Modelling and Control in Water Treatment

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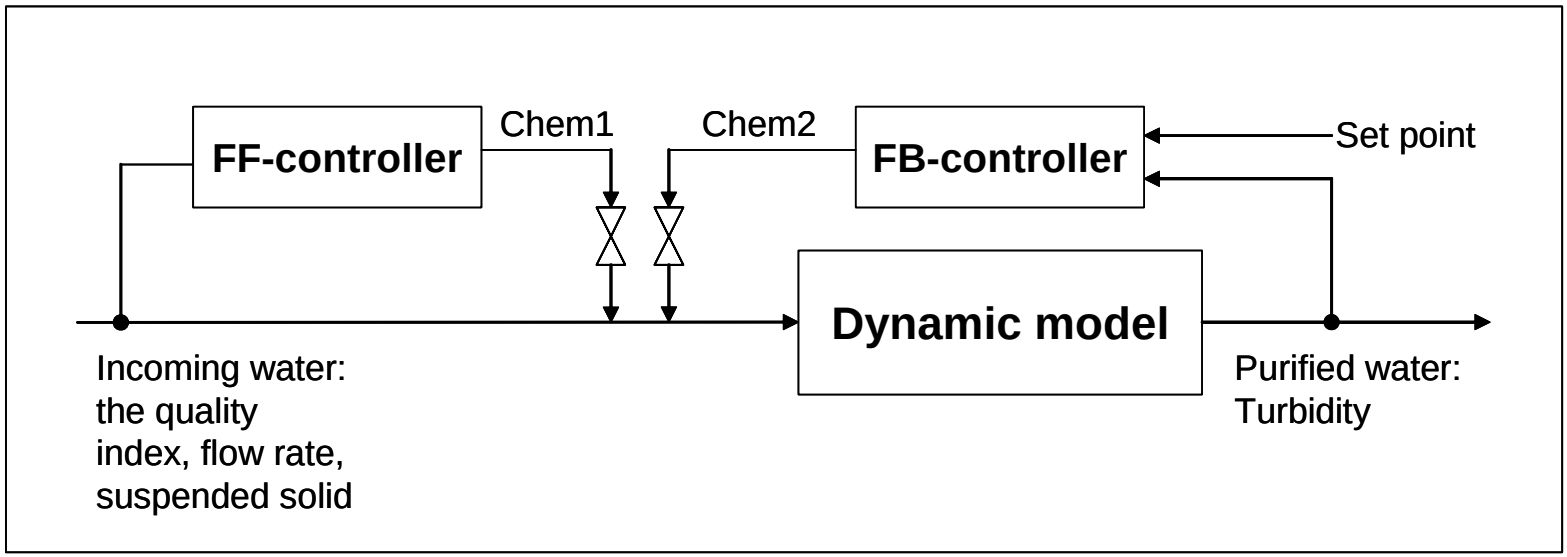
Feedforward & adaptive feedback control



- Control of flotation: a typical example of a intelligent control system
- Feedforward controller gets the system to approximately good operation
- Feedback controller makes final corrections
- Chemicals 1 1nd 2 may also have different purpose

