

A Look Back: 50 Years of Scientific Computing

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November 16, 2006

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**
- **Requirement: Make money!**
 - $Ax = b$
 - **Several important research and industrial problems**
- **Krzysztof Moszynski**

1959 – 1961

**Department of Mathematics
Technical University of Warsaw**

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

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 (EMC)**
- **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**
Jerzy Hallay
- **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, MINSK**
 - **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 “Scandinavian Workshop”**
 - **PARA’98 – Umeå, Sweden**
 - **PARA2000 – Bergen, Norway**
 - **PARA2002 – Espoo, Finland**
 - **PARA2004 – Lyngby, 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**
- **Alexander Karaivanov**
- **Ivan Lirkov**
- **Minka Marinova**
- **Jerzy Wasniewski, coordinator**
- **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**

1999 – 2007

- **Collaboration with Roman Wyrzykowski:**
 - **Parallel Processing
and Applied of Mathematics**
 - * **Conferences: PPAM'99, PPAM'01**
 - * **PPAM'03 – minisymposium
with Dr. Piotr Krzyżanowski**
 - * **PPAM'05, and PPAM'07**

1992 – 2006

- **A few Bulgarian Conferences
Proceedings, lectures
and minisymposia**

2001 – 2007

HPC Linear Algebra Algorithms

My main collaborators:

- **Bjarne Stig Andersen**
DMI, Denmark
- **Jack Dongarra**
University of Tennessee
- **Fred Gustavson**
IBM T.J. Watson Research Center
- **Kaj Madsen**
Technical University of Denmark
- **John Read**
Rutherford Appleton Laboratory
- **Zahari Zlatev**
DMU, Denmark

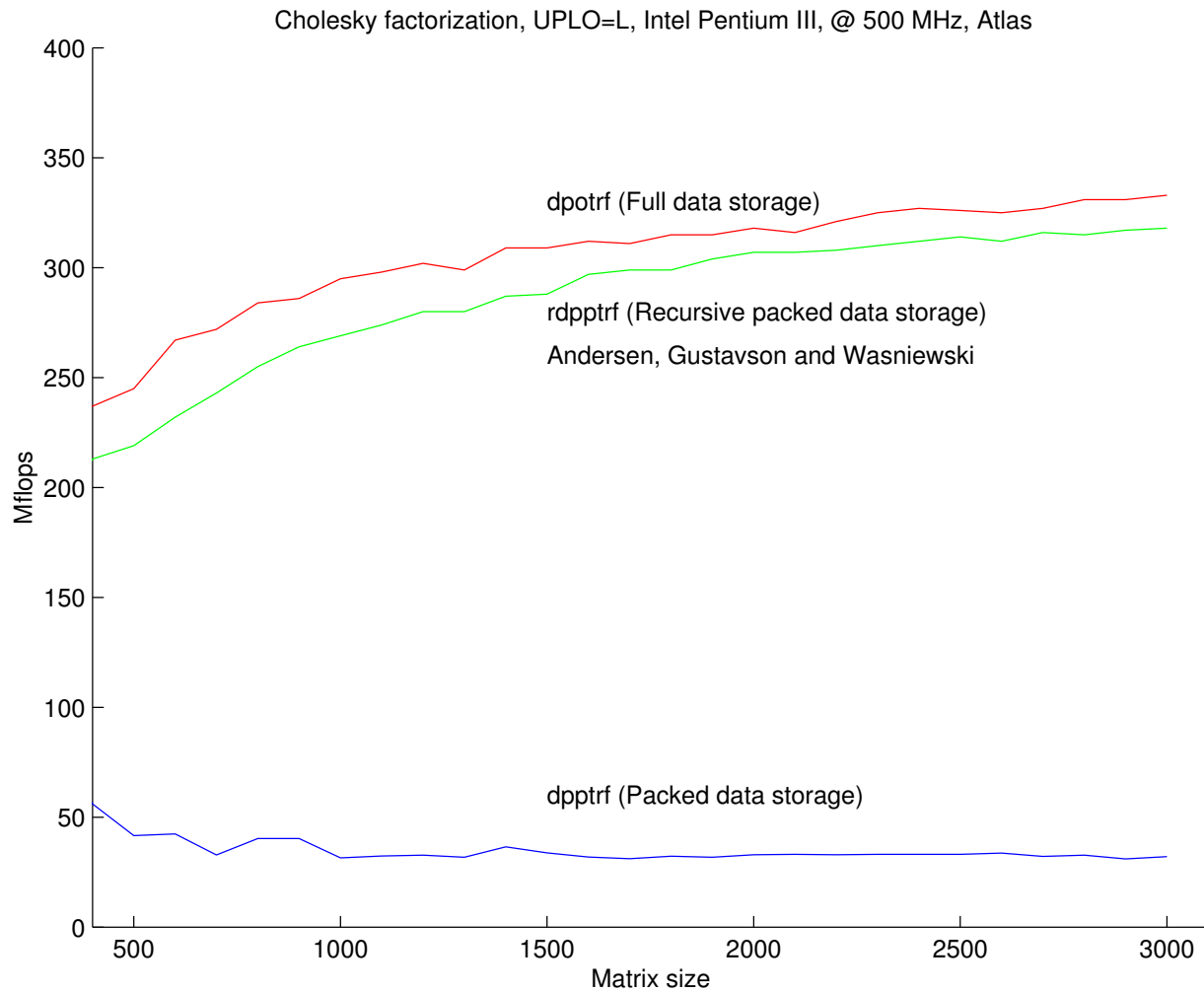
2001 – 2007

HPC Linear Algebra Algorithms

The most important recent references:

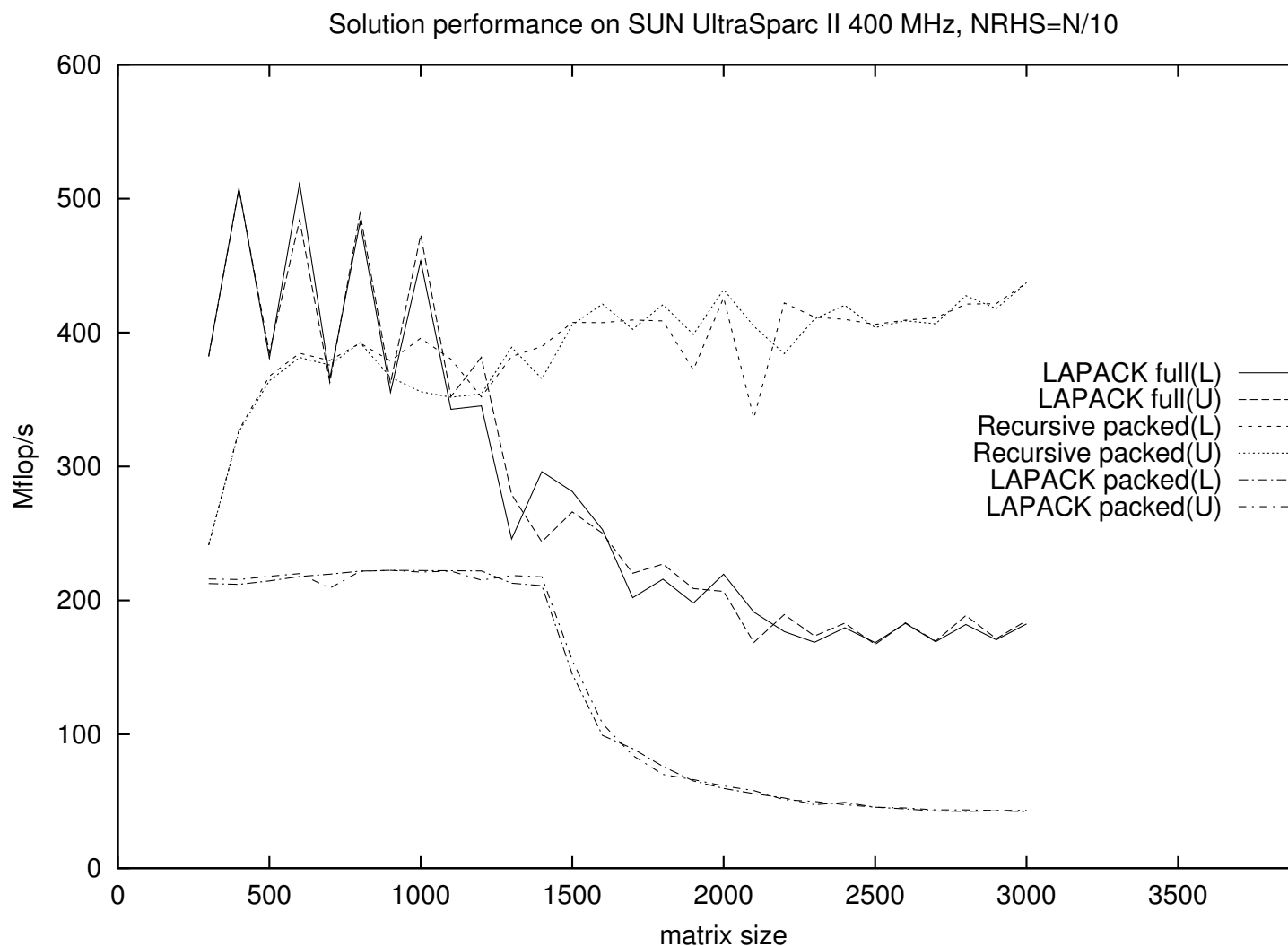
- **B. S. Andersen, F. G. Gustavson, J. Waśniewski. A recursive formulation of Cholesky factorization of a matrix in packed storage. *TOMS*, Vol. 27, No. 2, June. 2001, pp. 214-244.**
- **B.S. Andersen, J. Gunnar, F.G. Gustavson, J.K. Reid, J. Waśniewski. A fully portable High Performance Minimal Storage Cholesky Algorithm. *ACM Trans. on Math. Software* 31, 2005, 201-227.**
- **F.G. Gustavson, J.K. Reid, and J. Waśniewski. Algorithm 8xx: Fortran 95 Subroutines for Cholesky Factorization and Solution in Blocked Packed Hybrid Format. Already accepted and will be published in *Trans. of Math. Software of ACM*, upcoming 2007 (see <http://math.nist.gov/toms/Upcoming.html>).**

Cholesky, a packed and full data storage



B. S. Andersen, F. G. Gustavson, J. Waśniewski. A recursive formulation of Cholesky factorization of a matrix in packed storage. *TOMS*, Vol. 27, No. 2, June. 2001, pp. 214-244.

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2001 – 2007

HPC Linear Algebra Algorithms Presentations

- **Computer manufactures:**
IBM Research and Development Centers (several times)
HP (several times), SUN California, SGI
- **Universities:**
Warsaw University, University of Tennessee, Cornell University, Stanford University, Western Michigan University, University of Quebec, Danish Technical University, Technical University of Częstochowa, Technical University of Warsaw, Institute of Mathematics of PAS, and several other places.
- **Conferences:**
PARAs, PPAMs, PMAAs, SIAMs, EUROPARs, and others

2005 – 2007

Rectangular Full Packed format

- **Already accepted
for the new version of LAPACK.**
- **Extended abstract (10 pages) published
in the PARA'06 Springer Proceedings.**
- **Paper is being prepared for TOMS of
ACM.**

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