EVENTS THAT CHANGED THE IT WORLD

Experiences and Reflections of a Computer and Systems Engineering Pioneer

Harold “Bud” Lawson

IEEE COMPUTER SOCIETY
CHARLES BABBAGE
COMPUTER PIONEER

Association for Computing Machinery
Advancing Computing as a Science & Profession

FELLOW

IEEE computer society

FELLOW and LIFE MEMBER

INCOSE
International Council on Systems Engineering

FELLOW and SYSTEMS ENGINEERING PIONEER

KEEP THIS IN MIND AS WE PROCEED

As we march into the future, we should not ignore the side-effects of the events that have changed the world of information technology.

Many of our problems with safety and security have their root cause in past developments in the computer industry.

Overlapping Phases

- **Phase 1 (1959-1974) – Computer Industry**
- **Phase 2 (1974-1996) - Computer-Based Systems**
- **Phase 3 (1996-Present) – Complex Systems**

Parallel Academic Career 1967 - …

- **Dedicated to all the talented colleagues that I have worked with during my career.**
- **We have had fun and learned from each other.**
- **Interesting Reflections and Happenings are indicated in Red.**

Computer Industry (1959 to 1974)

- Summer 1958 - US Census Bureau
- 1959 Temple University (Introduction to IBM 650 (Drum Machine))
- 1959-61 Employed at Remington-Rand Univac
- 1961-67 Employed at IBM
- 1967-69 Part Time Consultant (Professor)
- 1969-70 Employed at Standard Computer Corporation
- 1971-73 Consultant to Datasaab, Linköping
- 1973-… Consultant .. Expert Witness..

Rear Admiral Dr. Grace Murray Hopper

(December 9, 1906 – January 1, 1992)

Minted the word "BUG" – During her time as Programmer of the MARK I Computer at Harvard

Minted the word "COMPILER" with A-0 in 1951

Developed Math-Matic and Flowmatic and inspired the Development of COBOL

Grace loved US Navy Service – The oldest active officer, retirement at 80.

From Grace I learned that it is important to question the status-quo, to seek deeper meaning and explore alternative ways of doing things.

1980 – Honarary Doctor Linköpings Universitet

Univac Compiler Technology of the 1950's

The USS Hopper

Posthumous Recipient of the Presidential Medal of Freedom

Grace Hopper's Early Programming Languages

Math-Matic

Solve:

$$Y = \frac{X^3(2+X)}{3 \text{ Cos } A} - \sqrt[4]{3P}$$

for P running from 0.2 to 0.8 in increments of 0.2, A running from 0.35 to 1.05 in increments of .175 and X running from 1.8 to 3.8 in increments of 0.5

A MATH-MATIC pseudo-code statement of this problem is as follows;

(1) VARY P 0.2 (0.2) 0.8
SENTENCES 2 THRU 5 .

(2) VARY A 0.35 (0.175) 1.05
SENTENCES 3 THRU 5 .

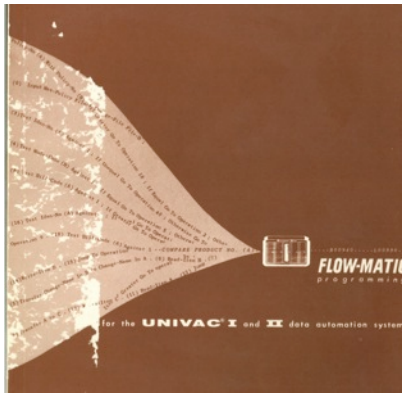
(3) VARY X 1.8 (0.5) 3.8
SENTENCES 4 THRU 5 .

(4) Y = X**3*(2+X)/(3*COS A)-4
ROOT (3*P) .

(5) WRITE AND EDIT Y X A P .

(6) STOP .

Flowmatic



FOR SAMPLE PROBLEM I

```
(0)  INPUT INVENTORY FILE-A PRICE FILE-B ; OUTPUT PRICED-INV FILE-C UNPRICE
     INV FILE-D ; HSP D .
(1)  COMPARE PRODUCT-NO (A) WITH PRODUCT-NO (B) ; IF GREATER GO TO OPERATIO
     10 ; IF EQUAL GO TO OPERATION 5 ; OTHERWISE GO TO OPERATION 2 .
(2)  TRANSFER A TO D .
(3)  WRITE-ITEM D .
(4)  JUMP TO OPERATION 8 .
(5)  TRANSFER A TO C .
(6)  MOVE UNIT-PRICE (B) TO UNIT-PRICE (C) .
(7)  WRITE-ITEM C .
(8)  READ-ITEM A ; IF END OF DATA GO TO OPERATION 14 .
(9)  JUMP TO OPERATION 1 .
(10) READ-ITEM B ; IF END OF DATA GO TO OPERATION 12 .
(11) JUMP TO OPERATION 1 .
(12) SET OPERATION 9 TO GO TO OPERATION 2 .
(13) JUMP TO OPERATION 2 .
(14) TEST PRODUCT-NO (B) AGAINST ZZZZZZZZZZZZ ; IF EQUAL GO TO OPERATION 16
     OTHERWISE GO TO OPERATION 15 .
(15) REWIND B .
(16) CLOSE-OUT FILES C , D .
(17) STOP . (END) Space Fill to End of Block.
```

