TEACHING CONTROL PRINCIPLES TO INDUSTRY PRACTITIONERS

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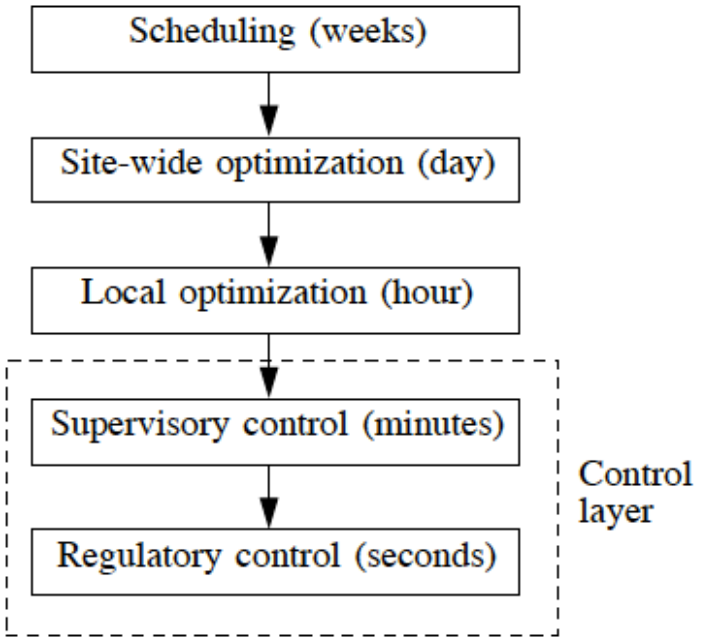
A HIERARCHIC VIEW OF PROCESS INDUSTRY

The block diagram outlines a process industrial plant from a controls perspective.

Control layer: Close connection to Physical Processes.

- Level control of buffers
- Temperature control of reactors
- Flow rate control in pipes



THE TUNING SITUATION

Many (over 95%) processes within the control layer are governed by Proportional-Integral Derivative (PID) controllers. Of these 90 % use the simpler PI controller.

Adequately tuning the controller comes down to choosing a few parameters. Still, reports repeatedly indicate poor performance.

Ender 1993
>30 % manual
> 30 % increase short term variability
≈ 25 % use factory default parameters

Bialkowski 2002
50 % work well
25 % ineffective
25 % dysfunctional

THE TUNING SITUATION II

- Poorly functioning PID control often lead to unnecessary loss of revenue.
- A process industrial plant typically contains several thousand PID controllers.
- Hiring an engineer to adequately tune one PID controller costs USD 250 – 1000 (Honeywell 2002).

Course purpose: Educate the process operators to identify poorly tuned controllers and give them the necessary tools to conduct the parameter tuning.

AUDIENCE

The intended course audience are the process operators. The situation is somewhat different from an ordinary university course.

- Some have academic background, some do not
- Generally very strong intuition and practical skills
- Used to acquire skills and knowledge through doing, rather than academic course work

RELIANCE, DISUSE AND MISUSE

Handling undesired behavior in process industry control loops often involves switching the loop to manual mode.

- Disuse: under-utilization of functional control
- Misuse: over-utilization of poorly performing control

It is not enough to optimize control performance. The interaction between automatic aid and the human operator must be considered.

INCREASED EFFICIENCY AND PERSONAL MOTIVATION

- There is often low hanging fruit; large performance gains from minor adjustments.
- It is worthwhile to teach the operators to identify some typical situations.

- An increased skill-set generally leads to better motivation.
- The fact that the company invests in the continued education of the individual employees contributes to a positive atmosphere.

COURSE GOALS

In engineering education, the challenge is normally how to incorporate practical examples in an otherwise mathematical framework.

The situation here is rather the opposite: practitioners generally have many hours of on-site experience.

Give a thorough understanding of the simple control loop

Become familiar with process types common in industry

Handle practical implementation aspects

Recap manual tuning of the PID controller and introduce alternatives

Introduce more advanced controller structures

Discuss influence of sensor and actuator placement and character-istics

METHODOLOGY

Zone of proximity. The ability to acquire knowledge and skills is strongly coupled to what one previously knows.

➔Make laboratory exercises a central part of the course.

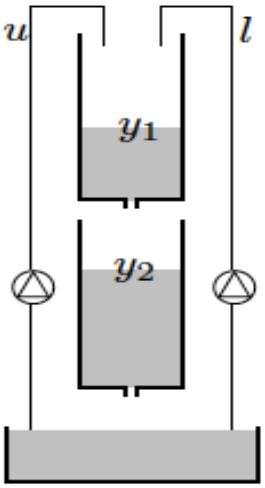
Deep versus superficial learning. Deep learning is more persistent and more easily extendable.

