Control,
Control Engineering
and
Control Science

A Motivation

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❖ Feedback – A crucial ingredient of control

Feedback is a universal principle of nature,
e.g. natural evolution, trial-and-error, greenhouse effect, ….

- Invented and intuitively applied by humans
  for purposes of control,
  i.e. **artificial feedback**

- and later discovered in nature,
  i.e. **natural feedback**.

- Often re-invented and refined by engineers
  over the last 250 years

❖ Sample Characterizations of Control

- **"Hidden Technology"** (Aström):
  Embedded in technological, biological, socio-economic and many other man-made systems

- **"Enabling Technology"**
  for numerous application areas

- **"Make things work better or sometimes even work at all"**
  (Control Professional)

- **"Use of algorithms and feedback in engineered systems**"
  (2003 Panel on Future of Control)

- **“Out of control . . . . “**
  (Title of a book)

➢ ***“Confidence may be good, but control is better“***
(Lenin)

Note different semantics
of the term “control“, when used
in technology, economy, politics or daily life

➢ **”Don’t wait for the future – control it”**

❖ Where/What ?

- Anytime - anywhere, pervasive, ubiquitous
- Daily life devices
- *HiTech* and *CleanTech* products, manufacturing, processing, traffic, transportation, agriculture ……..
- Instruments
- Human body and biology
- Society, economy, ecology, climate
- ……

❖ Why *Automatic* Control? - Benefits

- Reduce human fatigue and stress (mental and physical)
- Cope with substantial reaction times or limited strength of humans
- Assure reproducability and safety
- Increase convenience and quality of life
- Operate at the limits (economy)
- Stabilize unstable systems/processes/behaviours
- Modify natural dynamic behaviour
- Cope with uncertainties through feedback (robustness)
- .....

❖ Types of Controls ?

- Manual/human
- Automatic
- Shared
- Active/passive
- Computer/microprocessor
- Closed or open loop
- Feedback/feedforward
- Single/multiple loop
- Continuous, discontinuous, discrete/logical or hybrid
- PID or switching, on-off
- Analogue/digital
- Centralized/decentralized
- Fuzzy/neural
- Predictive/preview
- Hierarchical
- Embedded
- Adaptive
- Intelligent, cognitive
- Autonomous (perception-based)
- . . . . . .

❖ How to deal with ?

- "Understand, analyze, model, simulate the function and dynamics of the object to be controlled and work out (synthesize) appropriate (technical) means for achieving performance according to given control specifications"

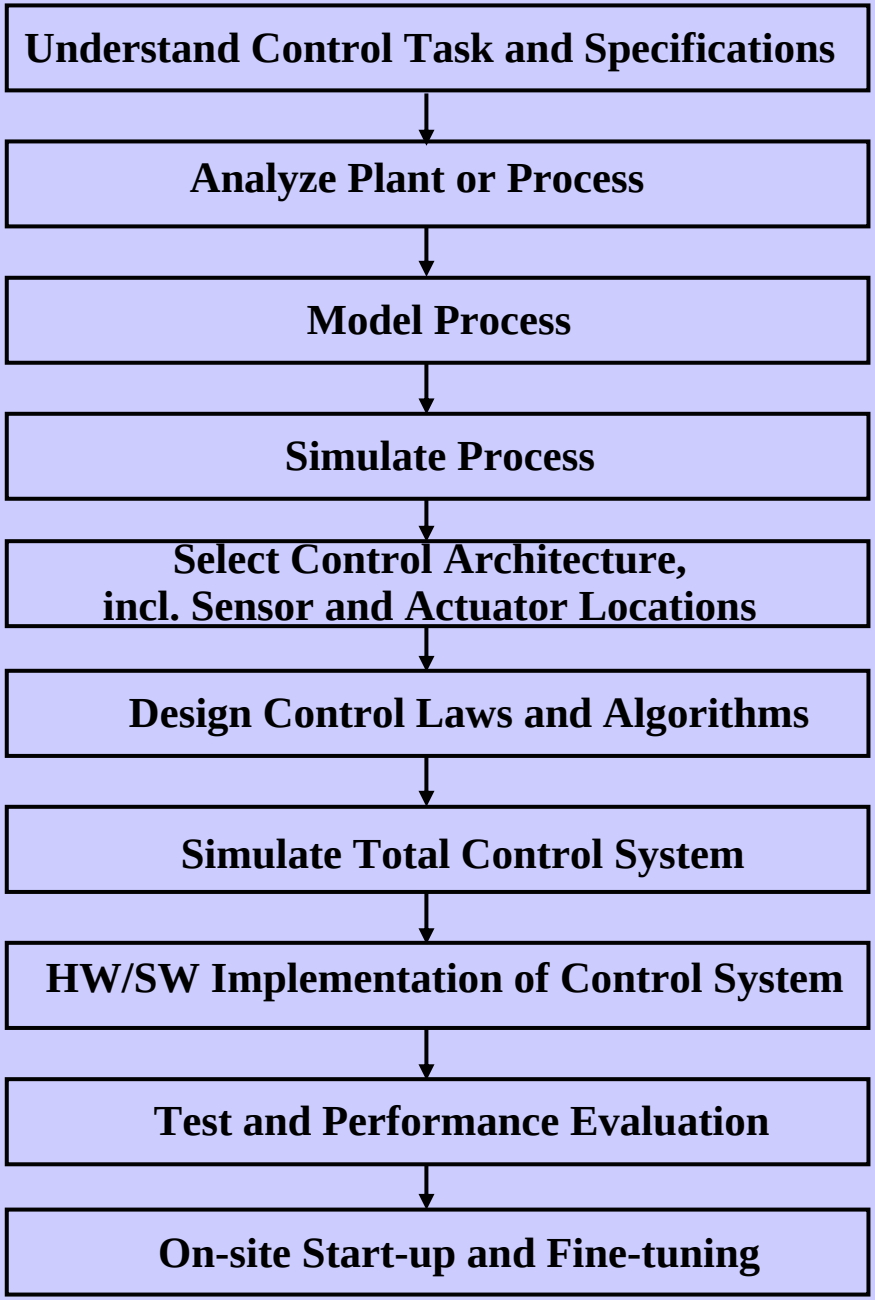
- Implementation depending on current HW & SW technology and specific requirements of application field

- Broad spectrum of standard industrial components and systems: sensors, actuators, control computers, SW packages …….

- Excellent theories, methodologies and efficient CACSD tools, e.g. *MATLAB* & code generators, available

- Methodological background for analysis and synthesis to a great extent **independent of current technology and specific application area**

❖ Steps of Control System Development



❖ Trends and Challenges ?

- Novel areas and challenges need new efforts and approaches in systems and control, automation ……
  To be discussed in more detail during this lecture series!

❖ Ultimate Objectives of this Lecture ?

- Apply systems and control ideas, concepts or techniques in your job and capitalize by adopting the ***"systems perspective"***
- Develop models, understand system dynamics and feedback
- Reduce time delays and latencies in all kinds of closed loop operations and activities for stability and better performance
- Close as many (information or feedbck) loops as possible for improved performance and higher degrees of robustness
- Team up with control experts in an early phase of a project
- Put new knowledge into action