ICA and optimization in sewer, WRRF and river at Waterschap De Dommel – A strategic decision with impact on several fronts

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This contribution presents an overview of recent developments as well as current and future work in process optimization and ICA at Waterschap De Dommel. Before going into the 'technical issues', the context is described. After introducing the Waterschap tasks and goals, it describes the water quality goals derived from legislation and other objectives that have been and are driving improvement of WRRF plant performance. Then it sketches how the decision to invest in innovation in several projects and developments via a large, integrated innovation project Kallisto led to cost-effective solutions and has an impact on several fronts. Then several ICA aspects are presented, starting with existing examples of process control at several WRRF's and recent and ongoing projects in Kallisto, then reflecting and sharing some experience with Instrumentation, followed by several issues of process information and automation.

Waterschap De Dommel is the regional authority responsible for water management of the Dommel river basin in the of south-eastern part of the province of Brabant, The Netherlands. The working area is approx. 1.540 km^2 with near 1 million inhabitants. Tasks include river quantity and quality management, flood protection, river restoration, sewage transport and treatment. Goals have been defined for water quality and ecology, energy and circularity as well as expediency. In the EU, an initial driving force for plant retrofit and control was the Urban Water Directive, requiring effluent limits of typically N=10 and P=1 mg/l (depending on the situation). This initiated R&D in several western-European countries like Germany, Scandinavian countries and The Netherlands, where the level of control since then has advanced and ammonia based DO control is now routinely used for larger plants. Later, the Water Framework Directive led to higher ambition for nutrient levels in several places requiring higher plant performance thus stimulating more advanced control schemes. In addition, objectives were often set for energy efficiency. More recently, circularity and biobased economy have become additional drivers, leading to frame treatment plants to WRRF's. The product specs that will have to be met simultaneously with effluent standards will initiate an additional need for process control

To achieve these goals, at De Dommel it has been decided to invest in innovation as well as in cooperation. Several projects were started, such as the MORE project with Gent University on Model-based optimization, a PhD project on interactions in between sewer and treatment plant with TU Delft and sewer monitoring with the municipalities. The idea behind this is the adagium 'More brains and bytes, less concrete and money', where data and models are applied to build knowledge how to optimize the overall system with control and with minimal, cost-effective additional investments.

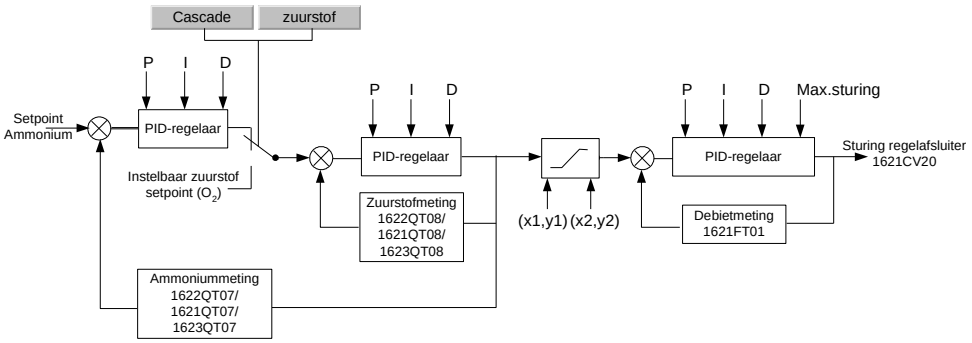

Figure 1. Cascade ammonia control Eindhoven WRRF

For **control** of effluent nutrients, typically ammonia based DO control is applied, often complemented with nitrate control. Figure 1 gives the Eindhoven WRRF ammonia control scheme. The most important other loops will be presented. For the WFD, for several plants more stringent performance have been set for N as well as P. Additional control loops for ortho-P have been implemented in combination with chemical dosing for P-removal, leading to improved process performance. In the Kallisto project, the objective was to find cost/effective solutions to mitigate urban water system impact during peak events to meet WFD objectives for ecology. Therefore, an integrated approach was applied, considering the system as a whole (sewer, WRRF and river) and considering control and investment measures. This has led to a cost effective set of measures, consisting of control measures in the sewer and at the WRRF together with investment measures aiming at reducing DO dips by effluent and in/river aeration. Recently control systems for ammonia peak shaving, RBT control and Smart buffer control, have been implemented and evaluated. The aeration systems will delivered this summer and their control will aim at reducing DO dips in the river.