ABC MANUFACTURING COMPANY INVENTORY

FIGURE 23

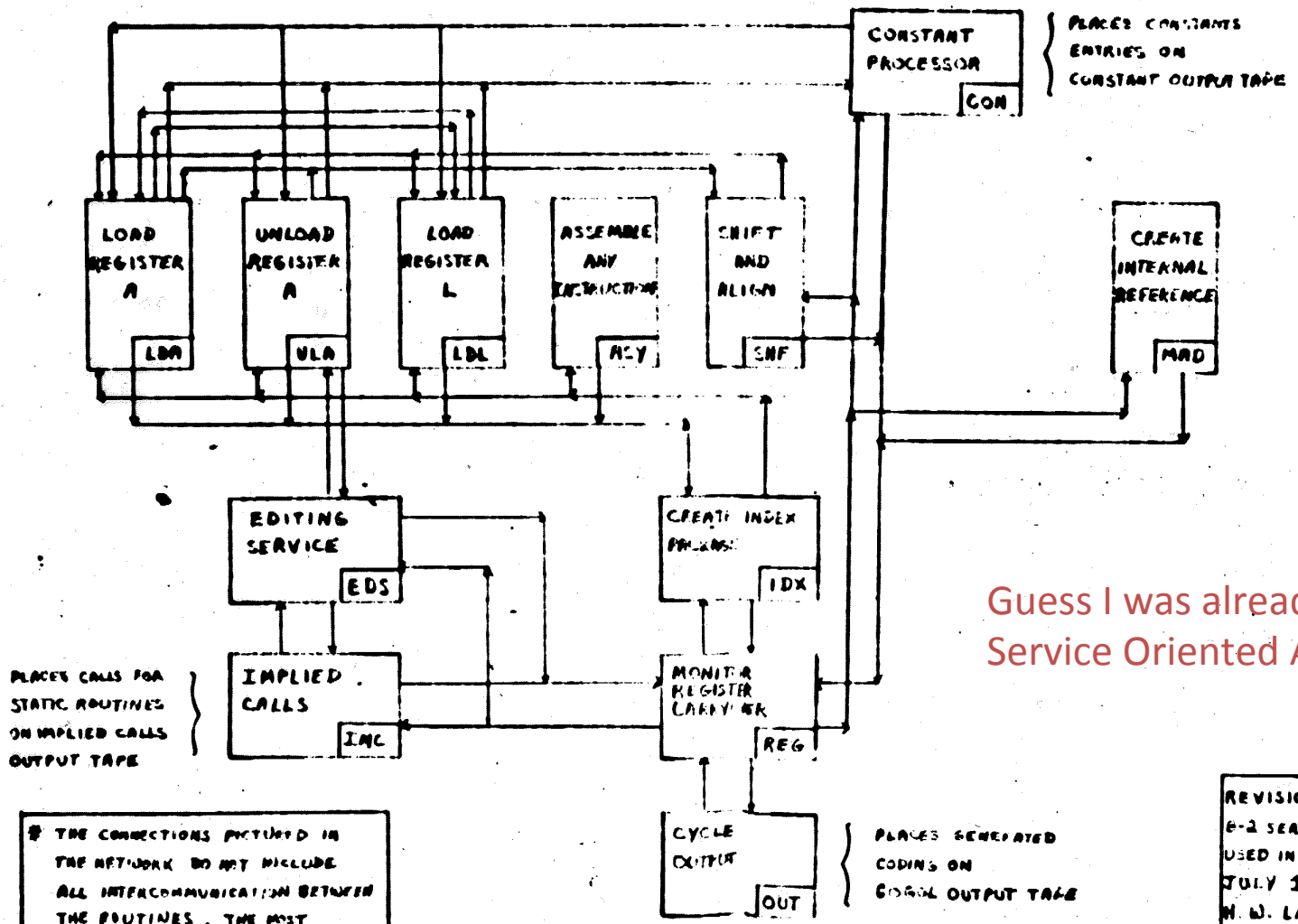
The UNIVAC II

Core Memory 2K Words of 12 Decimal Digits/Characters
Up to 10 Tape Drives Powerful Intuitive Instruction Set
Off line Typewriter/Punch Card to Tape and Printer

The COBOL Implementation

- Grace insisted that we view the compiler as a data processing system
- The compiler was implemented in Flowmatic!!!!! and had approximately 60 passes
- I did the initial parser, the code generator and part of the I/O
- I called the code generator DUZ (DUZ does everything)
- Developed Generalized Algorithms for Decimal Alignment
- A parallel implementation was done at RCA in Camden, New Jersey
- December 1960 - first time the same program compiled-executed on two machines
- Seminar 1999 – CHM (Stanford University) with Howard Bromberg

B-2 SERVICE ROUTINE NETWORK *



Guess I was already thinking about Service Oriented Architectures!!!

* THE CONNECTIONS PICTURED IN THE NETWORK DO NOT INCLUDE ALL INTERCOMMUNICATION BETWEEN THE ROUTINES. THE MOST IMPORTANT CONNECTIONS ARE REPRESENTED.

REVISION 1
B-2 SERVICE ROUTINE NETWORK
USED IN THE DUE (GENERATION) PHASE
JULY 1, 1960
M. W. LAWSON, JR.

Grace was not a very “manageable” person and often in conflict with Corporate management. She returned to full-time Navy service at the Pentagon.

Jay Elliot described Grace Hopper as appearing to be "'all Navy', but when you reach inside, you find a 'Pirate' dying to be released” (From Wikipedia − Grace Hopper)

Several members of her Automatic Programming Department left Sperry Univac.

An important WWII slang term crept into our department vocabulary

BLIVIT sometimes spelled **BLIVET**

In traditional Military slang dating back to the Second World War, a blivit was defined as *"ten pounds of shit in a five pound bag"* (a proverbial description of anything ugly or unmanageable); it was applied to an unmanageable situation, a crucial but substandard or damaged tool, or a self-important person.

Blivit Avoidance – Finding a limited number of driving concepts and principles that guide thinking, influence decision making and provide a controlled means of acting.

MY FIRST PROFESSIONAL PUBLICATION

The Use of Chain List Matrices for the Analysis Of COBOL Data Structures

H. W. Lawson, Jr.
IBM Corporation Poughkeepsie, N. Y.

THE ANALYSIS, reduction, and verification of the data hierarchy utilized in *COBOL* presents a major problem for implementors of the language. The use of chain list matrices, to be presented in this paper, provides a significant aid in reducing the time required to process the variably structured data elements in a *COBOL* program.
Chain list matrices have been developed to provide a means of classifying and relating the elements of a tree structure. Offered will be definitions of tree terminology such as nodes, branches, roots, leaves, subtrees, branching ratios, etc. Examples that explain the structure and meaning of arbitrary order, level order, and subtree order chain list matrices will also be presented.

1962 ACM National Conference
Syracuse, New York

- **Based on my Univac Experiences**
- **Referred to by Don Knuth –**

  The Art of Computer Programming:

  Fundamental Algorithms
- First Publication- Algorithms for Multi-Linked

  Data Structures

Provided a good basis for my eventual work on The Pointer Variable.

