Seed Research Area for LCCC:
d. Process Control and Information Handling

Researchers:
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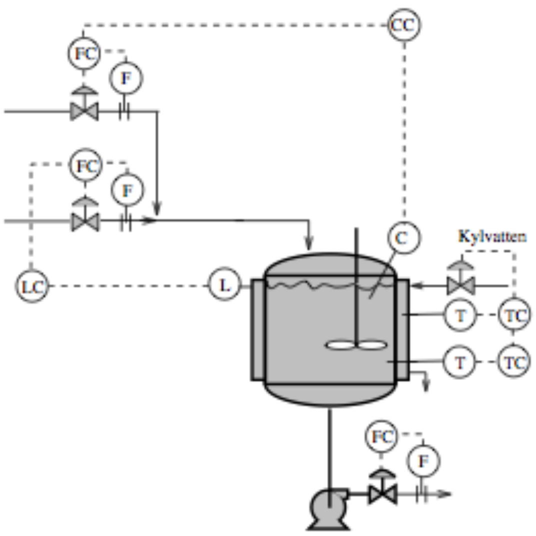
Vision: to establish a link between the two domains ”Enterprise control and operations management” and ”Automatic Control”.

Objective: To show how data from control systems used at production plats in the process industry can be transformed into more elaborated information, and to demonstrate/examine how this information can be used to control the plant from a plant-wide perspective.

Description: At production plants in the process industries there are many variables that are being monitored and controlled. A common number is to have between 1000-10 000 variables and about 100-1000 control loop at each site. Today, all variables are saved in an historical database. A dilemma is that these variables and control loops do not have their focus on the overall plant performance but rather on a local part of the plant (e.g. a control loops controlling the level in a tank or the temperature in a tank).

When designing local control loops, the common procedure is to 1) start by selecting the control-parameters and the sensors i.e., select what variable should be controlled and select how it should be measured. 2) When this is done, the manipulated-variables and the actuators are selected, 3) thereafter the control loop can be constructed and the search for an optimal set-point can start.



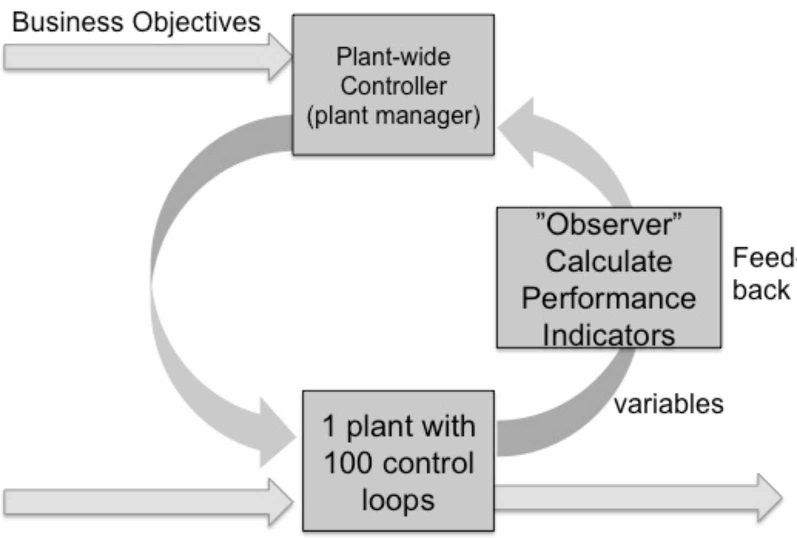
1. Control-variables and sensors.
   We would like to control the level, concentration and temperature in the tank.
2. Maniplated-variables and actuators
   Level is affected by the inletflow, concentation is affected by the inlet flow, temperature is affected by the cooling water.
3. Create control loops and find good set points.

The task in this project is to examin if a similar procedure can be applied for ”plant-wide control-loops”.

1) At the plant wide level it is difficult to directly measure a variable that indicates the plant performance, instead this is a variable that depends upon one or many measureable-variables. It is therefore a variable that is calculated rather than measured. I.e. by using the data from the control systems and historical databases (originally intended for local control) more elaborated information can be obtained. For an average site with about 1000-10 000 variables and about 100-1000 control loop, it would be reasonable to calculate about 10 performance indicators. The work of defining performance indicators will partly be an answer to the industry-wide problem of having ”poor visibility into plant operations” and to start utilizing ”the hidden resource that data is known to be”.

2) The second step consists of understanding what variables that should be manipulated in order to make a change in a performance indicator in a desired direction. At the plant-wide level, the same variable often influences many performance indicators. It is therefore of importance to have an understanding of the intricate web of variables and performance indicators, also refered to as the Vollmann decompositioning (ref). With a tool that displays the variable-performance-web, the manual work of performing the plant-wide control could be facilitated and executives could get some help in ”capturing and understanding information rapidly in order to make sound business decisions”.