Water Quality Indicator

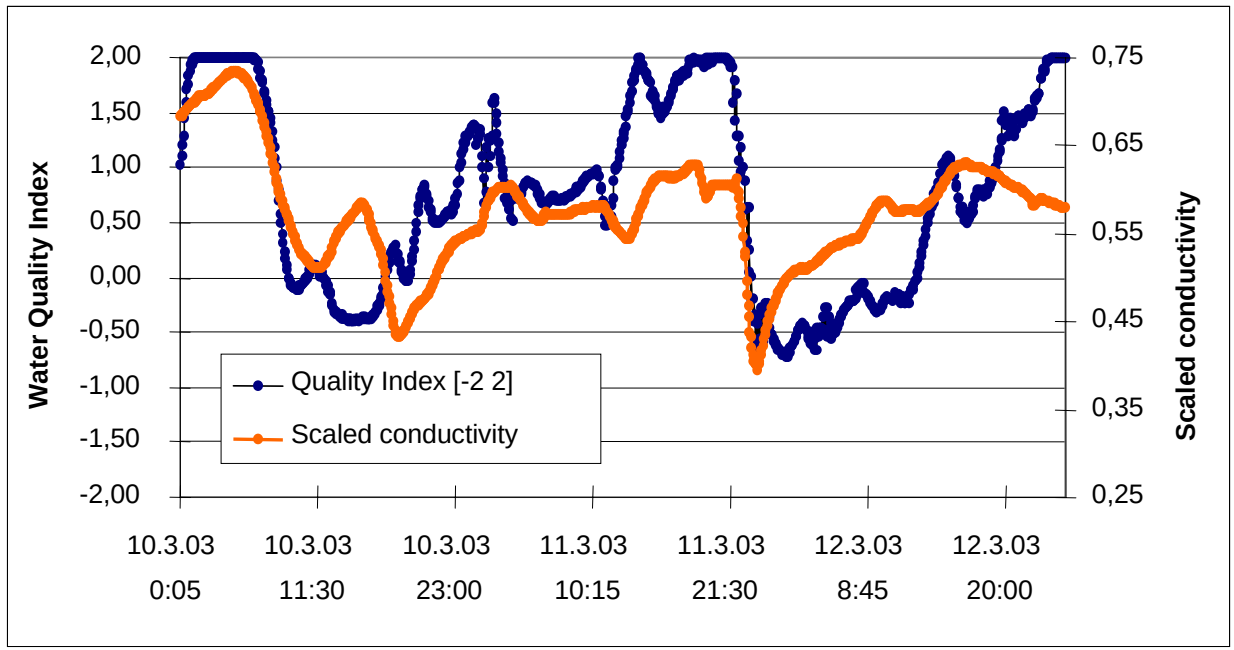
Real-time Quality Index
and Conductivity