My Time at IBM 1961-67

- Research in Compiler-Compiler techniques, in particular SLANG (Systems Language) based upon instrumented Backus-Naur Form (BNF) notation.
- System/360 announced in 1964. PL/I specified.
- Member of the PL/I Language Board and assigned to develop a List-Processing facility for PL/I.
- The Birth of the Pointer Variable.
- Represented PL/I on the OS/360 Change Control Board and observed the Entropy as the OS implementation deteriorated.
- Manager of Advanced Technology at the New York Programming Center. Start of my interest in Microprogramming and Computer Architecture.

An Interesting and Important SLANG Colleague
Don Estridge (1937 – 1985)

- Made important contributions to SLANG
- A very impulsive person
- Led a group of 4 (including me) that implemented a FORTRAN compiler in SLANG over a weekend
- Called “the father of the PC era” – as an IBM Vice President - led IBM into the PC market
- Made Microsoft and Bill Gates what they became as a result of the 1980 agreement.
- Tragically died in a crash at Dallas Airport together with his wife in 1985.

The Pointer Variable - 1964

PL/I List Processing

HAROLD LAWSON,JR.
International Business Machines Corp.,
New York, N. Y.

The concepts of list processing have been introduced into the PL/I language. With these new facilities, it is possible to write PL/I procedures that operate on simple and complex data list organizations. Most list-processing languages have suffered from their inability to deal directly with complex data structures and/or from their inability to perform the complete range of programming language operations upon the data list structures. These two problems have been eliminated in the list-processing facilities of PL/I. The basic concepts of list processing and the philosophy of the PL/I language extensions are discussed. In addition, several detailed list-processing examples are provided.

Communications of the ACM

Volunme 10 / Number 6 / June, 1967

Essential for AI, Deep Learning, Machine Learning, Blockchains…

- PL/I Language lacked facilities for treating linked lists
- Customer demand to write Graphics Driver routines in PL/I – Especially GM Research Laboratories
- Plan to implement PL/I (H-level) compiler in PL/I
- Developed the concepts of the Pointer Variable and Based Variables to flexibly treat linked lists.
- Feedback from Don Knuth and Doug McIlroy.
- Tried to restart the definition and implementation of PL/I – Would have made PL/I less complex and more useful.
- Developed a PL/I subset as a Systems Programming Language. Implemented and used internally by IBM
- PL/I used to implement the Multics OS at MIT
- Bell Labs backed out of the MIT cooperation and built Unix and C heavily using pointers and the Multics concepts.
- Concepts further implemented in amongst others Pascal, C, C++, Ada, BASIC, Fortran, COBOL. Eiffel, Oberon and PL/M.
- When used properly – a powerful programming facility used by millions of software designers and programmers but when not used properly can lead to chaos.
- Awarded the IEEE Computer Society Charles Babbage Computer Pioneer Award in 2000
- Don Knuth: “I do consider pointer variables to be among computer science's most valuable treasures.”

OS/360 – The Black Hole of Complexity

Documented in the Mythical Man Month

Dr. Fred Brooks

- Started with reasonable concepts and principles – coding conventions
- As implementation proceeded more and more projects requested exceptions
- The document pile grow rapidly out of control – nobody read anymore
- A cast of about one thousand from around the world joined the deteriorating effort
- Every release solved some problems but introduced many more
- A root cause – the mismatch between the Instruction Set Architecture (ISA) and the performance goals of the system software
- The unnecessary complexity created many jobs for consulting companies
- Fred in retrospect stated that OS/360 should have been implemented in PL/I (like Multics)

Microprogramming and Computer Architecture

- From 1965-67 I was manager of Advanced Technology at the New York Programming Center
- One interesting aspect of System/360 was the use of microprograms to provide compatibility between series members.
- Several research groups and companies became interested in exploiting microprogram capabilities and this became the focus of my group of six researchers
- We developed the concept of T-Machine and E-Machine architectures
- T-Machines implemented microcode to support compilers
- E-Machines provided via microcode the run-time execution environments for compiled code
- During this time, I taught a graduate course at New York University on Programming Languages and Compilers
- It was impossible to convince IBM to change directions and so the fruits of our research would not be used - The march into the black hole of complexity proceeded in an accelerated manner.

Start of my Academic Caree

- Joined the Polytechnic Institute of Brooklyn (now New York) in 1967 as an Associate Professor in the Department of Electrical Engineering
- Responsible for establishing both undergraduate and graduate computer engineering programs (some of the earliest in the USA)
- Wrote, together with Erik Neuhold (IBM Vienna colleague) the book: *The PL/I Machine: An Introduction to Programming*, Addison-Wesley
- Developed with several students PLAGO (A PL/I Subset Load and Go Compiler) based on the T-Machine and E-Machine architecture
- Research program in Microprogramming and Computer Architecture
- Several students went on to make significant contributions in the computer industry (several at Digital Equipment Corporation) as well as some that went on to do a doctorate.

