

The background features a large, faint watermark of the seal of the University of Gothenburg. The seal is circular and contains a central figure of a lion holding a sword and a book. The text around the seal includes "SIGILLUM UNIVERSITATIS GOTHORVM CAROLINÆ A VT RVMQVIVM 1666".

A Short History About PLC and DCS

**Alfred Theorin
Vanessa Romero Segovia**

Outline

- ▶ PLC
 - ▶ Motivation
 - ▶ Problems faced during the 60's
 - ▶ The Birth of the PLC (1968)
 - ▶ The Race is On
 - ▶ The History goes On
 - ▶ Fathers of the PLC
 - ▶ PLC Evolution



Motivation

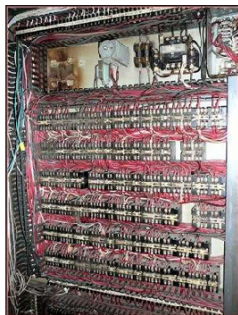
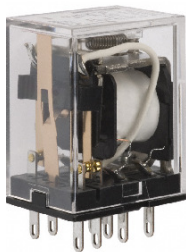


Figure: Drinking Water Plant La Tomilla, Arequipa - Peru



Problems faced during the 60's

- ▶ Control systems implemented using relay controller
- ▶ Lack of flexibility for process changes or expansion
- ▶ Troubleshooting: "Five hours to find it and five minutes to fix it"



The Birth of the PLC (1968)

Bill Stone part of the Hydramatic Division of GM presents a paper at the Westinghouse Conference.

The paper outlined problems related with reliability and documentation for the machines at this plant. It also presented a design criteria to developed a "standard machine controller" which included:

- ▶ Elimination of costly scrapping of assembly-line relays during model changeovers and replace unreliable electromechanical relays
- ▶ Reduction of machine downtime related to controls problems
- ▶ Provide for future expansion, it had to be modular
- ▶ Work in an industrial environment



The Race is On

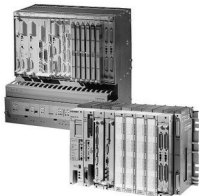
These specifications along with a proposal request to build a prototype, were given to four control builders:

- ▶ Allen-Bradley, by way of Michigan-based Information Instruments, Inc.
- ▶ Digital Equipment Corporation (DEC)
- ▶ Century Detroit
- ▶ Bedford Associates



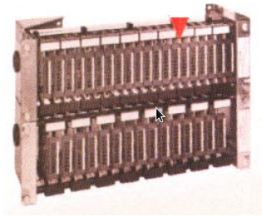
The Race is On

- ▶ Digital Equipment brings a "mini-computer", rejected due to static memory
- ▶ Allen-Bradley has two attempts: PDQ II and PMC. Both of them too large, too difficult to program and too complex
- ▶ Bedford Associates (Morley, Greenberg, Landau, Schwenk and Boissevain) already working from 1968 on the "084". They form Modicon and together in 1969 build the "Programmable Controller 084" also known as the "Modicon 084" which wins the proposal



The History goes On

- ▶ In 1971, Allen-Bradley (Struger and Dummermuth) present the "Bulletin 1774 PLC" also known as the "PLC"
- ▶ In 1973, Modicon (Greenberg and Rousseau) develop the "Modicon 184", which produces the take off of Modicon



The History goes On

- ▶ The acceptance of the PLC during its early days was very difficult
- ▶ "It was difficult to convince that a small box could replace 50 feet of cabinets" (Morley)
- ▶ "Considerable effort was made to not identify PLCs as computers due to the poor reliability of computers and the fact that they were not things procured by manufacturing operations" (Morley)
- ▶ Another difficult rising was because of the dedicated hardware terminals employed to program the early PLC versions



The History goes On

- ▶ Scott Zifferer (ICOM Software), focused on Allen-Bradley products. "I wanted to use a computer for PLC programming and documentation, instead of the dedicated hardware A-B called a T-3 Terminal". The evolutionary approach enhanced the user interface, helped control engineers and maintenance people interface with A-B PLCs
- ▶ Neil Taylor (Taylor Industrial Software), focused on Modicon products. "I was consulting and saw the need to replace drafting table-produced ladder diagrams, which cost plenty to maintain and too much time to create." His interest on documentation resulted on a variety of report options and reporting formats which helped troubleshooting the PLCs (offline)



Fathers of the PLC

Richard Morley

- ▶ Bedford Associates, Modicon
- ▶ More than 20 US patents
- ▶ Novel computer design, AI, chaos and complexity, factory of the future



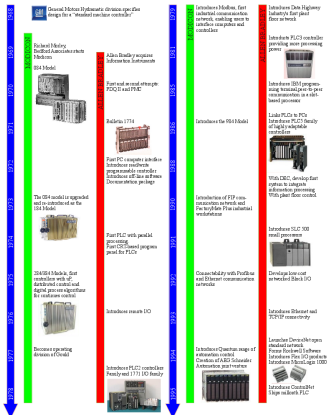
Odo Josef Struger

- ▶ Allen-Bradley
- ▶ PLC acronym, holds 50 patents
- ▶ Leadership role developing NEMA, IEC 1131-3