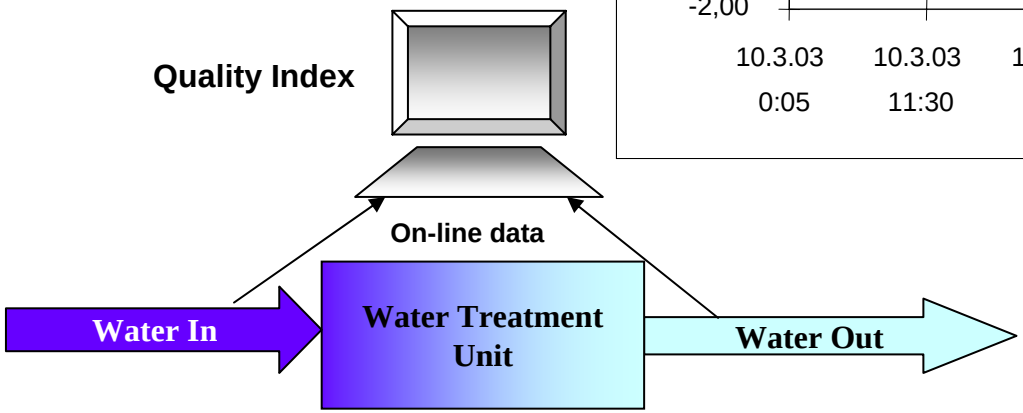
↓

Detection of process disturbances
pH control
Process chemicals

↓

Feedforward control

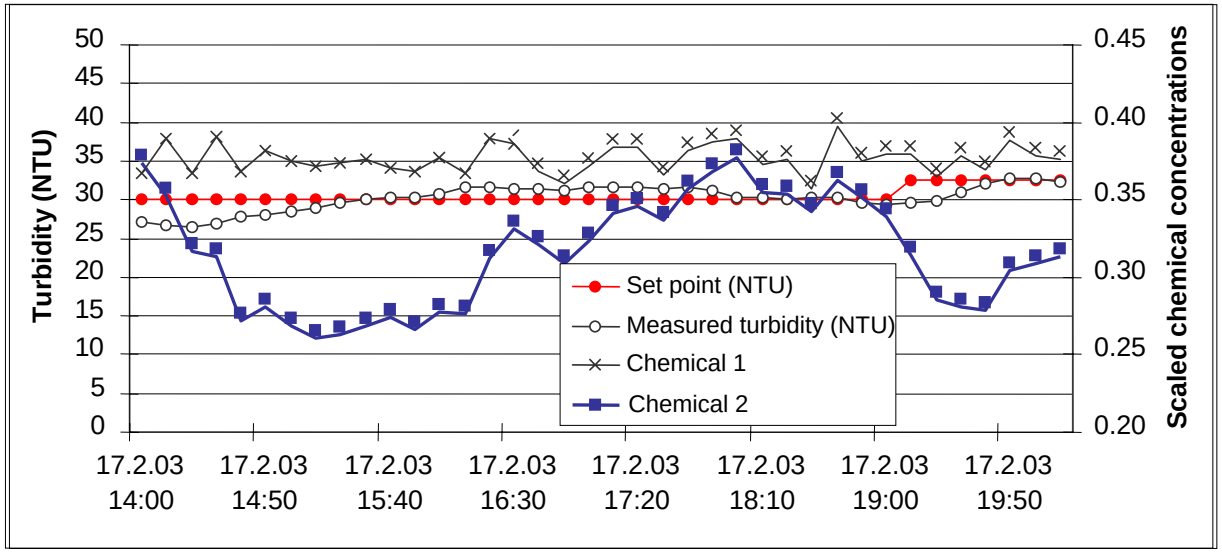


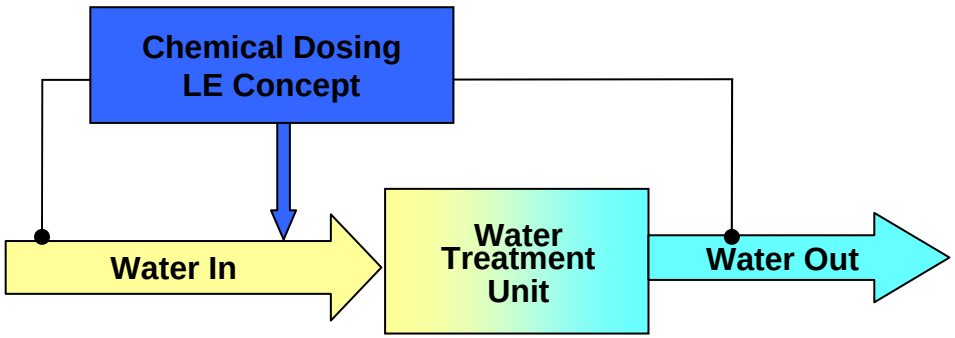


- Water quality changes quickly
- There are (expensive) analysers available to detect changes BUT they cannot detect all the changes in the reliable way.
- The water quality indicator is a robust tool for this.

Intelligent control

Experimental design
Test Campaigns
↓
Modelling
↓
Simulator:
Control Design,
Tuning
Testing
↓
Dosing Tool

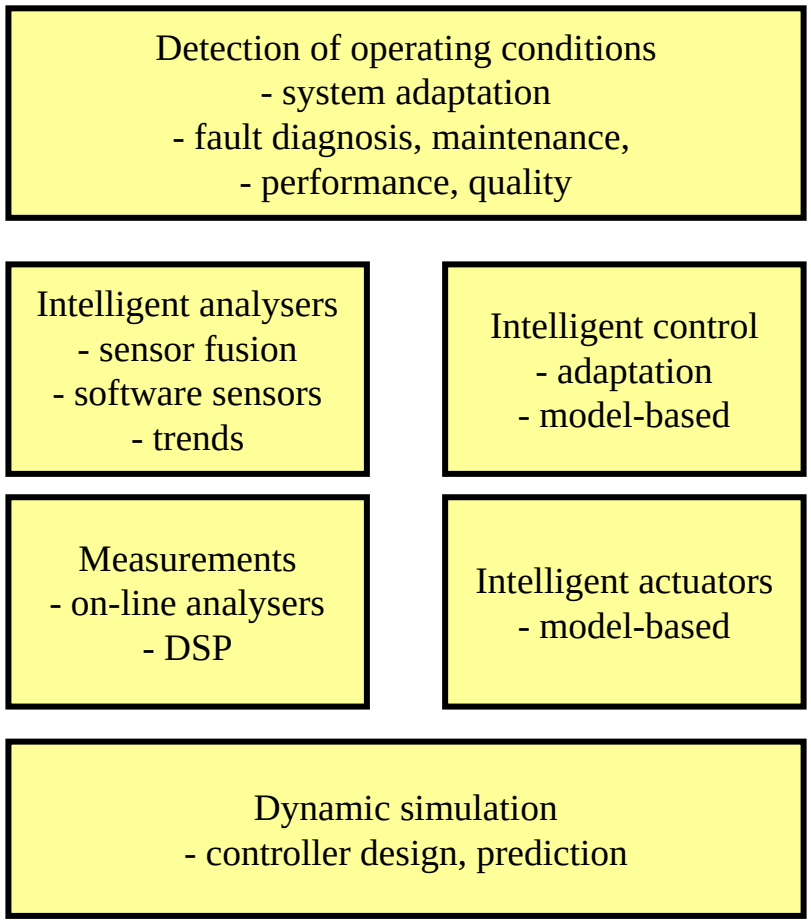




- Flotation in internal water circulation
- Fast changes in operating conditions
- The controller needs to adapt without information about the process changes
- Also for domestic/industrial/mixed waste water treatment

Functions and features

- The systems are based on functions and features, which are needed in the application.
- Methodologies and connections between subsystems can selected case by case.