Len Shustek

One of my most successful students

Married
Donna Dubinsky
Creator of Palm Pilot

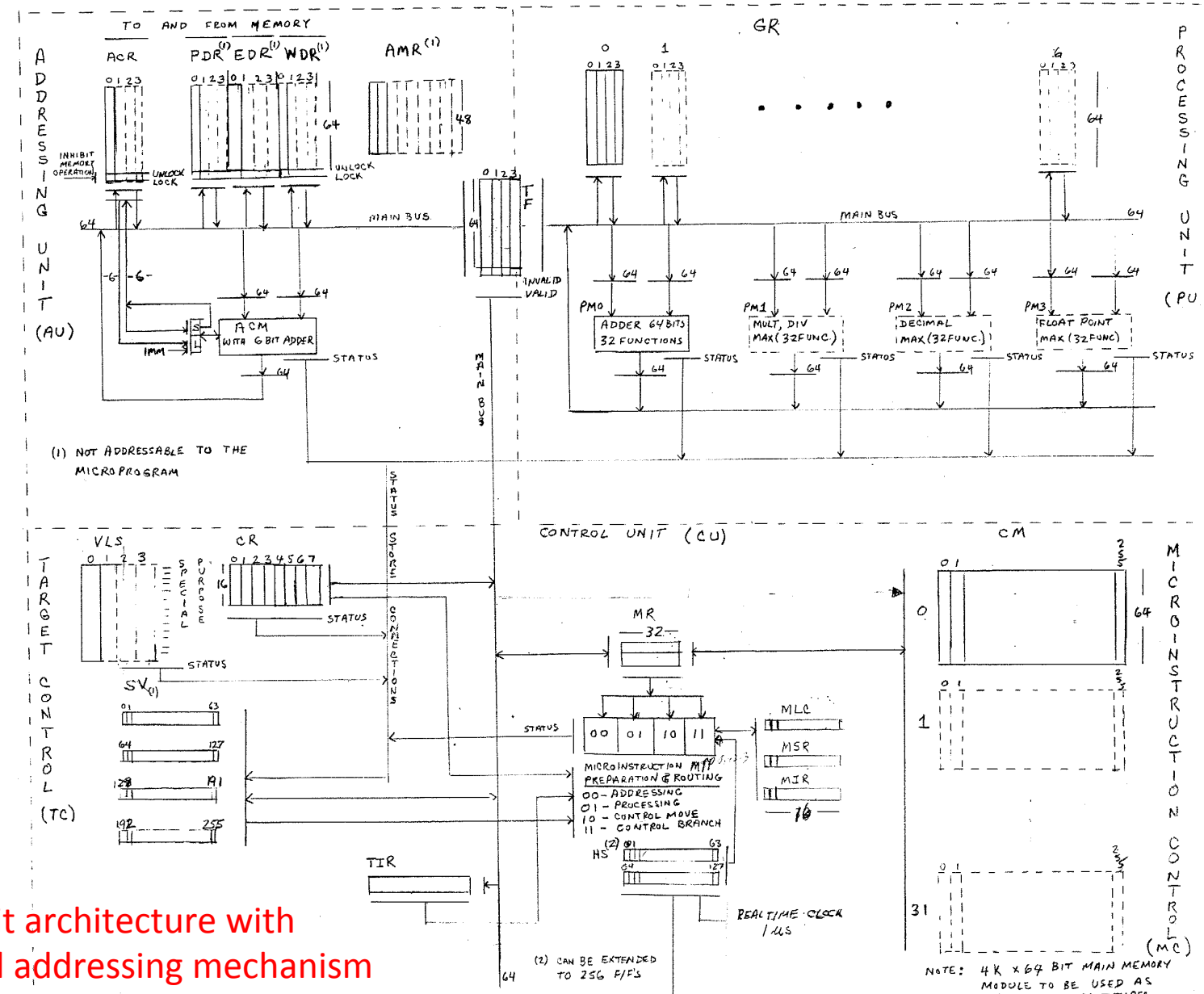
- At Brooklyn Poly - convinced him to change from Physics to Comptuer Science.
- He did the code generator for PLAGO.
- He did his PhD at Stanford.
- Inventor of the Sniffer – Peformance evaluation of LAN's
- Nestar made lots of "dollars" for him.
- Now Board Chairman of the Computer History Museum
- Created an endowed chair in Computer Science at Polytechnic of New York

Standard Computer MLP-900

- Joined Standard Computer in Costa Mesa, CA in 1969 to be co-architect of a new general purpose Microprogrammed Computer
- Many innovative ideas that created interest of several potential customers and other computer manufacturers (including Datasaab and ICL in the UK)
- Capable of implementing multiple instruction sets, including support for operating systems and higher level languages
- Orders from Stanford Linear Accelerator and RAND Corporation.
- Alan Kay explored implementing FLEX (became Smalltalk) on the MLP-900
- Management change resulted in the project being cancelled
- The prototype delivered to RAND and then moved to the University of Southern California Information Science Institute (ISI)
- ISI developed software support tools, did an emulator of the PDP-10 and placed the MLP-900 in the original ARPA network
- Provided a microprogram research tool for remote downloading of microprogram instruction interpreters (ex. ANYUK – computers)

Datasaab Flexible Central Processing Unit

- Datasaab wanted to license the MLP-900. When not an option, ask me to come to Linköping to explore designing a new machine
- Came to Sweden 1 February 1971 and studied the situation for 3 months. Developed a new strategy that Datasaab liked. Stayed on until September
- Datasaab decided to build the machine and do the first emulator as a D23 machine. However the plan was to do support for OS and higher level languages directly in microcode. Potentially even to emulate the IBM 360.
- Returned in January 1972 and participated in the detailed design and implemented some of the tricky microprograms for example, floating point arithmetic
- FCPU created significant interest in Uppsala, Lund, KTH, Linköping and Chalmers – Did a lecture tour. Resulted in the establishment of a Nutek program to support further FCPU development and use.
- There where 9 FCPU's produced and several D23s delivered or ordered to the Miltary (Bertil and Cecilia), Kockums, Volvo Flygmotor, Allmana Brand, SMHI
- Technical aspect: Probably the first machine to use the idea of Local Synchronous, Global Asynchronous and the hardware implementation of semaphore variables.
- Design provided for accelerated testing and verification of the prototype and series production.
- Unfortunately the planned hardware-software developments did not happen. If it had been done, based upon T and E machine architecture concepts it was estimated that compiler performance for Fortran, Cobol and Algol-Genius would have been up to a factor of 20 and execution time performance a factor of 5 to 6 x D23 native performance.



A 64-bit architecture with
a novel addressing mechanism

FCPU - Continued

- Many thanks to Gunnar Lindström, Viggo Wentzel, Bengt Asker, Bengt Malm, Häkan Niska, Torbjörn Granberg, Bengt Magnhagen, Bengt Jiewertz, Rolf Flisberg, Lars Blomberg, Lennart Löfgren,Lennart Pettersson, Gunnar Hesse and others
- Found working with a small group of competent engineers to be very rewarding compared to earlier US computer industry experiences
- In Sweden we are forced to design and build complex systems with limited resources (a strength and weakness)
- "Advantages of Structured Hardware" co-authored with Bengt Magnhagen received the Best Paper award at the second Computer Architecture symposium, 1975
- The advent of the microprocessor in the mid-1970s changed hardware economics and moved the world of computing into a new era that has accelerated the march into the black hole of complexity
- The FCPU became the object of two patent infringement cases

Three Computer Architects

Me Maurice Wilkes Gordon Bell

For me, computer architecture died by the late 1970s as the focus shifted to the primitive microprocessors (particularly X86). The hardware-software relationship was no longer of interest. The world has since then paid the price for unnecessary complexity.