PLC Evolution

- ▶ In the early 1980s PLCs began incorporating distributed control functions
- ▶ During the 90s, standardization and open systems were the main themes
- ▶ Ethernet peer-to-peer networking became available from virtually all PLC manufacturers
- ▶ Redundancy became a standard product
- ▶ Appearance of very small nano or pico PLCs
- ▶ Safety PLCs featuring triple redundancy were introduced



Outline

- ▶ DCS
 - ▶ <1950s - Early Process Control
 - ▶ 1950s - The Pioneering Period
 - ▶ 1960s - Direct Digital Control
 - ▶ 1970s - Cheaper Computers
 - ▶ 1980s - DCS Emerges
 - ▶ 1990s - The Fieldbus Wars
 - ▶ Outlook



<1950s - Early Process Control



- ▶ Analog devices
- ▶ Wired by hand
- ▶ Poor flexibility
- ▶ Main cost = the analog devices
- ▶ More loops = more space
- ▶ Simple loops not automated



1950s - The Pioneering Period

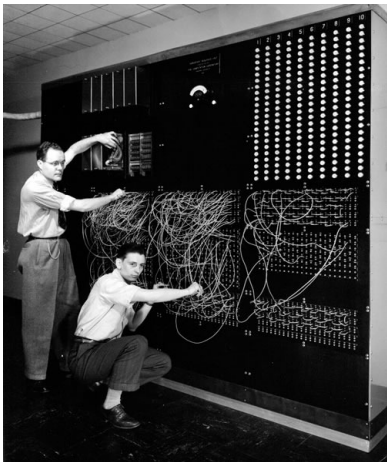


Figure: Harvard Mark I 1944

- ▶ Thomson Ramo Wolridge
- ▶ Online after 3 years
- ▶ MTBF 50 – 100h
- ▶ Addition 1ms, Multiplication 20ms
- ▶ Supervision, printing instructions, set point control
- ▶ Control still analog



1950s - The Pioneering Period

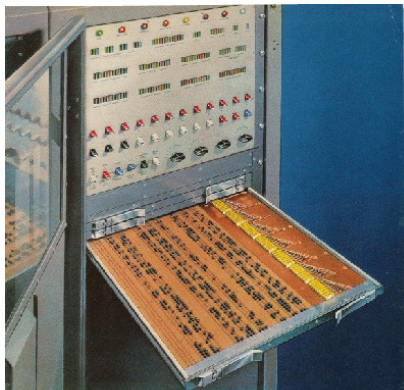
- ▶ Improved understanding
- ▶ Specialized hardware
- ▶ interrupts



Figure: IBM1710 from 1961



1960s - Direct Digital Control



FERRANTI ARGUS

Process-Control Computer System

- ▶ Imperial Chemical Industries
- ▶ Direct Digital Control
- ▶ Bloodhound Mk2 Missile
- ▶ Only large systems
- ▶ Digital operator panels
- ▶ Better flexibility



1960s - Direct Digital Control

- ▶ DDC languages
- ▶ No programming, just configuration
- ▶ Only pre-defined control
- ▶ Building automation
- ▶ Function Blocks



1970s - Cheaper Computers



Figure: IBM1800 from 1964

- ▶ Minicomputers
- ▶ Cheaper, faster, more reliable
- ▶ Smaller systems
- ▶ Faster processes
- ▶ More critical processes
- ▶ 1970 5,000 → 1975 50,000
- ▶ Boot time!



1970s - Cheaper Computers

**We asked
Control
Data**
to pack
the power
of a big
computer
into a militarized
microcomputer
for our navigational
guidance control
system.*

They did it.

Show actual size...
Control Data 1770 microcomputer
in size of hole punch,
2000 microchip, same
from 1961 and used
in computer to one new
military specification
is shown.

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**CD CONTROL DATA
CORPORATION**

- ▶ Microcomputers – Cheaper, faster, more reliable
- ▶ \$10,000 → \$500
- ▶ Final blow



1980s - DCS Emerges



- ▶ Until now - Analog to digital
- ▶ R-Tec - Advanced building system
- ▶ Midac - Distributed DDC
- ▶ 11 microprocessors sharing tasks and memory
- ▶ Coordinated distributed controllers over a serial network



1980s - DCS Emerges

- ▶ New control languages
- ▶ Token Bus Network
- ▶ Redundancy and real-time communication



1990s - The Fieldbus Wars



- ▶ Communication analog to digital
- ▶ No standard communication protocol
- ▶ Fieldbuses
- ▶ Many organizations and DCS vendors
- ▶ Many fieldbuses
- ▶ Yes indeed many!



1990s - The Fieldbus Wars



- ▶ Microsoft Windows
- ▶ OPC



1990s - The Fieldbus Wars

- ▶ COTS
- ▶ Hardware → Software



Outlook

- ▶ PLC and DCS more similar