-Indirect measurements and software sensors are essential parts of the systems.

-These systems are based on on-line measurements and are designed to replace laboratory measurements and/or expensive analysers.

- Differences to the steady-state or dynamic models are also used for detecting changes, e.g. water quality

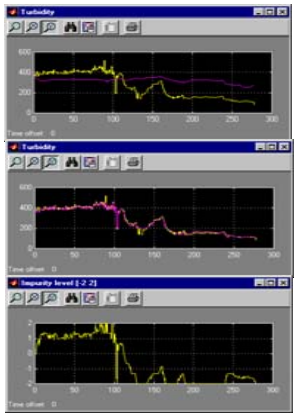
- Controllers need to be
  - nonlinear
  - multivariate
- Fast adaptation is required, e.g. in internal water circulation
- special solutions for water treatment

-Dynamic simulation models are developed first, and control and diagnosis systems are tuned with these models.

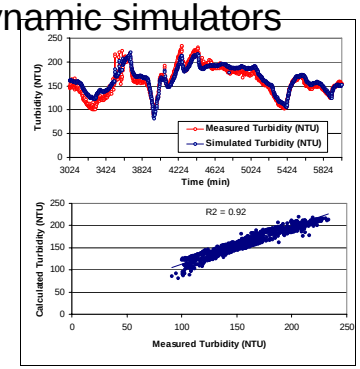
- Controllers can be connected with OPC
  - -to the simulator in the development phase and
  - to the process in use.

Functions and features

- software sensors and indicators



- Dynamic simulators



Detection of operating conditions
- system adaptation
- fault diagnosis, maintenance,
- performance, quality

Intelligent analysers
- sensor fusion
- software sensors
- trends

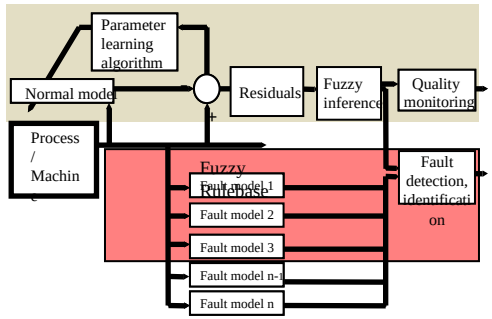
Intelligent control
- adaptation
- model-based

Measurements
- on-line analysers
- DSP

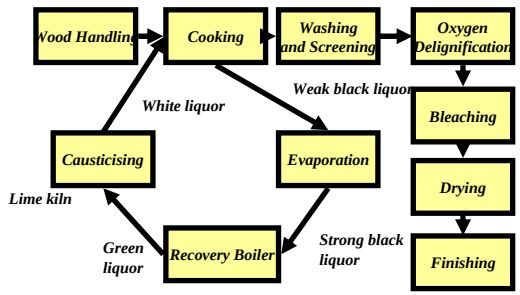
Intelligent actuators
- model-based

Dynamic simulation
- controller design, prediction

- Normal operation
- Faults



Pulp and paper industry
- chemical recovey
- internal water circulation
- waste water treatment



Control Engineering Laboratory

- Methologies:
  - control
  - intelligent methods, nature inspired systems
  - modelling and simulation
  - design of experiments
- Expertise
  - software sensors
  - intelligent control
  - detection of operating conditions
  - smart adaptive systems
- Industry
  - pulp and paper
  - metal
  - chemical
  - biotechnical
  - energy
  - ...
- Water treatment was taken as an example.
- More information: http://ntsat.oulu.fi

Co-operation possibilities

- Biological water treatment:
  - process knowledge & data-driven methodologies
- Water treatment in pulp and paper industry
  - fluctuations in the main process operation
  - laboratory analysis
  - on-line analysers
  - modelling
  - control