Challenges in Control

A tribute to LIDS and Sanjoy

K. J. Åström
Department of Automatic Control
Lund University

Proceedings
IBM Scientific Computing Symposium
Control Theory and Applications

General Chairman

ROBINSON, L., Director of S
IBM Corporation, White P

Session Chairmen

SESSION I

FELLER, W., Professor, Princeton University, Princeton, New Jersey

SESSION II

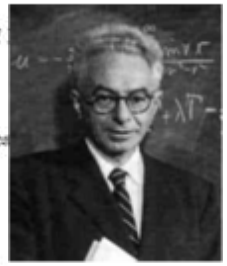
LEFSCHETZ, S., Professor, Brown University, Providence, Rhode Island

SESSION III

TRUXAL, J. G., Dean of Engineering, Polytechnic Institu
Brooklyn, New York

SESSION IV

COURANT, R., Professor Emeritus, Courant Institute of
New York University, New York, New York



SESSION V

MOSER, J., Professor, Courant Institute of Mathematics
New York University, New York, New York

Research Technical Adviser

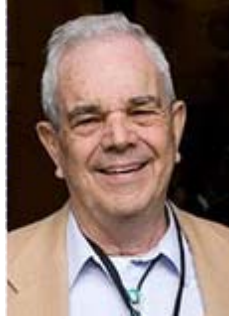
GOLDSTINE, H. H., Director of Mathematical Sciences,
Thomas J. Watson Research Center, IBM Corporation,
Yorktown Heights, New Yo

Symposium Technical Plan

COHEN, H. G., Research Staff
IBM Corporation, Yorktown

EATON, J. H., Manager, Cont
IBM Corporation, San Jose,

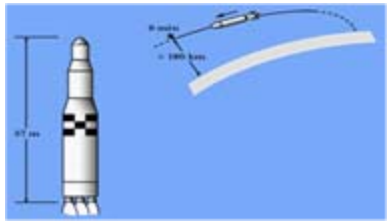
GAZIS, D. C., Thomas J. Wat
IBM Corporation, Yorktown



A Perspective

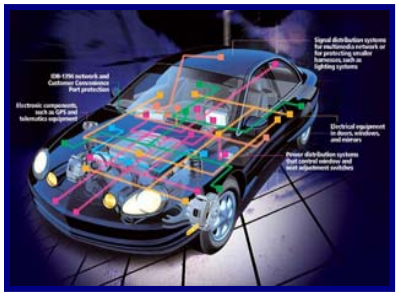
- Emergence
  - Drivers: World War II
  - Formation of the field
  - The Servomechanisms Laboratory 1940

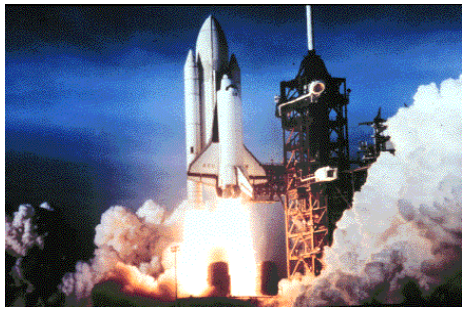
- The Second Phase
  - Drivers: Space race, computer control
  - Subspecialization: …

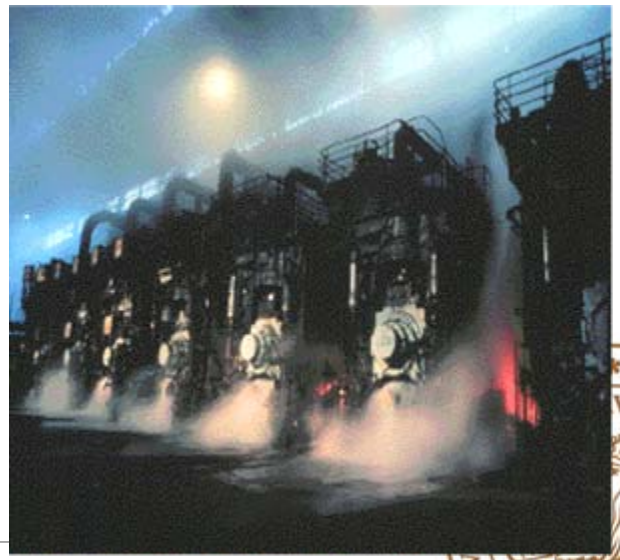


- The Third Phase?
  - Drivers: Complex networked systems,
  - Safe embedded systems
  - Autonomy
  - Recover the holistic view

Control Everywhere







The Power of Feedback

- Accurate systems from imprecise components
- Reduce effects of disturbances and component variations
- Regulate, stabilize, and shape behavior
- Drawbacks:

  Risk of Instability

  Sensor noise is fed into the system

A Third Phase?

