film tape,
practically no output device
 - No software!

1961 – 1965 (cont.)

- **Russian Computer URAL-2**
 - **Library of basic functions**
 - **Input on the paper tape**
 - **Output on teleprinter
and paper tape**
 - **Compiler with Polish notation**
- **Second Digital Computer UMC-1**

1961 – 1965 (cont.)

- **Practical problems**
 - **Hydraulical and meteorological simulation by linear modelling**
 - **Ordinary differential equations**
 - **Partial differential equations**
 - **Problems in operational research**
 - **Military problems**

1965

**Deputy Director General
of applied computers in Poland**

- **Provincial Computing Centers**
 - ZAM 2, ZAM 41, UMC 1, UMC 10
 - URAL 2, MIŃSK
 - ELLIOTT, GIER, ICT, IBM
- **Computer Factory, Wrocław**

1966 – 1968

Computing Group

Institute of Mathematics

Technical University of Warsaw

- **Taught Algol 60 and numerical methods**
- **Danish Digital Computer GIER**
 - **Taught GIER Algol 60**
 - **Computing using GIER**
- **Linear programming models of transportation problems**

1968

**Department of Computer Science
University of Waterloo, Canada**

- **Programming in Fortran,
WatFor and APL**
- **Computers: IBM, Fast IBM Terminal**

1969

Computel Systems Ltd Ottawa and Toronto

- **Worked in Users' Support Group**
- **Sold computing time by telephone**
- **UNIVAC 1108 (Exec 2) and IBM 360**
- **Linear programming**
- **Transportation problems**
- **ILONA & FMPS (UNIVAC)
& MPS (IBM)**
- **Collaborated mostly with
oil companies**

1970 – 1971

**Computing Center
University of Quebec**

- **Consulting and research**
- **Collaborations:**
 - **University of Montreal: CDC 6600**
 - **McGill University: IBM 360**
 - **Laval University: IBM 360**
- **IBM 1130 Terminal**

1970 – 1971 (cont.)

- **Montreal, Sherbrooke, Trois Rivieres, Rimouski, Quebec City, Chicoutimi and Hull**
- **CDC 6600 in Quebec City**
- **CDC 1175 and Terminal 200 at each location**
- **Teletype terminals to IBM (APL)**

1970 – 1971 (cont.)

- **Taught programming**
- **Assisted other departments**
- **Traveled between branches**
- **Fortran, Algol 60, Assembler**

1971 – 1986

**Regional Computing Center
at the University of Copenhagen
(RECKU)**

Consulting and Research

1971

- **IBM 1130 Terminal**
- **UNIVAC 1106**
- **Conversion program**

1971 – 1973

- **Numerical algorithms:**
 - **Special functions**
 - **Eigenvalue problems**
 - **Linear and nonlinear systems**
 - **Optimization problems**
- **RECKU's numerical software:**
 - **UNIVAC MATH-PACK**
 - **UNIVAC STAT-PACK**

1971 – 1973 (cont.)

- **Installation of new libraries:**
 - **The IBM SSP Library**
 - **CERN Library**
 - **Harwell Library from Lund**
 - **RECKU Library**
 - * **Some single users' routines**
 - * **Communications of the ACM**
 - * **Computer Journal**

1971 – 1973 (cont.)

- **Special functions:**
 - **Bessel, Gamma, Error**
- **Eigenvalues and eigenvector routine**
- **Optimization routines**
(Axel Hunding)
- **Interval arithmetic (Kaj Madsen)**

1973

- **Dundee 1973**
 - **Important contacts:**
 - * **Hans Bruun Nielsen, DTH**
 - * **Per Grove Thomsen, DTH**
 - * **Harwell Library staff**

1973 – 1975

- **Seminars at the
Dept. of Numerical Analysis**
- **Collaboration with Kaj Madsen**
- **Implementation of the UNIVAC 1100
version of the Harwell Library**
- **Users start to use the RECKU Library**

1973 – 1975 (cont.)

- **Collaboration with Axel Hunding**
- **Optimization algorithms**
- **Collaboration with Kell Schaumburg**
 - **Spectroscopic problem, ODE's**
- **Collaboration with**
Per Grove Thomsen
- **Collaboration with Erik Kirsbo**
- **Linear programming**
 - **ILONA, FMPS**

1975

- **Dundee 1975**
 - **Map-drawing presentation**
 - **Discussion of numerical libraries**
- **NAG Library collaboration**
- **Start of NAG Library implementation for the UNIVAC 1100 series**

1975 – 1986

- **The NAG Library Project:**
 - **NAG Fortran Library
(three compilers)**
 - **NAG Algol Library (two compilers)**
 - **NAG SIMULA Library**
 - **NAG Graphics**
 - **NAG GENSTAT implementation**
 - **NAG GLIM implementation**

1975 – 1986 (cont.)

- **RECKU obtains free licenses for all implemented NAG Software**
- **RECKU distributes NAG – UNIVAC software**
- **About 500 customers worldwide: Europe, America, Australia, Japan, Korea, Africa**

1975 – 1986 (cont.)

- **MATLAB for Univac 1100 Series**
- **Multiple precision for Univac 1100
(Christian de Polignac)**
- **Zahari Zlatev joins collaboration
with K. Schaumburg**
 - **Spectroscopic problem, ODE's**
 - **Y12M – General sparse equation
solver**
 - **Several publications a year**

1975 – 1986 (cont.)

