ifip
Working Group 5.7
Advances
in
Production Management Systems

IFIP

# IFIP WG 5.7

## Computer-Aided Production Management

(Founded 1978)

## Historic overview

Asbjørn Rolstadås
Norwegian University of Science and Technology

# Lady Ada Lovelace (1815 – 1882)

- Talented mathematician
- Studied under Charles Babbage
- Worked with Babbage on his “Analytical Engine”
- World’s first programmer

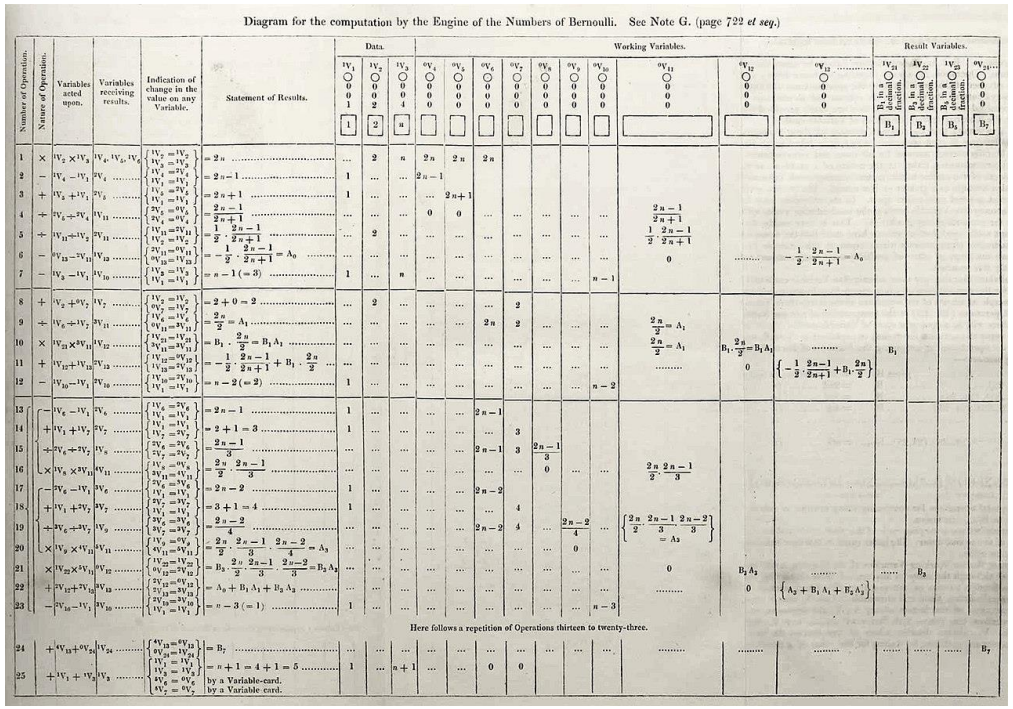
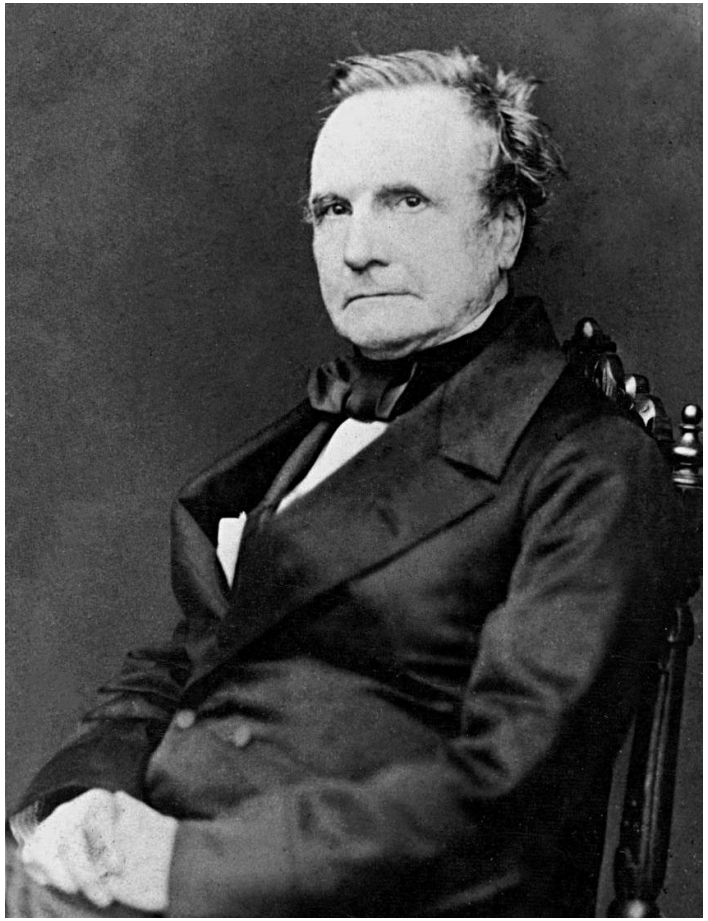