- Drivers: embedded systems, networks, biology, physics, economy ...
- Autonomous distributed systems
- Sensor and actuator rich systems
- Provable safe design and reconfiguration
- Can the holistic view be recovered?

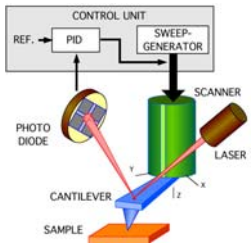
Physics

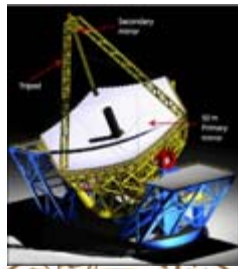
- Nobel Prizes

  Dahlén 1912

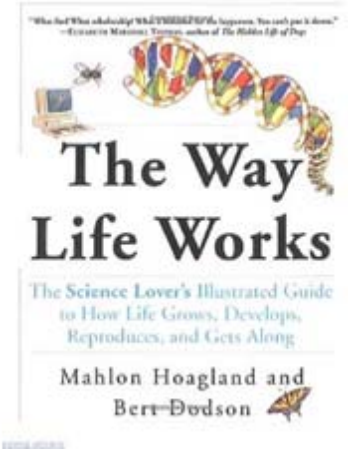
  van der Meer 1984

- Instruments mega to nano

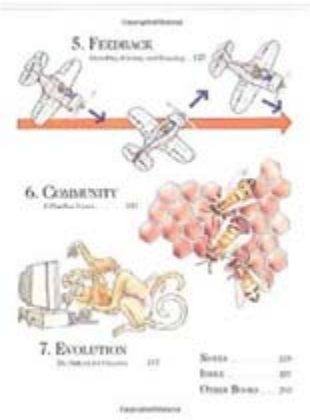




