FUDIPO

Future Directions of Production Planning and Optimized Energy and Process Industries

Start date	1st October 2016
Duration	48 months
Budget	5,740,676.25 €
Coordinator	Prof.Erik Dahlquist, MDH

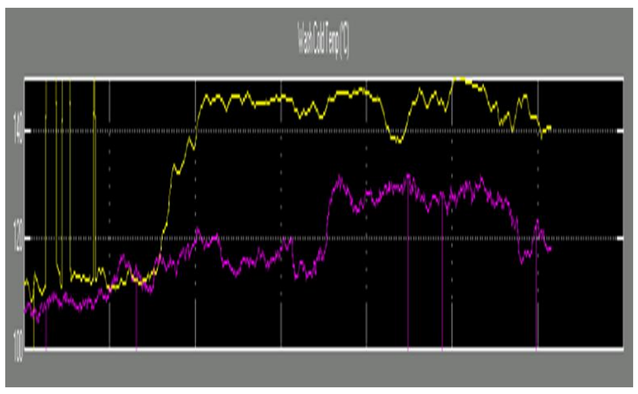
FUDIPO project aims to develop an integrated set of **methods combining mathematical modelling and simulation to optimize all the processes in a factory or technology from an holistic point of view**. The applications will be for both improvements of existing processes of a factory or technology as well as for developments of totally new production system solutions, where experience from existing processes is gathered in the simulation models. These models will be tested in 5 pilot and full-scale facilities: Micro and large heat and power plant, in a process of pulp and paper plant, oil refinery plant, and biological waste-water treatment plant.

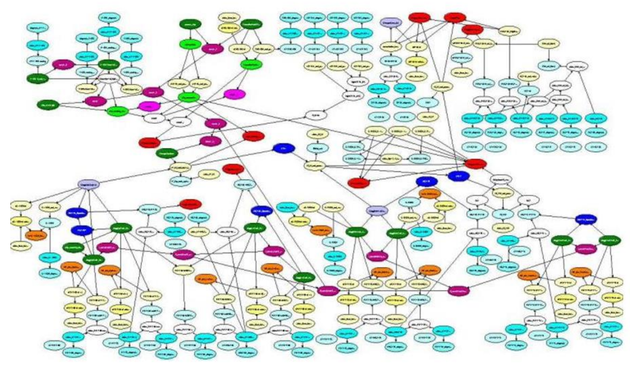
MODELLING APPROACH

The structure of FUDIPO is to **use models for single units in a plant, and from these build blocks for departments and then integrate these into a model for the complete entity.** Physical models (thermodynamic, mechanical) of equipment will be combined with blocks containing functions such as diagnostics, model based control, adaptation algorithms etc, to be updated with process measurements after analysis.

The **normal data relate to normal process variations while "exceptional data" are due to different kind of process or sensor faults. Tools for this separation and analysis is developed in FUDIPO.** From this, both process performance and data reconciliation is achieved. Overall production planning will also made and optimization from constraints like priorization of order delivery depending on situation in different plants in a corporation, and the situation in different parts of each plant. The points are sent to the departments and from here to the separate production units in a synchronized way. This is a **multivariable predictive control using models**. Statistical models are developed from process data plus lab data.

FUDIPO will develop a tool for diagnostics of separate process parts performance and sensor status. By operataing separate simulation models for the parts and comparing predicted data to measured, trends on variations that are used for the diagnostic can be obtained. This deviation together with other signals are sent to a causality tree e.g. a **Bayesian Network (BN**) where probability for different faults is determined. The probability tree is updated with new data after verification of different faults by operators. This diagnostic system is developed into a decision support system.





Example of BN used for fault diagnostics

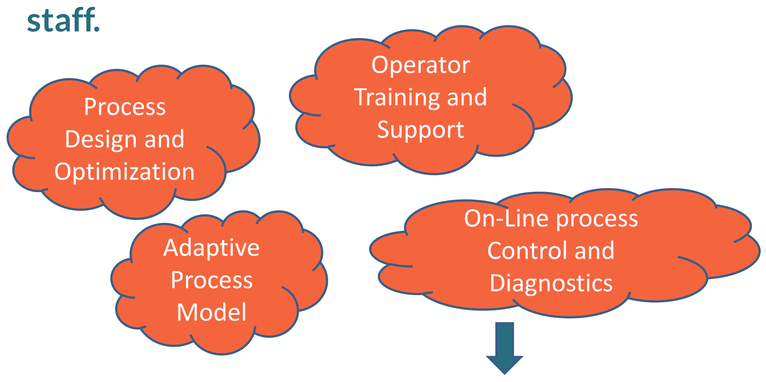
IMPUT TO THE MODEL

Data reconciliation utilizes that different parts of the plant are interacting physically and using this to determine **most probable parameter values with respect to both material and energy balances.** Through this more reliable inputs are obtained.

This is possible thanks to **soft sensors (Thermo Optical Measurement, TOM from Fraunhofer; Radio Frequency, RF from MDH and Bestwood; and Near InfraRed reflectance spectroscopy, NIR from MDH and Bestwood)** as a complement to process measurements to get faster prediciton of quality properties of the final products before it is too late to react.

UPDATING THE MODEL

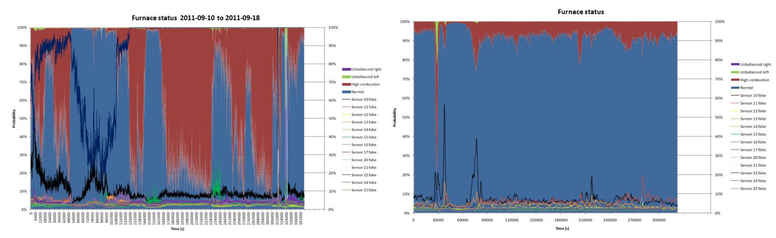
The models need continuous updating to follow process changes as well as learning from experience. The feedback is done automatically, as well as from **operators and maintenance staff.**



Control system set-points adjusted to co-ordinate PIDs and production planning

MODEL OUTPUT - INTERACTION

To make this system possible, a **communication between the system and the users, operators, maintenance staff, planners, managers etc is needed.** This is addressed and accomplished as several companies involved in FUDIPO as Tieto and ABB have expertise in this field.



This figure is an example of problems with combustión in ciclones to the left (a lot of red showing approximately 90% probability) while normal operation to the rigth (almost zero probability for a fault) illustrated in an easy way to undersatnd for the operators. Probability determined by BN

IMPLEMENTATION AND VALIDATION

The learning system (toolbox) concept will be developed by FUDIPO partners and implemented/demonstrated in individual full-scale case studies up to TRL 6.

Process Models:
- Oil and Gas
- Pulp and Paper
- Biological WWT
- CHP

Big Data Analytics

Learning System

- Compare process model expecifications to on-line measurements
- Feed signatures (deviations) to "learning system" for Continuous Knowledge Improvement

Normal degradation: Adapt process models, Use for on-line control and optimization

Abnormal trends (faults): Use information for process and sensor diagnostics

Concurrent Engineering: Design Process modifications coupled to control

Maintenance on Demand and Production Planning

Plant-wide Model-Based Predictive Control (MPC)

THE FUNCTIONS TO IMPLEMENT ARE DISCUSSED AND EVALUATED IN FUDIPO WORK PACKAGE 2 (WP LEADER: RISE SICS). To get more information please e-mail to: blerim.emruli@sics.se

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