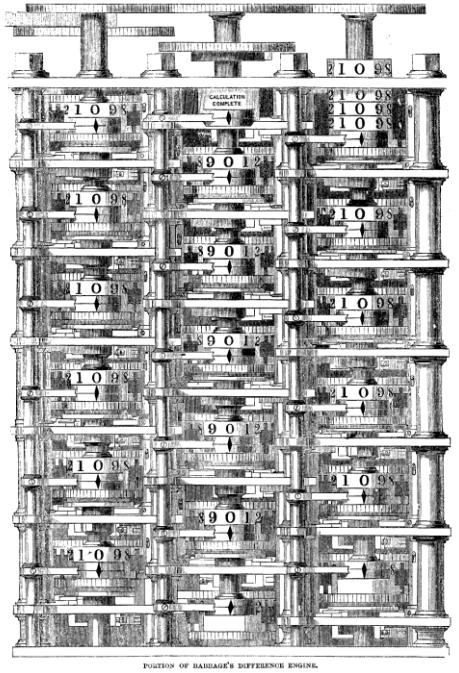
Diagram for the computation by the Engine of the Numbers of Bernoulli. See Note G. (page 722 *et seq.*)

| Number of Operation. | Nature of Operation. | Variables acted upon. | Variables receiving results. | Indication of change in the value on any Variable. | Statement of Results. | Data. | | | Working Variables. | | | | | | | | | Result Variables. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $^1V_1$ 0 0 0 1 | $^1V_2$ 0 0 0 2 | $^1V_3$ 0 0 0 4 | $^0V_4$ 0 0 0 0 | $^0V_5$ 0 0 0 0 | $^0V_6$ 0 0 0 0 | $^0V_7$ 0 0 0 0 | $^0V_8$ 0 0 0 0 | $^0V_9$ 0 0 0 0 | $^0V_{10}$ 0 0 0 0 | $^0V_{11}$ 0 0 0 0 | $^0V_{12}$ 0 0 0 0 | $^0V_{13}$ 0 0 0 0 | $^1V_{21}$ $B_1$ in a decimal fraction. | $^1V_{22}$ $B_2$ in a decimal fraction. | $^1V_{23}$ $B_3$ in a decimal fraction. | $^0V_{24}$ 0 0 0 0 |
| | | | | | | 1 | 2 | $n$ | | | | | | | | | | | | $B_1$ | $B_2$ | $B_3$ | $B_7$ |
| 1 | × | $^1V_2$ | $^1V_3$ | $^1V_4, ^1V_5, ^1V_6$ | $= 2n$ | ... | 2 | $n$ | $2n$ | $2n$ | $2n$ | | | | | | | | | | | |
| 2 | − | $^1V_4$ | $^1V_1$ | $^2V_4$ | $= 2n-1$ | 1 | ... | ... | $2n-1$ | | | | | | | | | | | | | |
| 3 | + | $^1V_5$ | $^1V_1$ | $^2V_5$ | $= 2n+1$ | 1 | ... | ... | ... | $2n+1$ | | | | | | | | | | | | |
| 4 | + | $^2V_4$ | $^2V_4$ | $^0V_{11}$ | $\frac{2n-1}{2n+1}$ | ... | ... | ... | 0 | 0 | ... | ... | ... | ... | ... | $\frac{2n-1}{2n+1}$ | | | | | | |
| 5 | + | $^1V_{11}$ | $^1V_2$ | $^2V_{11}$ | $\frac{1}{2}\cdot\frac{2n-1}{2n+1}$ | ... | 2 | ... | ... | ... | ... | ... | ... | ... | ... | $\frac{1}{2}\cdot\frac{2n-1}{2n+1}$ | | | | | | |
| 6 | − | $^0V_{12}$ | $^0V_{11}$ | $^1V_{12}$ | $-\frac{1}{2}\cdot\frac{2n-1}{2n+1} = A_0$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0 | ..... | $-\frac{1}{2}\cdot\frac{2n-1}{2n+1} = A_0$ | | | | |
| 7 | − | $^1V_3$ | $^1V_{10}$ | $^1V_3$ | $= n-1\,(=3)$ | 1 | ... | $n$ | ... | ... | ... | ... | ... | ... | $n-1$ | ..... | | ..... | | | | |
| 8 | + | $^1V_2$ | $^0V_7$ | $^1V_7$ | $= 2+0=2$ | ... | 2 | ... | ... | ... | ... | 2 | | | | | | | | | | |
| 9 | ÷ | $^1V_6$ | $^1V_2$ | $^2V_{11}$ | $= \frac{2n}{2} = A_1$ | ... | ... | ... | ... | ... | $2n$ | 2 | ... | ... | ... | $\frac{2n}{2} = A_1$ | | | | | | |
| 10 | × | $^{V_{11}}$ | $^{2V_{11}}$ | $^1V_{12}$ | $= B_1\cdot\frac{2n}{2} = B_1A_1$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | $\frac{2n}{2} = A_1$ | $B_1\cdot\frac{2n}{2}=B_1A_1$ | ..... | $B_1$ | | | |
| 11 | + | $^1V_{12}$ | $^1V_{12}$ | $^2V_{12}$ | $= -\frac{1}{2}\cdot\frac{2n-1}{2n+1} + B_1\cdot\frac{2n}{2}$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ..... | 0 | $\left\{-\frac{1}{2}\cdot\frac{2n-1}{2n+1}+B_1\cdot\frac{2n}{2}\right\}$ | | | | |
| 12 | − | $^1V_{10}$ | $^1V_1$ | $^1V_{10}$ | $= n-2\,(=2)$ | 1 | ... | ... | ... | ... | ... | ... | ... | ... | $n-2$ | | | | | | | |
| 13 | − | $^1V_6$ | $^1V_1$ | $^2V_6$ | $= 2n-1$ | 1 | ... | ... | ... | ... | $2n-1$ | | | | | | | | | | | |
| 14 | + | $^1V_1$ | $^1V_7$ | $^2V_7$ | $= 2+1=3$ | 1 | ... | ... | ... | ... | ... | 3 | | | | | | | | | | |
| 15 | ÷ | $^2V_6$ | $^2V_7$ | $^2V_8$ | $= \frac{2n-1}{3}$ | ... | ... | ... | ... | ... | $2n-1$ | 3 | $\frac{2n-1}{3}$ | | | | | | | | | |
| 16 | × | $^2V_8$ | $^{2V_{11}}$ | $^4V_{11}$ | $= \frac{2n}{2}\cdot\frac{2n-1}{3}$ | ... | ... | ... | ... | ... | ... | ... | 0 | ... | ... | $\frac{2n}{2}\cdot\frac{2n-1}{3}$ | | | | | | |
| 17 | − | $^2V_6$ | $^1V_1$ | $^2V_6$ | $= 2n-2$ | 1 | ... | ... | ... | ... | $2n-2$ | | | | | | | | | | | |
| 18 | + | $^1V_1$ | $^2V_7$ | $^2V_7$ | $= 3+1=4$ | 1 | ... | ... | ... | ... | ... | 4 | | | | | | | | | | |
| 19 | ÷ | $^2V_6$ | $^2V_7$ | $^2V_9$ | $= \frac{2n-2}{4}$ | ... | ... | ... | ... | ... | $2n-2$ | 4 | ... | $\frac{2n-2}{4}$ | ... | $\left\{\frac{2n}{2}\cdot\frac{2n-1}{3}\cdot\frac{2n-2}{3}\right\}$ | | | | | | |
| 20 | × | $^1V_9$ | $^{4V_{11}}$ | $^8V_{11}$ | $= \frac{2n}{2}\cdot\frac{2n-1}{3}\cdot\frac{2n-2}{4} = A_3$ | ... | ... | ... | ... | ... | ... | ... | ... | 0 | ... | $= A_3$ | | | | | | |
| 21 | × | $^{V_{22}}$ | $^{2V_{11}}$ | $^{2V_{12}}$ | $= B_3\cdot\frac{2n}{2}\cdot\frac{2n-1}{3}\cdot\frac{2n-2}{3} = B_3A_3$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0 | $B_3A_3$ | ..... | ..... | $B_3$ | | |
| 22 | + | $^{2V_{12}}$ | $^{2V_{13}}$ | $^{2V_{13}}$ | $= A_0 + B_1A_1 + B_3A_3$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ..... | 0 | $\{A_3 + B_1A_1 + B_3A_3\}$ | | | | |
| 23 | − | $^{2V_{10}}$ | $^1V_1$ | $^{2V_{10}}$ | $= n-3\,(=1)$ | 1 | ... | ... | ... | ... | ... | ... | ... | ... | $n-3$ | | | | | | | |
| | | | | | Here follows a repetition of Operations thirteen to twenty-three. | | | | | | | | | | | | | | | | | |
| 24 | + | $^{4V_{13}}$ | $^{0V_2}$ | $^{1V_{24}}$ | $= B_7$ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ..... | ..... | ..... | ..... | ..... | ..... | $B_7$ |
| 25 | + | $^1V_1$ | $^1V_2$ | $^1V_3$ | $= n+1 = 4+1 = 5$ by a Variable-card. by a Variable card. | 1 | ... | $n+1$ | ... | ... | 0 | 0 | ... | ... | ... | ..... | ..... | ..... | ..... | ..... | ..... | |