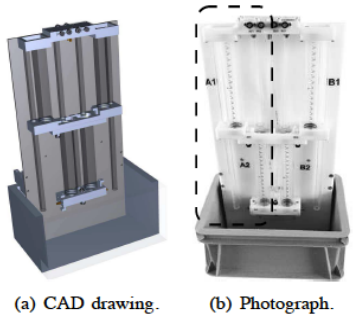
➔Practical problem focus with some material presented in standard lecture format.

PROCESS OVERVIEW

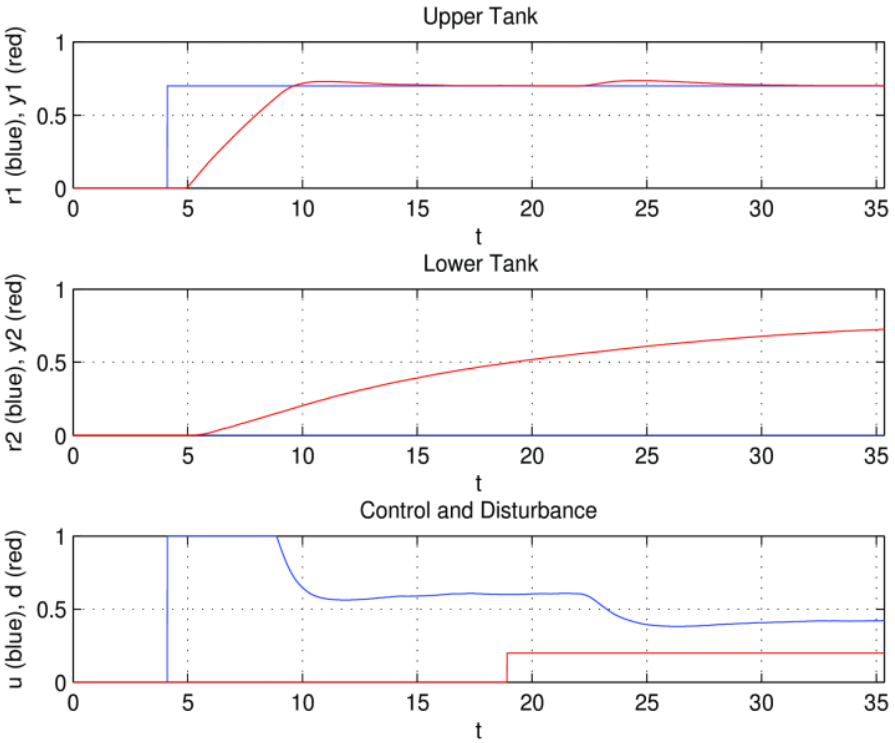
The double tank process:

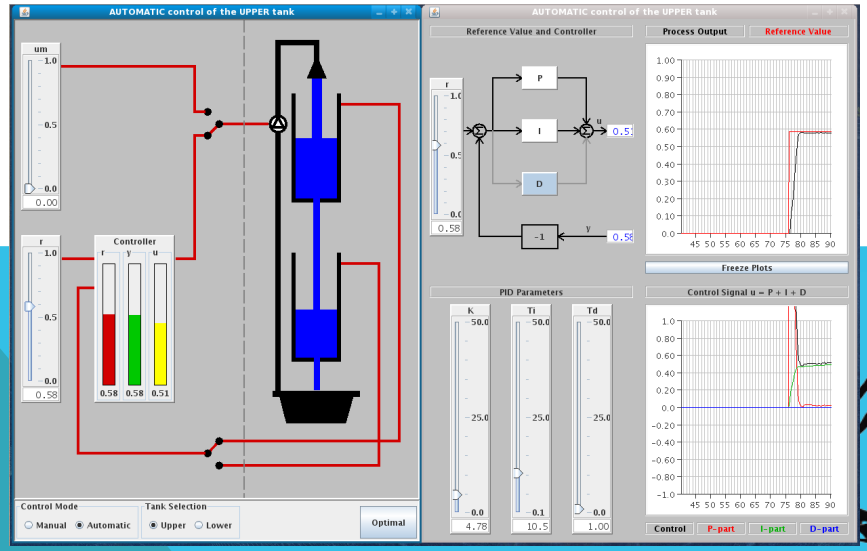
- Two tanks
- Water pump
- Level sensors





(a) CAD drawing. (b) Photograph.





MOTIVATION OF PROCESS CHOICE

- Intuitive, but not trivial, dynamics
- Suitable time scales
- Visual and audible feedback
- Easy to generate load disturbances and measurement noise
- Relevant in process industry (buffer tank)

Example of experiments

•Intuition versus model based tuning
•Disturbance feed forward
•Cascaded control loops

OUTCOME

The course has been held twice during the past two years.

Participants obtain a certificate and a copy of a relevant book (no formal examination)

Feedback from participant evaluation forms. Participants feel that the course is relevant for their work and that the format was well-suited for their professional background.

Some participants kept contact with the department and have come back with questions regarding their work.

QUESTIONS?

More information: **pic.lu.se**