ES EVM ЕС ЭВМ, Единая система электронных вычислительных машин

“Unified System of Electronic Computers”

In the early-1970s at the height of the Cold War, the US Government gave the go-ahead to IBM to license 360 technology (including OS/360) to the Soviet Union.

There were about 15000 computers developed in Russia and other Eastern Block countries.

They never mastered the complexity of OS/360.

This probably set Soviet Computer Technology back at least 20 years. Perhaps forever!!!

This was most likely the intention: Export your complexity to your Enemy!!!

Several prior Soviet Machines (Elbrus, Minsk and BESM-6) where explicitly addressing the hardware-software relationship similar to the Burroughs Machines and the plans for the FCPU

Tragic Note: There was an alternative to the System/360 at IBM called the IBM 8000 Series that also planned to use a similar approach − That team lost out to System/360

The March into the Black Hole of Complexity

- **The IBM System 360 (Plus and Minus)**
- **The Hardware-Software Mismatch and Attempts to Improve**
- **The Birth of the Microprocessor**
- **Early System Softwares for Microprocessors**
- **The Gates-Estridge Agreement in 1980**
- **The Cementing of the X86 Instruction Set**
- **The Functionality – Hardware Spiral (WINTEL)**
- **Middleware hides Complexity – it does not remove it**
- **The Market Impact of Inexpensive PC's and the Internet**

We Build Ever Increasing Complex Software Systems on Hardware that Does not Support the Reduction of Software Complexity

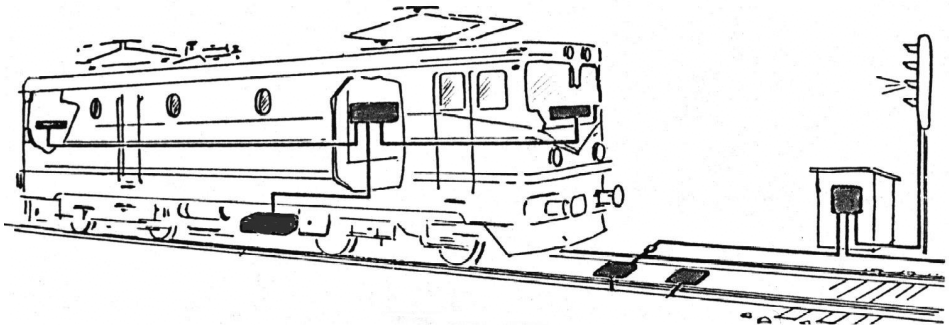
Perhaps it will require a melt down of the Internet before action is taken to improve upon the situation

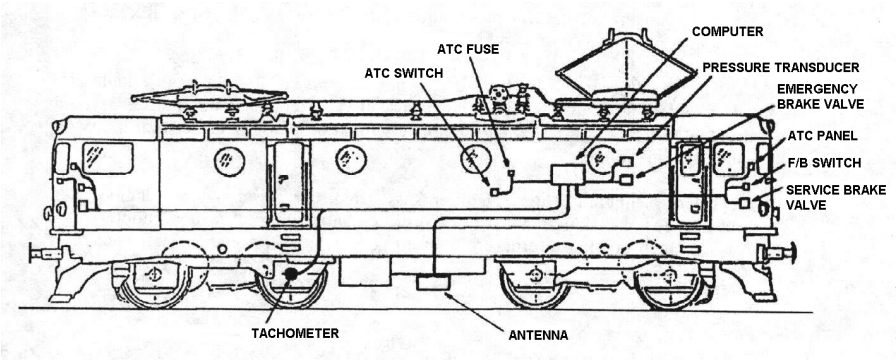
Rebirth of the Computer Industry, Communications of the ACM, June 2002/Vol. 45, No. 6

Computer-Based Systems (1974-1996)

- High Voltage Power Control System for ENHER, Barcelona
- Consultant to ITT in Brussels, Harlow, Antwerp, Madrid and Vällingby (Standard Radio)
- **Automatic Train Control for Standard Radio**
- Incentive's Science Advisor (Electronics and Computers)
- **Nutek – VIA (Vehicle Internal Architecture) Program**
- Automotive Component for Haldex
- Studies for FMV on Safety Critical Real-Time Systems
- Authored the book: *Parallel Processing in Industrial Real-Time Applications*, Prentice-Hall (contributions from Bertil Svensson and Lars Wanhammar)
- Mid-life update of the Viggen aircraft
- **Cooperation with Arcticus Systems AB**

Automatic Train Control





- In the mid 1970s SJ proposed implementing the World's first **Automatic Train Control** system composed of transponders (balises) and microprocessor based on-board control
- Ericsson Radio and ITT-Standard Radio delivered designs and bids.
- Standard Radio selected by SJ to do their on-board control
- Ericsson Radio selected to do the balises and selected by SL to do their on-board control
- Sivert Wallin (former relay engineer) at Standard Radio started implementing a solution that was becoming quite complex.
- ITT asked me to help out in Vällingby. We met and I studied the situation

Automatic Train Control (Continued)

- Proposed a solution that viewed the software more like hardware thus providing for deterministic execution meeting the stability requirement of 250 milliseconds
- Small procedures did well defined transformations in a cyclic loop.
- Sivert and Birgit Bryntse implemented according to this architecture and the result was a very compact 10K byte program that met all requirements.
- The deterministic solution led to significant advantages in testing and verification of the prototypes as well as the series production. Installation on locomotives became straight-forward. **No** software changed from 1980-93.
- Ansaldo (of Italy) bought the ATC system. It was re-implemented in ADA by Allied Signal in Pittsburgh and runs on all the locomotives of the New Jersey Transit
- This solution encouraged me to further explore the use of deterministic execution and I produced three research papers (two related to multi-processor environments) – Could, with significant advantages, be used for Real-Time systems in todays Multi-Core processor environments
- ATC was updated for the X2000 and further developed. Same architecture in use for 37 years. No accidents have been attributed to the failure of ATC.
- This experience provided a basis for my eventual participation in the NUTEK VIA project and my long-term cooperation with Arcticus Systems AB

NUTEK VIA Project

- 1990- Meeting at Arlanda to organize a project to be run by Mecel AB for developing a LAN for vehicles (Vehicle Internal Architecture)
- Nutek project funded with Mecel, Chalmers, Uppsala, SICS, Arcticus Systems and Lawson Konsult.
- The idea of separating deterministic and non-deterministic tasks got the label Red and Blue since Jan Torin (Chalmers) used these colors on a white board
- We cooperated with Herman Koptez in Vienna who also explored Time-Triggered execution - now realized by TTTech in Austria
- I suggested the name "software circuits" to identify the hardware like transformations done in Red (deterministic) tasks as previously implemented in the ATC system.
- The VIA ideas that evolved where very promising and we had an important meeting in Göteborg with several important European vehicle stakeholders.
- Unfortunately, the chance to take a dominant European position with VIA fell.
- Bosch managed to get the CAN network established as a de facto standard
- Two articles where published in research journals authored by Hans Hansson, Olle Bridal, Mikael Strömberg, Henrik Lön, Sven Larsson, and myself.