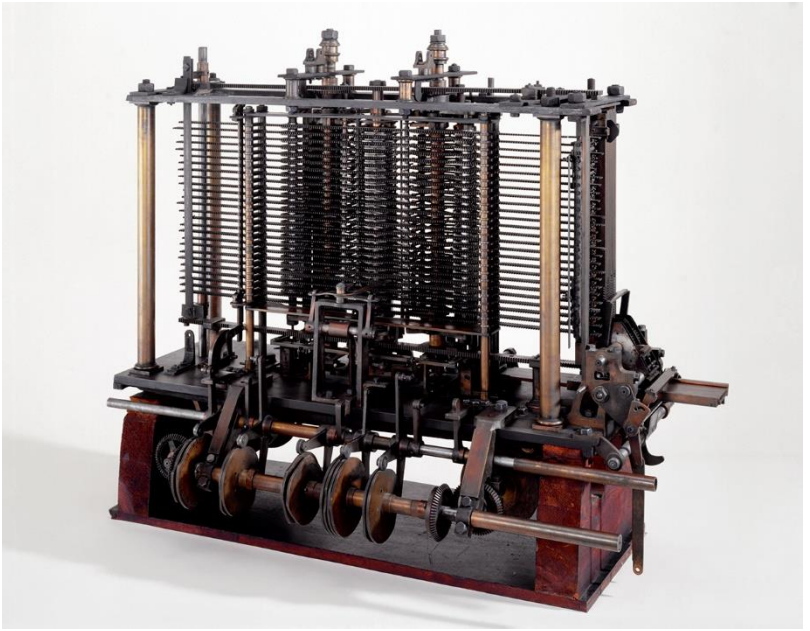
# Charles Babbage (1791 – 1871)



- “Father of the computer”
- “Difference Engine” – mechanical special-purpose computer
- “Analytical Engine” – programmable general-purpose computer using punched cards



PORTION OF BABBAGE'S DIFFERENCE ENGINE.