- **Close collaboration with NAG**
- **Collaborations with
Jeremy Du Croz, Steve Hague,
Sven Hammarling and others**
- **Invited to many places
in Europe and USA**
- **Presented papers at NPL,
oil companies and other places**

1982

Invited to visit

- **Argonne National Laboratory
(Jack Dongarra)**
- **Oak Ridge National Laboratory**
- **IBM Research Center,
Yorktown Heights (Fred Gustavson)**
- **US National Bureau of Standards**

1982 – 1986

- **Much involved with the UNIVAC 1100 series computers**
- **Invited to collaborate on the new UNIVAC virtual system**
- **Tested with Jeremy Du Croz the UNIVAC Vector Processor, ISP System**

1986 – 2001

**Danish Computing Center for
Research and Education
(UNI•C)**

Consulting and Research

1986

- **The computing centers
NEUCC, RECAU and RECKU
form UNI●C**
- **UNI●C acquires the AMDAL 1100
(Fujitsu 100) and Alliant
vector computers**
- **My office is moved to Lyngby**
- **NAG implementation for AMDAL**
- **NAG UNIVAC implementation**

1988

- **Invited to AMDAL headquarters to improve the level 2 BLAS**
- **Collaboration with Jeremy Du Croz**
- **AMDAL BLAS improved by a factor of at least 2 or 3**
- **The improved BLAS were incorporated into the compilers**

1989 – 1990

USA

Multiflow Computer Corporation

Senior Numerical Analyst

- **Multiflow built supercomputers**
- **Worked on the BLAS
for Multiflow computers**
- **Sparse Matrix Code (Y12M)**
- **The NAG Library**
- **Consulting**

1990 – 1994

Danish Computing Center for Research and Education (UNI•C)

- **Connection Machines, MasPar and KSR**
- **Air pollution problem with Zahari Zlatev**
- **Several visits to**
 - **Thinking Machines Corporation**
 - **KSR Computer Corporation**
- **Several papers published**

1994 – 1996

- **Collaboration with Jack Dongarra:**
 - **Applied Parallel Computing Workshops: PARA'94, PARA'95 and PARA'96**
 - **LAPACK95**
 - **NetSolve**
- **Collaboration with V. Allan Barker**

1997 – 2000

- **PARA becomes “Nordic Workshop”**
 - **PARA’98 – Umeå, Sweden**
 - **PARA2000 – Bergen, Norway**
 - **PARA2002 – Espoo, Finland**
 - **PARA2004 – Copenhagen, Denmark**
 - **PARA2006 – Umeå, Sweden**

1997 – 2000 (cont.)

- **LAWRA project started**
(Linear Algebra with Recursive Algorithms)
 - **Collaboration with**
Fred Gustavson and
Umeå University
- **Workshop on**
Scientific Computing (1997)

1997 – 2000 (cont.)

LAWRA team:

- **Bjarne Stig Andersen**
- **Fred Gustavson, coordinator (IBM)**
- **Alexander Karaivanov**
- **Ivan Lirkov**
- **Minka Marinova**
- **Jerzy Waśniewski, coordinator (UNI●C)**
- **Plamen Yalamov**

1997 – 2000 (cont.)

- **LAWRA project:**
 - **Symmetric matrices**
 - * **Full storage, n^2 ; fast**
 - * **Packed storage,**
 $n(n + 1)/2$; **slow**
 - * **New packed storage,**
 $n(n + 1)/2$; **fast**
 - * **Perturbation algorithms**
 - **Gauss LU Factorization**
- **Publications**
- **LAWRA Workshop (1999)**

1997 – 2000 (cont.)

- **LAPACK95 project**
 - **Updated to LAPACK version 3**
 - **LAPACK test included**
 - **LAPACK95 Users' Guide**

2001

- **I've Retired**
- **NetSolve – I've stopped**
- **NAG Library – only scientific**
- **LAPACK95 supporting**
- **PARA Conferences**
- **PPAM Conferences**
- **SIAM Conferences**

2001 –

- **PARA becomes “Nordic Workshop”**
 - **PARA2002 – Espoo, Finland**
 - **PARA2004 – Copenhagen, Denmark**
 - **PARA2006 – Umeå, Sweden**
 - **PARA2008 – Trondheim, Norway**
 - **PARA2010 – Reykjavik, Iceland**
 - **PARA2012 – Espoo, Finland**
 - **PARA2014 – Copenhagen, Denmark**

2001 – ?

- **LAWRA project (cont.)**
- **NetSolve**
- **NAG Library**
- **LAPACK95 supporting**
- **Research**

PARAxx and PPAMyy

- **Bjarne S. Andersen, Fred G. Gustavson, and Jerzy Waśniewski. “A recursive formulation of Cholesky factorization of a matrix in packed storage”. ACM Transactions on Mathematical Software, 27(2):214–244, June 2001**

- **B.S. Andersen, J.A. Gunnels, F. Gustavson, J.K. Reid, and J. Waśniewski. “A Fully Portable High Performance Minimal Storage Hybrid Format Cholesky Algorithm”. ACM Trans. of Math. Software, 31 (2005), 201-227.**
- **Gustavson, F. G., Reid, J. K., and Waśniewski, J., (2007). Algorithm 865: “Fortran 95 Subroutines for Cholesky Factorization in Blocked Hybrid Format”. ACM Transactions on Mathematical Software, 33, 1 (March), 5.**

Fred G. Gustavson, Jerzy Waśniewski, Julien Langou and Jack J. Dongarra: LAPACK Working Note Nr 199 “Rectangular Full Packed Format for Cholesky’s Algorithm: Factorization, Solution and Inversion”, ACM Transactions on Mathematical Software, Vol. 37, No. 2, Article 18, Publication date: April 2010.

**Fred G. Gustavson, Jerzy Waśniewski, Julien Langou and Jack J. Dongarra, Jos R. Her-
rero and Julien Langou: LAPACK Work-
ing Note Nr 249“Level-3 Cholesky Factor-
ization Routines as Part of Many Cholesky
Algorithms”, submitted to the ACM Trans-
actions on Mathematical Software.**

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