Cooperation with Arcticus Systems

- After VIA – further cooperation with MDH and KTH
- *A Real-Time Kernel Integrated with an Off-Line Scheduler*, Christer Eriksson (Nordström), Kurt-Lennart Lundbäck and me.
- Haldex Limited Slip Coupling Device – uses Rubus
- Observed the "organizational system" problems at Haldex and tailored a version of ISO/IEC 12207 to provide a set of relevant processes.
- Helped Arcticus in qualifying Rubus for use in medical devices using ISO/IEC 12207.
- Helped in qualifying Rubus as certifiable according to ISO 26262 Road Vehicles – Functional Safety
- Best Paper Award (2017) − Provisioning Embedded Software in the Vehicle Industry: The Rubus Approach, IEEE Software co-authors: Saad Mubeen, John Lundbäck, Mattias Gålnander, Kurt-Lennart Lundbäck

Complex Systems (1996 to ……)

- The need for a holistic view of systems, products, services and enterprises involving hardware, software, processes and humans became apparent.
- Tailored ISO/IEC 12207 for, in addition to Haldex, Gambro and Cambio
- Invited by Dr. Raghu Singh, US Navy and editor of ISO/IEC 12207 to participate in developing a new Systems Life Cycle Process standard
- "One cannot consider software without considering the system context in which the software is an element" – Not apparent for many programmers
- Received financial support to participate from FMV and Nutek - Vinnova (thanks to Ingemar Carlsson and Karl-Einar Sjödin)

ISO/IEC 15288

- The US DoD through the US standards organization proposed a System Standard – DoD had decided to use commercial standards
- Begun 1996 in Prague - Stuart Arnold (UK), Richard Schmidt (USA), Jerry Lake (USA) and myself assigned to structure the standard
- Stuart Arnold + Richard Schmidt editors – no real progress until 1999
- Stan McGee new convener – Arnold sole editor – need for an architect
- I was elected amongst the 14 countries involved
- Arnold and I developed the driving concepts in September 1999 in Sigtuna
- System of Interest, System Element, Enabling Systems, Recursive Decomposition, Life Cycle Models, Stages
- Finally became an International Standard in 2002
- Passes the "Arms length" test
- First implementation at FMV
- Has helped in organizing Systems Engineering
- INCOSE SE Handbook, SEBoK, SE certification

Academic Career (1967 – Present)

- **1967-72- Associate, then Professor Polytechnic Institute of Brooklyn**
- **1969-70- Guest Professor Univ. of California, Irvine**
- **1973-87-Guest, Adjunct, Professor Linköpings Universitet**
- **1974- Guest Professor University of Stuttgart**
- **1976-Guest Professor Politecnica de Barcelona**
- **1984-Guest Professor University of Malaya and Keio University**
- **2003-present Academic Fellow at Stevens Institute of Technology**
- **Graduate Courses at Stevens, Skövde, Stockholms Univ, KTH, Mälardalen and FHS**

Linköpings Universitet

- Guest Professor 1973-75 – graduate courses in computing and helped define the first D-line
- Lost to Erik Sandewall the first Swedish professorship of Computer Science in a split decision
- Adjunct Professor with Erik in the Mathematics department 1977-79 – taught both graduate and undergraduate courses and advised graduate students
- Became Professor of Computer and Telecommunication Systems at the Systemteknik department in 1979
- Wrote the book *Understanding Computer Systems* that was translated to Swedish, German, Dutch and Spanish.
- In 1983 – Erik and I left Mathematics, resp. Systemteknik and formed the Institution for Datavätenskap (IDA)
- I concentrated my research on the development of asynchronous circuits – and participated in a national microelectronics program
- Officially resigned in 1987.

Dr M pleased with MIMOS' growth

"When can you start?" asked Dato' Seri (now Tun) Dr Mahathir Mohamad in August 1984 when Tengku Dr Mohd Azzman Shariffadeen and Swedish-American visiting professor Prof Harold Lawson presented the concept paper for the "Malaysian Institute of Microelectronic Systems". Barely five months later, MIMOS was born, and what started in January 1985 has come a long way.

MIMOS was instituted as a result of Tun Dr Mahathir's far-sighted leadership, which provided the initial thrust for Malaysia's ICT boom. At MIMOS' 25th Anniversary celebration on 5 May, the organisation through the Ministry of Science, Technology and Innovation (MOSTI), honoured the great statesman with the National ICT Development Award, in recognition of his immeasurable contributions to the development of ICT in Malaysia.

MARKING A MILESTONE... Dr Mahathir inscribing his autograph to launch MIMOS' coffee table book, "Innovation for Life: A Journey beyond Frontiers".

"...You can see, with the very "stingy" amount of money that we spent on research, we have achieved quite a lot," he said. We later realised that Dr Mahathir was transitioning his speech to emphasise the importance of spending money on R&D for the country to continue to move forward. "I hope the government will fix a percentage of the national budget for research," he said. "Maybe not three per cent yet but slowly working up to three per cent," he added.