# Early highlights in the history of computing

- Alan Turing publishes his paper on the Turing Machine 1936
- John von Neumann architecture 1945
- First digital electronic computer developed 1936–1939 by IBM
- ENIAC (Electronic Numerical Integrator And Computer) – first electronic general-purpose computer announced 1946
- UNIVAC commercial computer 1950
- Backus presents Fortran 1954
- Murray publishes Cobol 1959
- IBM PC 1981

# Paris, June 1959

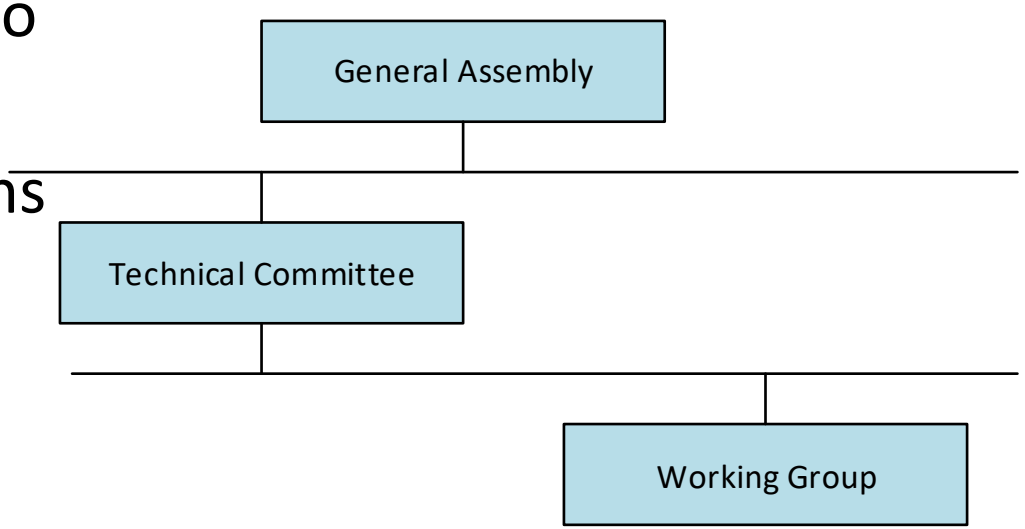
Representatives of computer societies from 18 countries met in Paris today to take the preliminary steps necessary to create an International Federation of Information Processing Societies which would carry on the sponsorship of future international conferences on information processing, including mathematical and engineering aspects, to establish international committees to undertake special tasks falling within the spheres of action of national member societies, and advance the interests of these member societies in international co-operation in the burgeoning information processing field.

- UNESCO organizes the first International Conference on Information Processing
- Considered as the first World Computer Congress.
- IFIP established under the auspices of UNESCO 1960

# What is IFIP?

- First World Computer Congress, Paris 1959
- IFIP founded in 1960 under the auspices of UNESCO
- Isaac L. Auerbach first President
- Any national computer society may apply for membership – membership restricted to one society per country
- Activity: congress, conferences, publications
- Organization

Isaac l. Auerbach



# CIRP Delphi Survey 1974


- By 1980, a computer software system for full automation and optimization of all steps in the manufacturing of a part will be developed and in wide use.
- By 1985, full automation and optimization of complete manufacturing plants, controlled by a central computer, will be a reality.
- By 1990, more than 50% of the machine tools produced, will not have a «stand-alone» use, but will be part of a versatile manufacturing system, featuring automatic part handling between stations, and being controlled from a central process computer.

# Late 1970ies – CAD/CAM/CIM

- CAD
  - Product modelling
  - Bezier-curves
- CAM
  - Automation of process and operations planning
  - Numerical control of machine tools (PROLAMAT)
  - APT, EXAPT
- CIM
  - Integration concept launched by E. Merchant
- Shift in focus from design and manufacturing technology towards planning and control of operations

P. Bezier

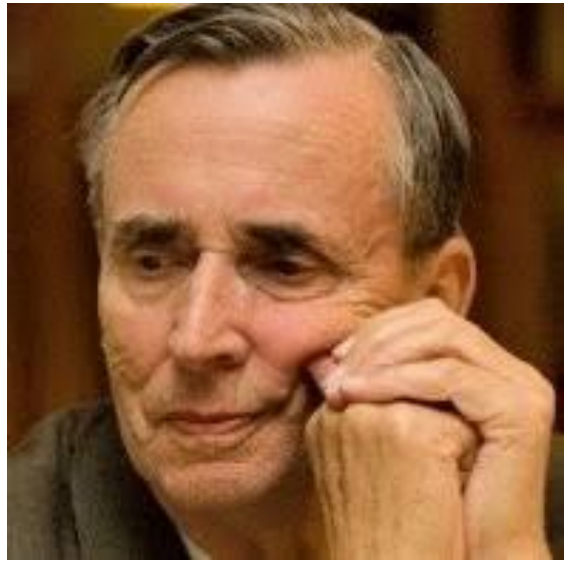
E. Merchant

# TC 5 in 1978
# Computer Applications in Technology

- WG 5.1 Transportation
- WG 5.2 Computer-Aided Design (CAD)  founded by Jakob Vlietstra chaired by Ernie Warman
- WG 5.3 Computer-Aided Manufacture (CAM) founded by Jozsef Hatvany chaired by Detlef Kochan
- WG 5.4 Standardized Hardware and Software Techniques
- WG 5.5 Continuous Process Industries
- WG 5.6 Maritime Industries