- Turbulence
- Quantum and molecular systems

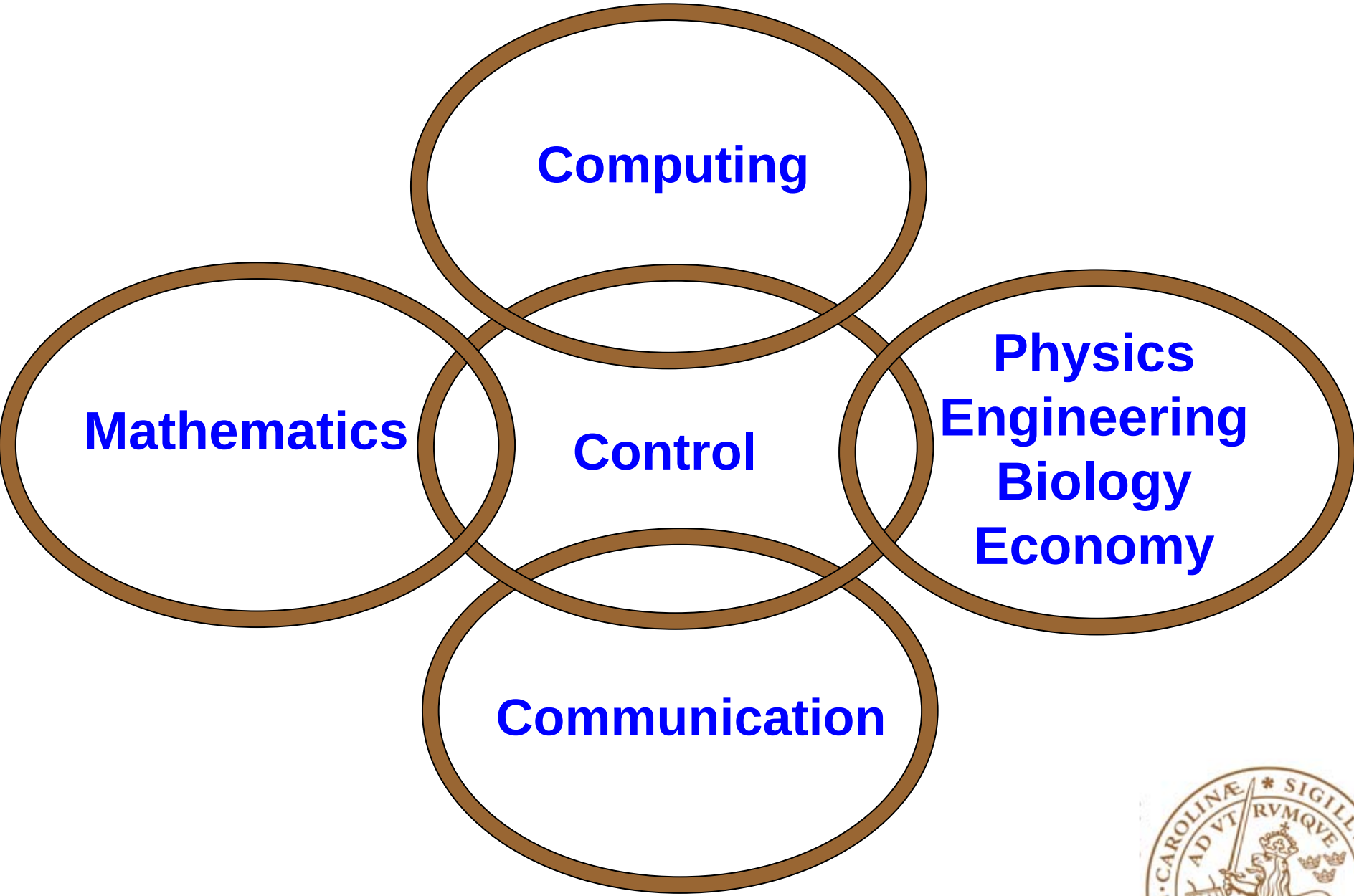


Biology



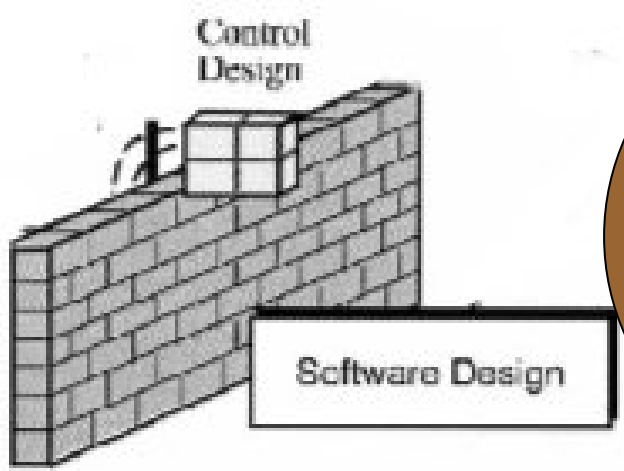
Feedback is a central feature of life. The process of feedback governs how we grow, respond to stress and challenge, and regulate factors such as body temperature, blood pressure, and cholesterol level. The mechanisms operate at every level, from the interaction of proteins in cells to the interaction of organisms in complex ecologies.