Dr Mahathir, who congratulated MIMOS several times throughout his speech, concluded with a final one, saying he had never thought "something that was very, very small in the field of research" was going to be this big. Dear Tun, our hearts swelled with your generous support and kind recognition, and we will continue to work hard to bring MIMOS to greater heights. ■

<u>During my sabbatical leave in 1984 At the University of Malaya.</u>

Malaysia at that time was a back-end low cost producer of Integrated Circuits for American, Japanese and European companies

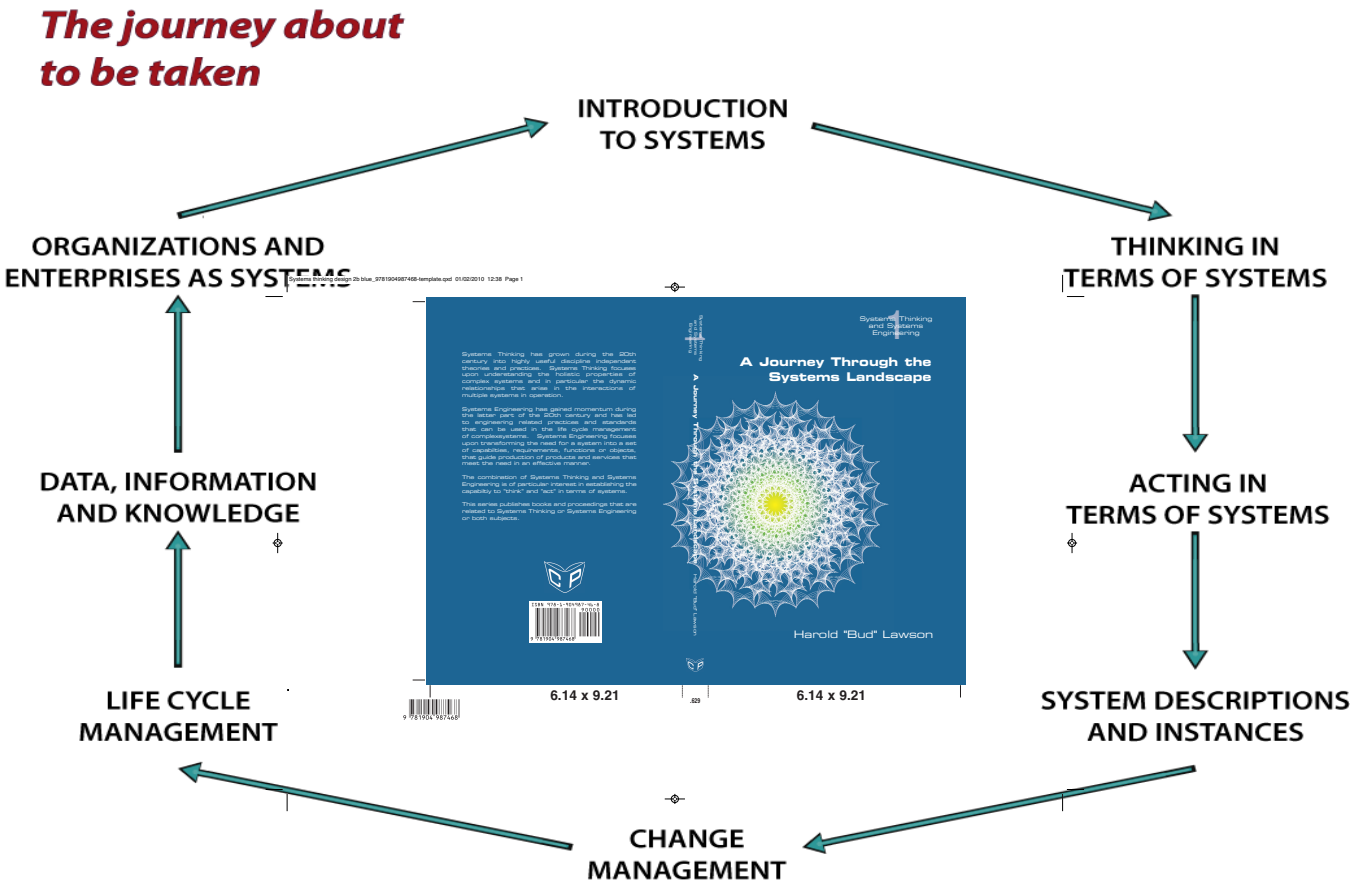
Dr. Tengku Azzman, Dean of Engineering enlisted my support in making a Proposal to the Prime Minister to create a Malaysian Institute of Microelectronic Systems – in order to move up on the value chain.

I arranged for Ericsson to donate One million dollars and a Japanese Company ½ million to MIMOS

As of the 25th Anniversary there where 400 researchers and MIMOS moved Malaysia into the forefront in Microelectronics and IT.

Systems Thinking – Systems Engineering

- In my search for deeper meaning, I found that the literature in Systems Science and Systems Thinking provided very useful insights
- Ask by Dr. Dinesh Verma (Stevens Institute) to develop a Systems Thinking graduate course that I delivered in 2002 and 2003
- Further developed the material that provides a sound basis for learning to "think" and "act" in terms of systems
- Graduate courses at Skövde, Stockholms Universitet, KTH, Mälardalen and Stevens
- Provided professional development courses for FMV, Swedish Military, Nokia and Rosatom
- Resulted in the book: *A Journey Through the Systems Landscape* (also available in Russian and French)