# TC 5 meeting, Grenoble, 1978

- Chairman Jacob Vliestra
- Proposal for a new WG
- Resistance from 5.2 and 5.3
- Strong support from Jozef Hatvany
- Recommendation to GA to create WG 5.7 Computer-Aided Production Management
- Decided by GA in Oslo, 1978



Jacob Vliestra

Jozef Hatvany

# Jozsef Hatvany
(1926 – 1987)

- 1982 PROLAMAT paper "Advanced Manufacturing Systems in Modern Society"
- Cape 83 paper "Dreams, Nightmares and Realities"

József Hatvany
*Computer and Automation Institute, Hungarian Academy of Sciences, H-1502, POB 63, Budapest, Hungary*

This is a phenomenological survey of the history of computer-controlled manufacturing systems over the last thirty years. First, came the *dreams* of the imminent push-button factory, controlled by a central computer. Then, the *nightmare* experiences of the first pioneers, contending simultaneously with inadequate hardware, software, skill, funding, receptivity and their own underestimation of the extra dimension of unprecedented interdisciplinary complexity. Finally today's *realities*: the possibilities opened up by distributed multiprocessor systems, by local area networks and by advanced systems synthesis techniques, the limitations imposed by investment, education, employment and environmental considerations.

# WG 5.7 first meeting Copenhagen 1979


IFIP

INTERNATIONAL FEDERATION FOR INFORMATION PROCESSING

Date : 1979-09-13

Address reply to : Associate Professor Peter Falster
Production Engineering
Laboratory NTH-SINTEF
7034 Trondheim-NTH
Norway

MINUTES OF THE 1st MEETING IN IFIP WG 5.7, AUGUST 31, 1979

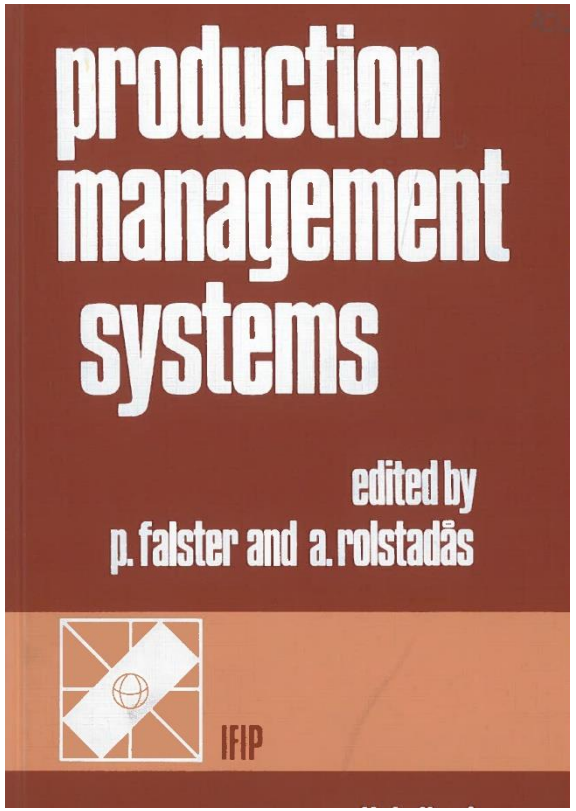
10.00 hours, ELECTRIC POWER ENGINEERING DEPARTMENT,
TECHNICAL UNIVERSITY OF DENMARK, LYNGBY, DENMARK

| | | |
|---|---|---|
| Attendants: | G. Doumeingts | (France) |
| | P. Falster | (Denmark) |
| | R.B. Mazumder | (Switzerland) |
| | E. Printz Moe | (Norway) |
| | A. Rolstadås, Chairman | (Norway) |
| | B. Svärdson | (Sweden) |
| | H. Wildemann | (West Germany) |

1. Opening

A. Rolstadås opened the meeting as chairman and welcomed the participants. He gave a short retrospect for the establishment of the working group and expressed his sincere hope for a fruitful work in the group the coming years.

# Production Planning and Control in the 80ies




PREFACE

The IFIP Working Group 5.7 on "Automation of Production Planning and Control" was established in the autumn 1978. The working group addresses itself to topics as

- design of and need for new production planning and control systems taking into account new technological and market developments
- standardization of international acceptable terms and phrases
- reduction of costs through development and standardization of techniques, software, and hardware
- development of the international level of know-how

In order to accomplish its scope the working group organized its first workshop to be held in Trondheim, Norway, in September 1980. The workshop was sponsored by the International Federation for Information Processing (IFIP) and the Production Engineering Laboratory, SINTEF-NTH.

The number of participants was 24 primarily coming from the working group but supplemented with invited speakers and people outside the group.