Mahlon B Hoagland and B Dodson The Way Life Works Times Books 1995


Computing
Mathematics
Control
Physics
Engineering
Biology
Economy
Communication

The CS Barrier

Control



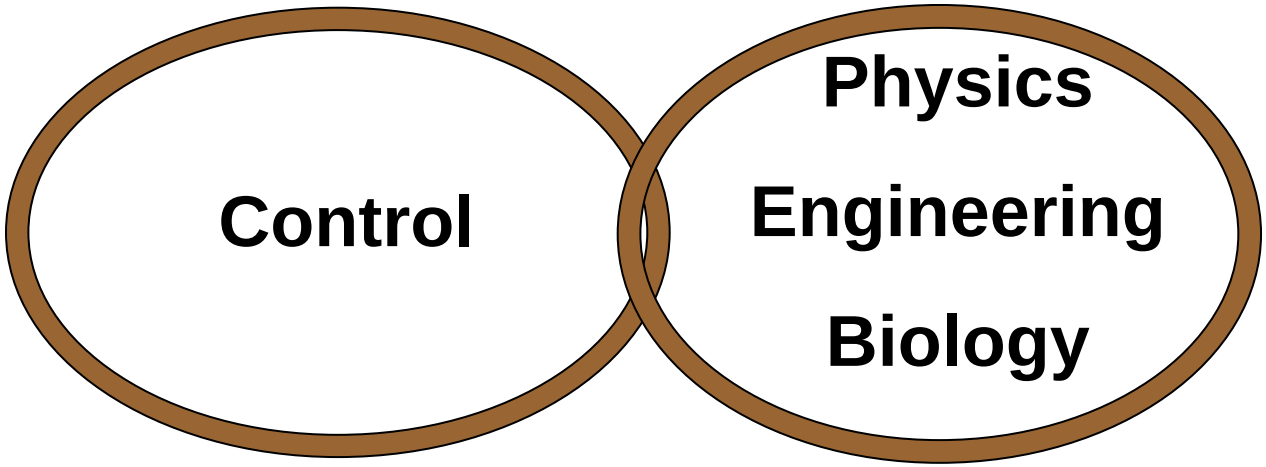
Computing

Feedback,Stability, ODE, PDE
Moderate complexity
Robustness

Logic, languages, DES,FSM
High complexity, abstractions
Architecture

The controller

The Physics Barrier

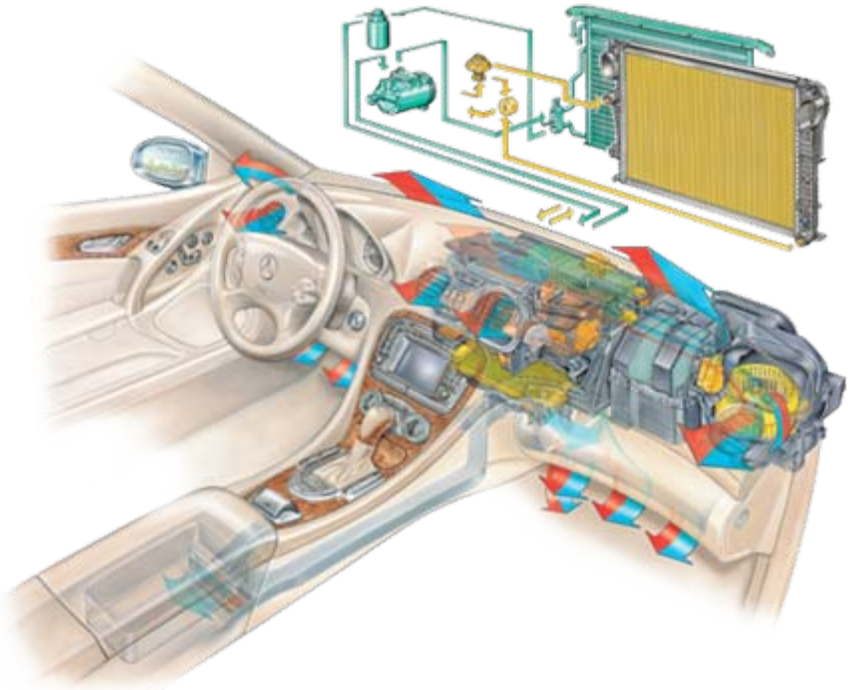


Blockdiagrams ODEs

Mass, energy, momentum

Block diagrams unsuitable for serious physical modeling

Automotive Climate Control



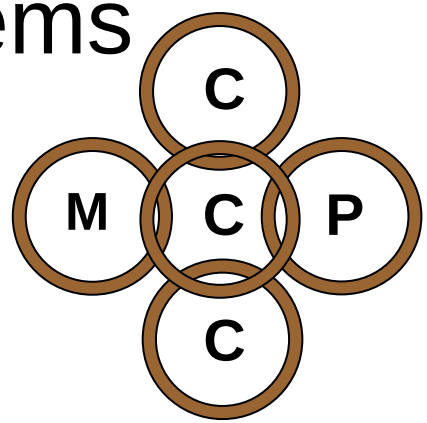
- *Audi, BMW, DaimlerCrysler, Volkswagen and their suppliers have standardized on Modelica*
- *Suppliers provide components and validated Modelica models based on the AirConditioning library from Modelon*
- *Car manufacturers evaluate complete system by simulation*
- *IP protected by extensive encryption*

Picture courtesy of Behr GmbH & Co.