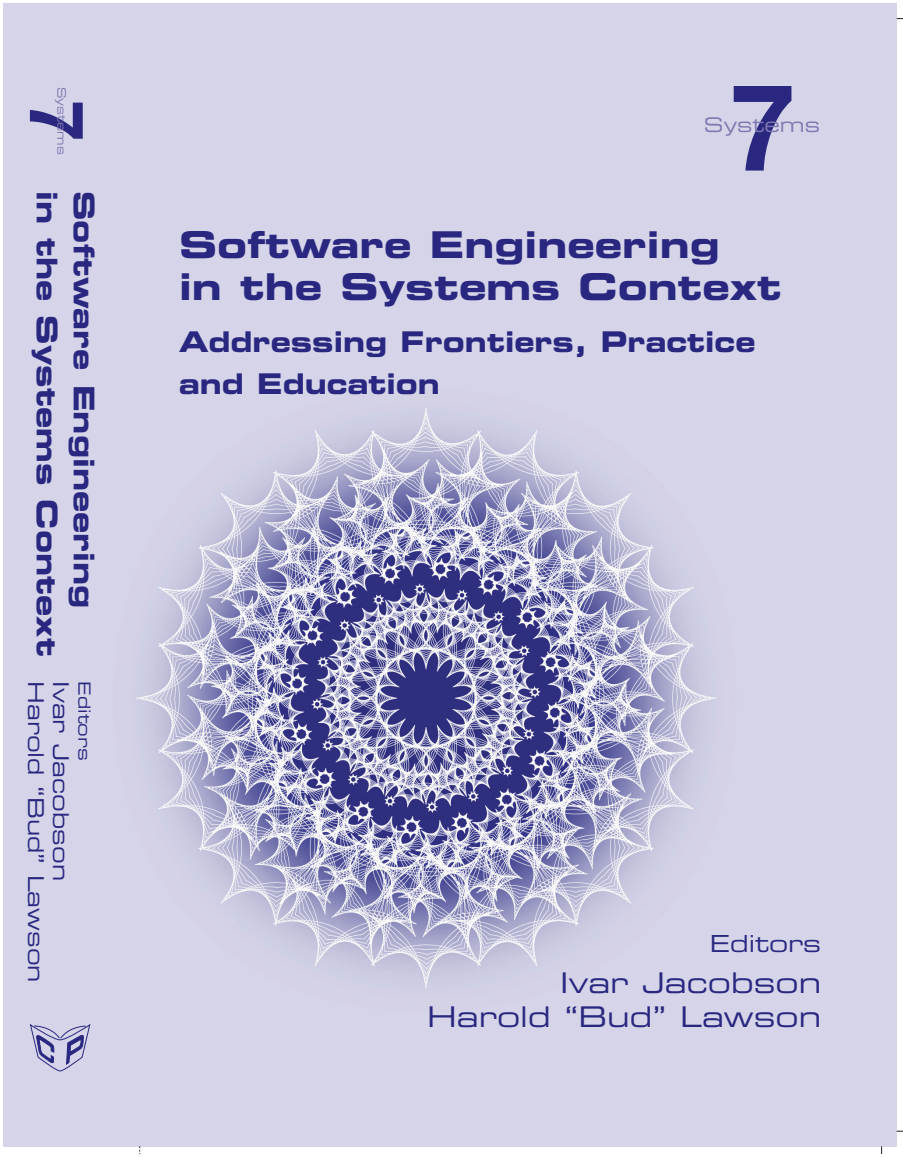


A Journey Through the Systems Landscape

Book website and Download of the Digital Version

http://www.thesystemslandscape.com/

Towards Unifying Software and Systems Engineering



Ilia Bider **Barry Boehm** **Lindsey Brodie**

Francois Coallier **Tom Gilb**

Rich Hilliard **Ivar Jacobson**

Harold "Bud" Lawson **Anatoly Levenchuk**

Svante Lidman **Paul E. McMahon**

Moacyr de Mello **Barry Myburgh**

Pan-Wei Ng **Don O'Neill**

June Sung Park **Sarah Sheard**

Ian Sommerville **Ian Spence**

A MUST READ FOR ALL SOFTWARE AND SYSTEMS ENGINEERS!!!

That's all folks

Do your best to avoid Blivits

"Think about the end before the beginning"

from the philosophy of Leonardo da Vinci

Follow the links in My Posts on LinkedIN to access the chapter:
Experiences and Reflections of a Computer and Systems Engineering Pioneer

Most Important Publications

- **“The Use of Chain List Matrices for the Analysis of COBOL Data Structures”, Proceedings of the ACM Conference 1962, Syracuse, New York.**
- **“PL/I List Processing”, Communications of the ACM, Volume 10, Number 6, June 1967.**
- **“Programming Language Oriented Instruction Streams”, IEEE Transactions on Computers, Volume C-17, Number 5, May 1968.**
- **“Functional Characteristics of a Multi-Lingual Processor”, IEEE Transactions on Computers, Volume C-20, July 1971. (Co-author: Burton K. Smith).**
- **“Advantages of Structured Hardware”, Proceedings of the Second Annual Symposium on Computer Architecture, Houston, Texas, January 1975. (Co-author: Dr. Bengt Magnhagen).**
- **“Function Distribution in Computer System Architectures”, Invited paper appearing in the Proceedings of the Third Annual Symposium on Computer Architecture, Clearwater, Florida, January 1976.**

Publications (continued)

- **“Philosophies for Engineering Computer Based Systems”, IEEE Computer, Vol. 23, No. 12, pp. 52-63, December, 1990.**
- **“CY-CLONE - An Approach to the Engineering of Resource Adequate Cyclic Real-Time Systems”, Real Time Systems, The International Journal of Time-Critical Computing Systems, Vol. 4, No. 1, February, 1992.**
- **Parallel Processing in Industrial Real-Time Applications, Prentice-Hall series on “Innovative Technologies”, ISBN 0-13-654518-1. 1992.**
- **“BASEMENT: A Distributed Real-Time Architecture for Vehicle Applications”, Real Time Systems, The International Journal of Time-Critical Computing Systems, Vol. 11, No. 3, November, 1996. (Co-authors: H. Hansson, M. Strömberg, and S. Larsson).**
- **“Salvation from System Complexity”, IEEE Computer, Vol. 31, No. 2, Feb 1998, pp 118-120.**
- **“Infrastructure Risk Reduction”, Communications of the ACM, Vol. 40, No. 6, June 1998, pp120.**

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- **“From Busyware to Stableware”, IEEE Computer, Vol. 31, No. 10, Oct 1998, pp117-119.**
- **“Rebirth of the Computer Industry”. Communications fo the ACM June 2002/Vol. 45, No. 6.**
- **“Twenty Years of Safe Train Control in Sweden”, Proceedings of the International Symposium and Workshop on Systems Engineering of Computer Based Systems, Washington, DC. April, 2001. (Co-authors: S. Wallin, B. Bryntse, and B. Friman).**
- **“Viewing Systems from a Business Management Perspective: The ISO/ IEC 15288 Standard”, The Journal of Systems Engineering, Vol. 7, No. 3, September, 2004. Co-author: Stuart Arnold**
- **A Journey Through the Systems Landscape, College Publications, Kings College, UK, ISBN 978-1-84890-010-3, 2010.**
- **Software Engineering in the Systems Context, College Publications, Kings College, UK, ISBN 978-1-84890-176-6, 2015. Co-editor: Ivar Jacobson**