3) The third and last step consists of creating the control loops, selecting control structure and finding a good set-points. This is sometimes refered to as Closed-loop enterprise control (ref). Other related industrial/academic domains are; Enterprice Manufacturing Intelligence, real-time enterprise control, operations management. Controlling the plant or the site is seen as a craftmanship where the controller (i.e., the plant manager) has a gut feeling for controlling the plant. It would be of interest trying to set up dynamical models for the Performance indicators without taking all the details of the production into account. There would probably be synergies with the LCCC-area: Modeling support for Design and verification (Topic C: Real-time simulation of Physical systems)



Step by step – more details:

1) The first step of the project will thus have the purpose of defining Performance Indicators suitable for the process industries. Today, an international standard is being developed that lists commonly used Performance Indicators. However, most of these Performance Indicators are defined in such a way that they fit the discrete manufacturing industries and not the process industries. For example; waste is defined as number of parts produced with bad quality divided per number of parts produced in total. In the process industries, the product is seldom counted as parts but measured in volume. In this first step, the research will be done in an inductive way (i.e., empirism and case studies are used to generate theory and definitions). In this step there are synergies mainly with other research done within the Process Control domain.

2) The second step of the project will have the purpose of making so called Vollman decompositionsing, i.e, graphical visualization of the connections between various performance indicator and variables. A simulation tool would be of interest where it is possible to see the effects on the performance indicators when one variable is changed. A simulation tool of this kind is also useful when examining if the Performance indicators are collaborating rather than counteracting each other. Example: assume there is one performance indicator for the production-rate and one performance indicator for time-spent-on-maintenance. If the production-rate is increased (which is considered positive), there will most probably also be an increase in the time-spent-on-maintenance (which is considered negative). In this second step research tasks in the field of distributed control enter. It would be of interest to tacle this also from an angle of distributed control. There are many persons/users that can manipulate the variables in the plant and thereby also manipulating various performance indicators. Controlling the plant can therefore be seen as a distributed control problem. An average site has about 1000-10 000 variables, about 100-1000 control loop, about 10 performance indicators and about 50 users. How could theories from distributed control be used to guide the users in the process industries so that the overall objective of controlling the plant in a good way is achieved? Example: How can one make sure that the incentives of making increases in the production-rate is larger than the incentives for reducing the time-spent-on-maintenance? In this second step the research will be done in a deductive way (start with theories in the filed of distributed control and simulation-tool-constructions, and verify that it fits). There are synergies with both ”Distributed decision making and control” and ”Modeling support for Design and Verification”

3) There could be synergies with the LCCC-area: Modeling support for Design and Verification (Topic C: Real-time simulation of Physical systems) and ”Distributed decision making and control”

Success stories for 2013:

Indicators of success would e.g., be to have a PhD student working in this field, to get separate funding from another source than LCCC.

Collaborations and Synergies with other LCCC research domains:

There is potentials for collaborations and synergies with the two domains ”Distributed decision making and Control” and ”Modelling support for design and verification”.

Value created: A starting-point for a new research domain within Automatic Control in Lund.

Publication strategy: The aim is to generate 1-2 article or journal papers per year. However, this is a relatively new domain and there are no journals/conferences dedicated to this specific area. This makes it harder to get articles and journal papers accepted.

References:

- Metric that Matters: Uncovering KPIs that Justify Operational Improvements: MESA International (Manufacturing Enterprise Solution Association), april 2007.
- ISO 22400-2 Key Performance Indicators for Manufacturing Operations Management (draft), 2011
- Hill and Smith. ISA Expo 2009, Enterprise integration track. Reliant center, Houston, TX, USA, 2009.

Publications 2009-2011:

- Charlotta Johnsson “Implementation Strategy for an EBR-solution”, ISA Expo 2009, Houston October 2009.
- Charlotta Johnsson “Graphical Languages for Production Control”, Book chapter in “New Trends in Technologies, 978-953-7619-X-X” Sciyo, 2010.

Other reports and publications:

- Charlotta Johnsson, Course material to the new course “Market driven systems”, 2010 and 2011.
- Mohamed Hamid, “Lean Production -Identify essential KPIs in a medical production process and design of an interface for visualization”, Master Thesis, 2011.

Related reports written by students as part of the courses TSS (Technology, Strategies and Structures) or MDS (Market-driven Systems):

- “Green Performance Indicators: Adding the environmental perspective”, Report 2009
- “Quantifying the Benefits of a Manufacturing Execution System Implementation: A Case Study of a Steel Production Plant”, Report 2009
- “Measure like you mean it, the unilever water index”, Report 2011
- “A closer look at Alfa-Laval’s OEE (Overall Equipment Effectivness) system”, report 2011
- KPIs for Production at TetraPak Processing”, report 2011.

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