# 1980 – Opening session

| Generation | Type of system | Decade |
|---|---|---|
| 1 | Integrated batch | 1960-ies |
| 2 | Interactive real time | 1970-ies |
| 3 | User adaption | 1980-ies |

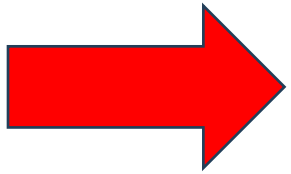
- PPC systems in the 80ies completely different
- Market conditions and dynamic environment together with new technology will require systems offering new functions based on new theory
- New ICT technology will enable strongly decentralized systems
- Development costs will be reduced by building prototypes

# From MRP to ERP

- BOMP  - Bill of Material Processor
  - Developed by Gene Thomas at IBM in the 1960-ies
  - Database containing the bill of material for all products and parts
- MRP – Material Requirements Planning
  - Uses BOMP to calculate when and how much of raw materials and purchases has to made based on sales forecasts
- MRP II – Manufacturing Resource Planning
  - Extension of MRP to include all manufacturing resources
- ERP – Enterprise Resource Planning
  - Integrated management of main business processes

# The Criticism against MRP

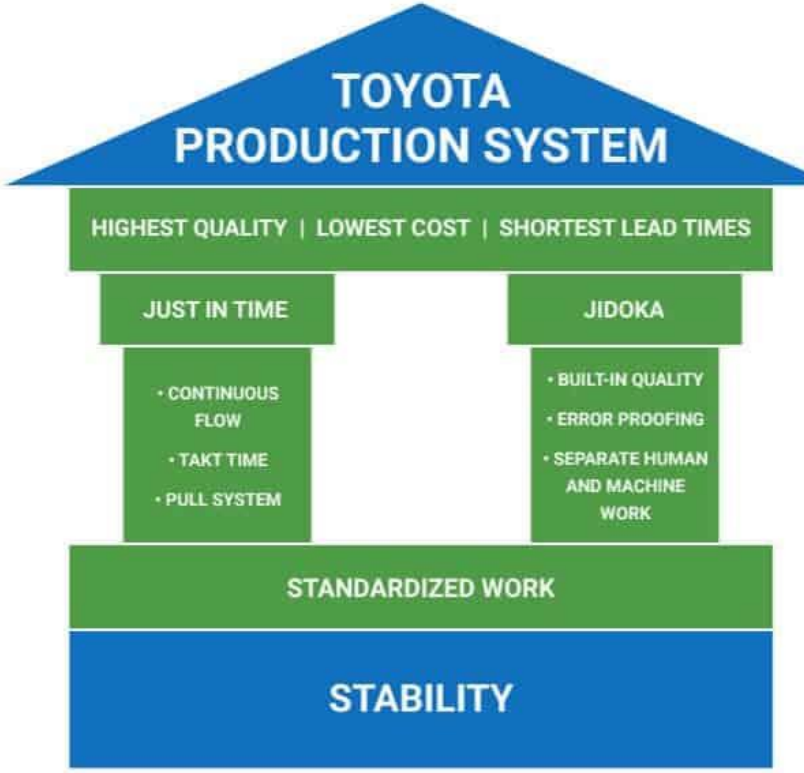
- Inaccurate sales forecasts
- Errors in BOMP
- Estimated lead times often wrong
- Inaccurate inventory level



- Large inventories
- Long throughput times

# And then ……..

- Taiichi Ono – Toyota Production system
  - Jidoka and Just in time
  - Kanban – pull rather than push
  - Heijunka and Kaizen
- MIT – The Machine that Changed the World (1990)
  - Lean production
- Eliyahu Goldratt
  - The Goal
  - Theory of constraints
  - Drum – Buffer - Rope



# IFIP WG 5.7 contributions

- Brought the advancements in industry into academia
- A forum for discussion and critical reflection
- Built a theoretical foundation in production management
- Research and education
- Conferences to exchange experience between industry and academia
- Journal for publication of research
- Built an international network

Since 1980 the group has grown from 11 to 112 members, 28 honorary members, and 41 candidate members in 2023.

# WG 5.7 Chairmen

Asbjørn Rolstadås
1978-1983

Peter Falster
1983-1989

Guy Doumeingts
1989-1995

Eero Eloranta
1995-2001

Umit Bittici
2001-2007

Marco Taisch
2007-2013

Dimitris Kiritsis
2013-2019

Gregor von Cieminski
2019 -

# WG 5.7 activities

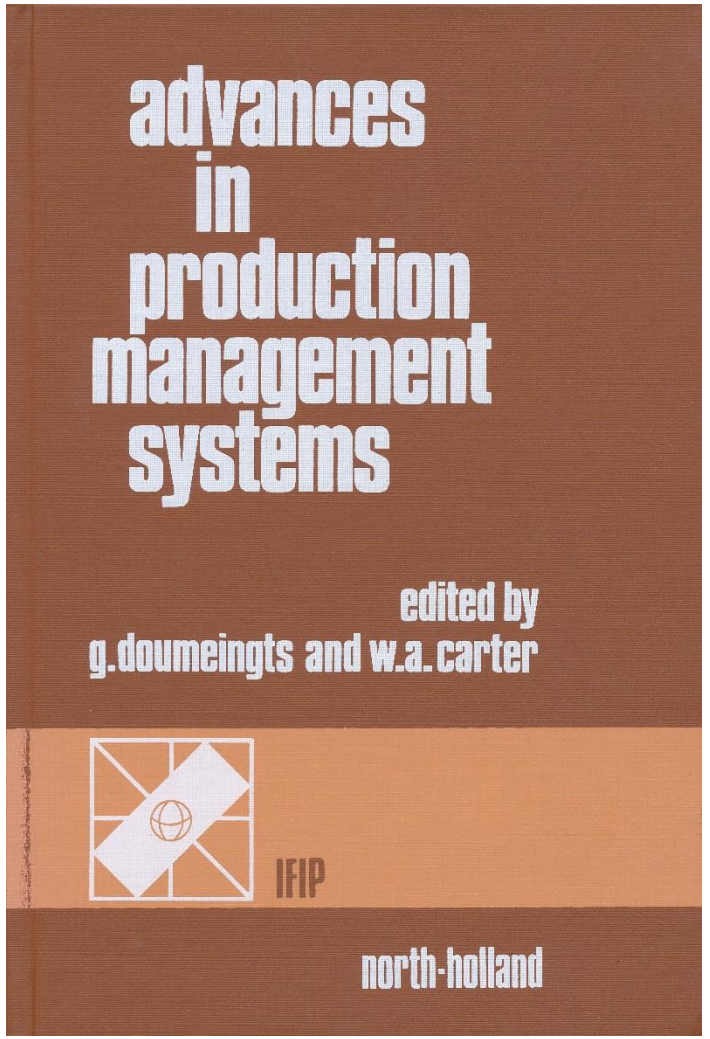
- Conferences
- IFIP state-of-the- art books
- International journal, 1989
- Joint research (FOF), 1989
- Special Interest Groups
  - Serious Games in Production Management
  - Product and Asset Lifecycle Management Service Engineering
  - Service Systems Design, Engineering and Management
  - Smart Manufacturing Systems & Cyber-Physical Production Systems
  - Lean Thinking & Practice
  - Operations Management in Engineer-to-Order Manufacturing
  - Production Management in Food Supply Chains
  - Eco-Efficient and Circular Industrial Systems