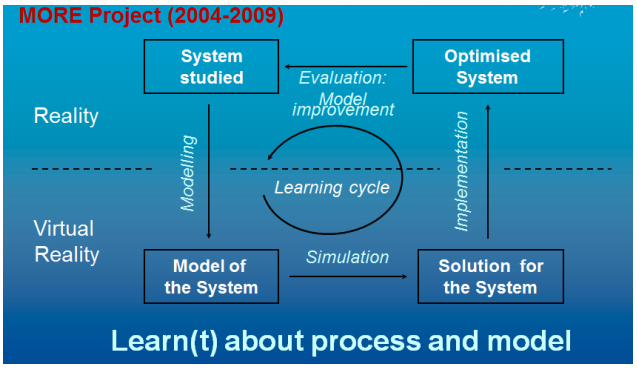

Figure 2. Learning cycle in the MORE project

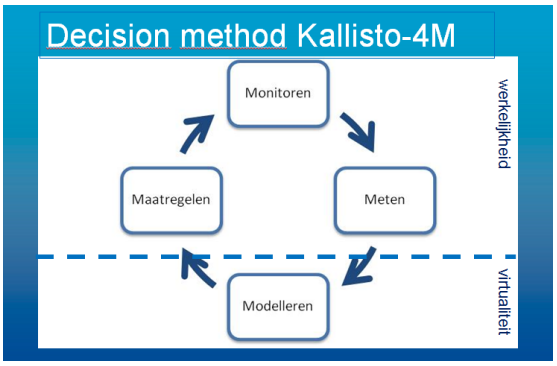

Figure 3. Policy cycle in Kallisto: The vision of creating a learning cycle through repeated model application incorporated in the policy cycle.

Over the past 10 years, several developments in **instrumentation** are illustrated. In 2007, we have started to implement and facilitate in-sewer quantity monitoring, for model calibration (for strategic decisions) as well as for learning system behavior (for operations). Influent monitoring was started at Eindhoven to learn about dynamics of COD (S::CAN), NH_4 and PO_4 (first Evita, later Hach-Lange). Different measurement set-ups have been tested, ultimately leading to useful set-ups. Currently we are applying ABB filter tubes to enable low-maintance NH_4 influent measurement and in-situ influent

conductivity and turbidity measurements, both to be used in advanced nutrient control next year. In the river system, a DO and ammonia network has been implemented to monitor the effect of peak events and their impact on ecology .

In process **automation** and information, several aspects are addressed. Data validation to obtain high-yield, timely and correct data is important so we are working towards implementing on-line validation tools in combination with optimizing sensor supervision and maintenance. For process automation software, a standard has been developed that allows consistent, vendor-independent software set-up and look-and feel. Security and cooperation with office automation is enhanced by virtualization of SCADA systems with VMWare. Recently, dashboards heave been developed to present accurate end actual process performance and financial information for management on the tactical plant level. Finally, a vision on process automation and information is being developed in cooperation with the other waterboards in Brabant, with the aim to have a shared view on the future.

For the near **future**, optimization of the Energy factory Tilburg is planned. A project will be started for model based optimization of this plant. Here, several objectives will have to be met, such as effluent quality, economics (such as biogas production) and sustainablilty. Other areas to be explored and developed are data–science (for e.g. data validation and maintenance), IoT, development and implementation of the vision that has the potential to strongly improve overall operational excellence.

BIO

Stefan Weijers is process manager for policy and innovation of wastewater systems and HR manager for wastewater engineers at Waterboard De Dommel in Boxtel, The Netherlands. In 1987, he graduated (cum laude) at the Wageningen Agricultural University as a Bioprocess Engineer. After his studies, in 1988 served the army in the School of the Military Intelligence Service as scientific translator Russian. In 1990, he started as environmental consultant at TAUW Infra Consult in Deventer. Then he joined TNO-TPD as a process control engineer. In 1994, he became assistant professor in Systems and Control at the Faculty of Applied Physics, Eindhoven University of Technology. He finished a PhD in Systems and Control in 2000 on modelling and control of activated sludge plants for enhanced nutrient removal. In this year, he became senior consultant innovation with the Common Technological Service of four waterboards in the southern part of The Netherlands. In 2004 he joined Waterboard De Dommel as consultant strategic policy where he became process manager in 2006. His interests and professional areas are innovation, leadership, wastewater treatment, (urban)water management and climate adaptation, water quality, process modelling, monitoring and optimization, ICA, sustainability and circularity.