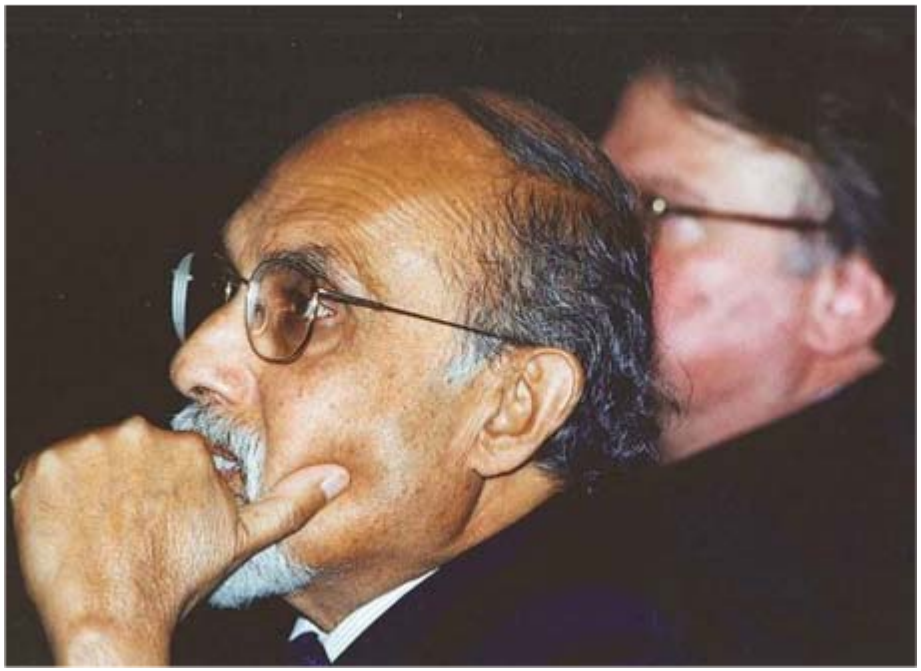
Modelon

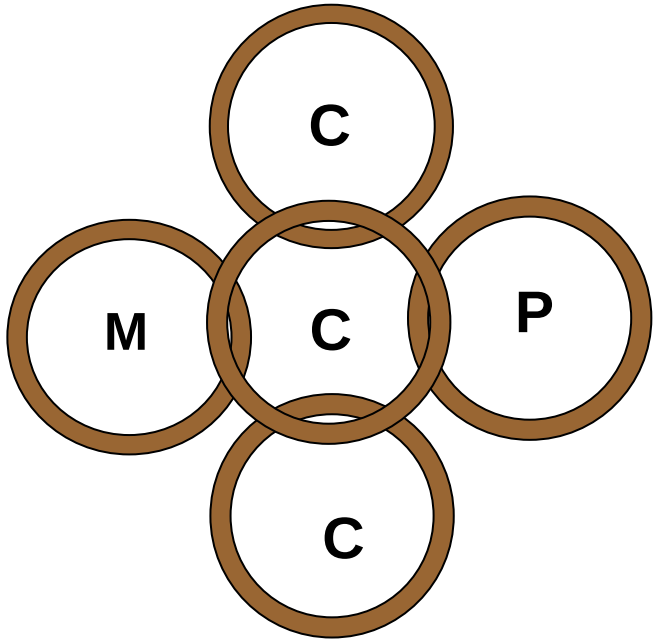
Summary

- Control is a vital dynamic field
- Networked embedded systems
- Autonomy and safety
- The educational challenge
- Recover the holistic view



Sanjoy's Half Plane





Thanks for all your contributions!
Continue to deepen insight and understanding !