# Participants at first APMS, Bordeaux 1982

# APMS 1982 Program Committee

**INTERNATIONAL PROGRAMME COMMITTEE**

S. AUGUSTIN (Siemens A.G.) (D)
A. BUCHEL (Technische Hochschule Zürich) (CH)
W.A. CARTER (Senior Vice-President and General Manager CAM-I) (GB)
G. DOUMEINGTS (Université de Bordeaux 1) (F), Chairman of "APMS 82"
S. EILON (Imperial College of Science and Technology) (GB)
P. FALSTER (Technical University) (DK), Vice-Chairman IFIP WG 5.7
I. HAM (Pennsylvania State University) (U.S.A.)
H.C. HOFER (Hilti AG) (FL)
H. HUBNER (Institute for Advanced Studies Vienna) (A)
D. LEVY (Cisi) (F)
R.B. MAZUMDER (Brown Boveri & Cie) (CH)
E.P. MOE (Profo) (N)
M. NAPIERALA (University of Wroclaw) (PL)
N. OKINO (Hokkaido University) (J)
A. ROLSTADAS (NTH-Sintef) (N), Chairman IFIP WG 5.7
N.W. SMITH (Westinghouse Electric Corporation) (U.S.A.)
B. SVARDSON (Habberstad A/B) (S)
E. SZELKE (Hungarian Academy of Sciences) (H)
K. TAKEDA (Production Engineering Research Lab. Hitachi) (J)
P. TIMM (LK-NES) (DK)
P. URONEN (University of Oulu) (SF)
H. WILDEMAN (Indust. Betriebswirtschaftslehre zu Köln) (D)
H. YOSHIKAWA (University of Tokyo) (J)

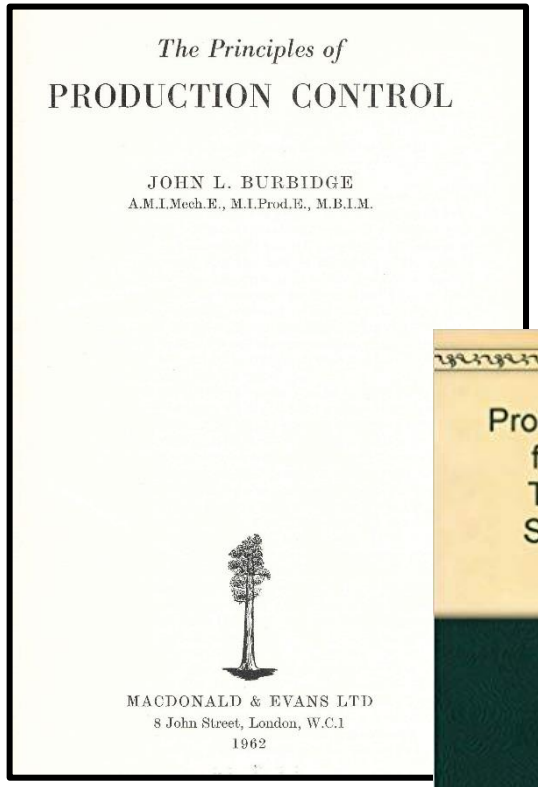


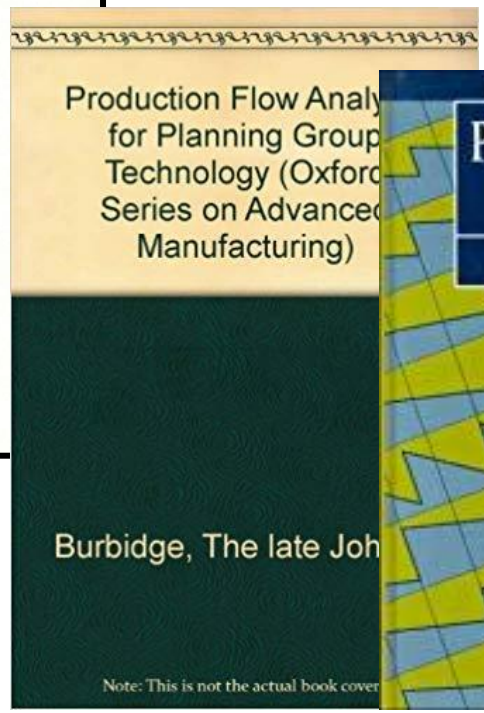
# Marco Garetti Doctoral Workshop

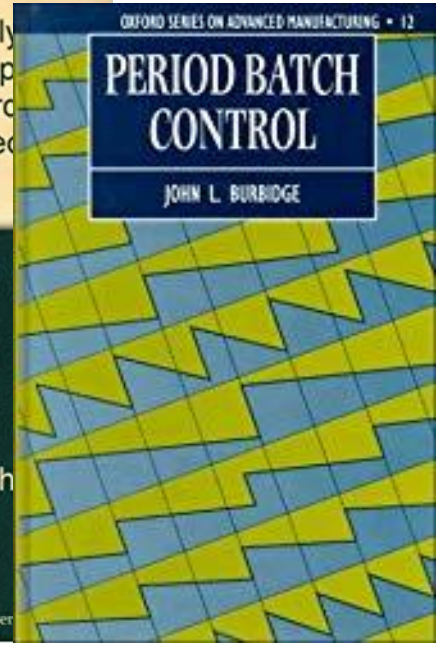
- Provides Ph.D. students with the opportunity to discuss their research and receive feedback and exchange ideas
- Ph.D. students submit a proposal up to 15 pages
- The objective of the proposals is to explain general research questions and outline the approach as well as the current status of the research.
- The texts are not published in the proceedings but can be considered for a possible submission to a journal.

# John L. Burbidge (1914-1994)

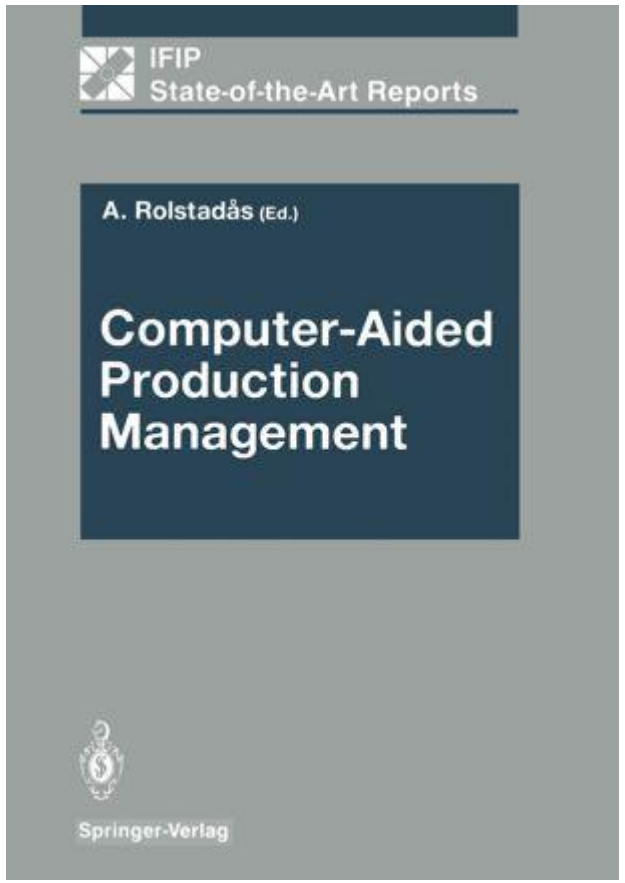
- The Principles of Production Control1962
- In strong opposition to MRP
- PFA and PBC
- Burbidge Award 1995
  - Author(s) of the best paper
  - Person(s) that made the best presentation.



# IFIP state-of-the-art books 1988



# PPC

Editor: Professor Bjørn Andersen,
Co-Editor: Dr Stephen J. Childe
Book Reviews Editor: Dr Irene Roda

Associate Editors:

- Dr Yang Cheng
- Dr Paolo Gaiardelli
- Professor Gordian Udechukwu Ojiako
- Dr Laura Purvis

From the first editorial 1989 (Asbjørn Rolstadås):

Why a new journal?

This journal is intended as a forum for all PPC-related activities, from the point of view of both academic research, and industrial application and development.

# Joint projects

Project manager Hans Wortmann

Factory of the Future: Towards an integrated theory for one-of-a-kind production

- Integration of several fragmented theories about the (re)design of production systems
- The theoretical framework consists of three views: the workflow view, the resources view, and the organizational/decisional view
- The design framework consists of a connectance network of design choices (DC's), performance indicators (PI's), and relationships between DC's and PI's.

# First Special Interest Group

## Experimental Interactive Learning in Industrial Management

At the APMS 1993, Athens, Greece, Professor Jens Ove Riis organized a workshop and exhibition of games as part of the activities of IFIP WG 5.7. This meant the birth of the idea to form a SIG in the field.

Jens Ove Riis

- First workshop at Aalborg University, 1994
- Chairpersons:
  1993-1999 Professor Jens Ove Riis at Aalborg University
  2000-2015 Professor Riitta Smeds, Aalto University
  2016- Lecturer Nick Szirbik, University of Groningen

# Co-Designing Serious Games

## 15th IFIP WG 5.7 SIG workshop, Aalto University, 2011

# Some reflections

- Unlike many of the other groups, why has WG 5.7 survived?
  - Ability to renew both with respect to membership, organization and activity
  - Need for a forum for research, publication and international cooperation
- Will it still survive?
  - Climate change effect
  - Social media visibility
  - Connection to industry
- Why is it needed?
  - A  guaranty for a high scientific standard
  - Future industry is dependent on the research and education in production management