SIMPLE INTERFACES FOR COMPLEX
WASTEWATER TREATMENT SIMULATORS

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1.0   INTRODUCTION

Gold Coast Water, in conjunction with UQ have developed a suite of modelling tools for dynamic simulation of their wastewater treatment plants. One end-application of these models is that they can be used to support operators as a training tool. It is not possible for operators to use the modelling software directly since is it orientated towards construction and solution of the model, whereas an operator interface is designed towards process control and monitoring. One option is to develop the model, and use a completely independent interface developed using application programming interfaces (APIs). In this way, key outputs and controls can be accessed and displayed in a similar manner to that which is displayed on a plants SCADA system, and much of the models complexity is hidden, providing a realistic, but accessible simulator, suitable for operators to use.

In this paper, we address interfacing of a Gold Coast Treatment Plant, which has classically been difficult to operate, due to highly variable loading, strict license limits and a substantial contribution from industrial sources. The complex underlying model was developed in the simulation package WEST, and the interface developed using Visual Basic. Key design elements of the interface mimic the actual Citect interface and include dynamic aerator control, scalable dynamic trending and stop and start buttons. Different input scenarios can be chosen to represent unusual operational conditions

2.0   PROCESS AND MODEL

2.1   Process Description and Model

The current Beenleigh wastewater treatment plant is a Bio-Denipho type design, however it is currently operated with the two ditches in series (as opposed to parallel). The first ditch, which is preceded by an anaerobic zone, is operated largely aerobically and is aerated by brush surface aerators. The second ditch is predominantly an anoxic fraction. Beenleigh is designed for a load of 60,000 person equivalents and currently operates at approximately 90% capacity.

The Beenleigh WWTP has been successfully modeled using the WEST[6] modeling software (developed by MostForWater, formerly Hemmis). The current version of the model is based on the ASM2D standard and includes phosphorus removal.

The WEST model of the Beenleigh plant was developed in 2006 by Michael Burns (GCW) and Damien Batstone (UQ). For the purpose of the modeling, the two ditches have been divided into sub-units, these are shown in figure 1 which also shows the flows

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[6] WORLD WIDE ENGINE FOR SIMULATION, TRAINING AND AUTOMATION
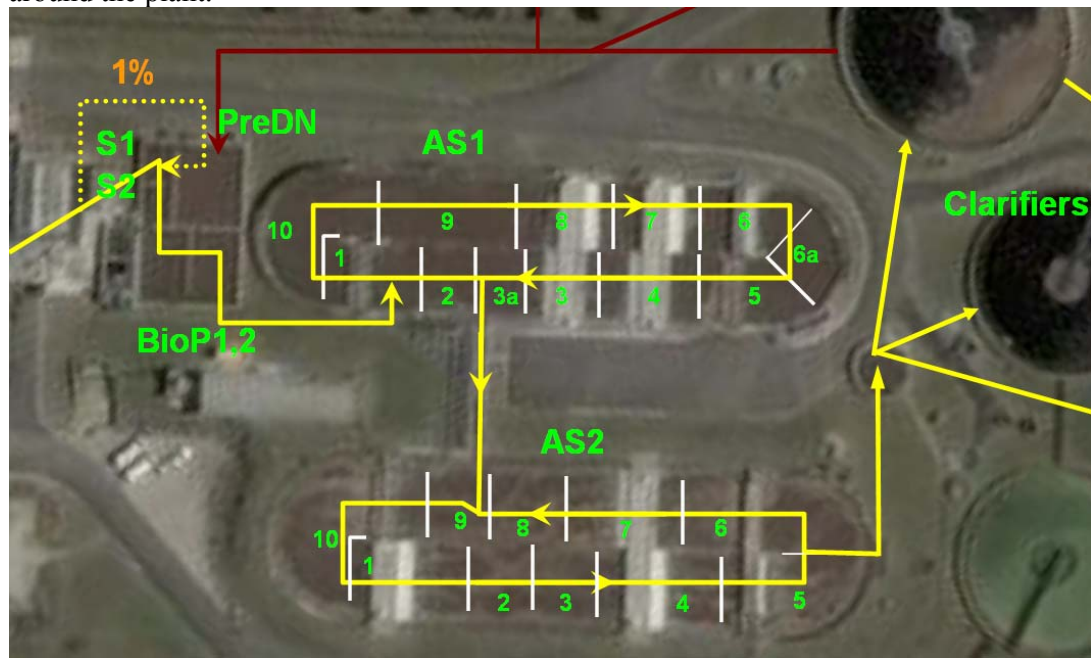
around the plant.

Figure 1: *Beenleigh WWTP layout and configuration*

An attempt at modeling and interfacing the new Pimpama WWTP has also been made. The Pimpama facility uses a 5 stage Bardenpho configuration and has six reactor zones: anaerobic, anoxic, aerobic, de-aeration, post anoxic and re-aeration. It is hoped that a model and model interface for the Pimpama plant can be used for pre-emptive operator training.

2.2   Control Systems (Beenleigh WWTP)

In ditch 1 (AS1) each aerator can be individually set to 'always on', 'always off' or to 'control'. The control system will turn the aerators on or off based on the dissolved oxygen (DO) limits measured in the ditch, at AS1-6a and AS1-2. There are rules in place which dictate the order in which the control system will activate or shutdown the aerators. Different DO set point limits are implemented throughout the day to cope with different diurnal loads on the plant.

Control systems have not been set-up for AS2 since this configuration is fixed, however, the model could be expanded to allow for automatic control.

3.0   INTERFACE DESIGN

3.1   Citect

The current Citect interface allows operators to monitor the plant in real-time, view historical data and make changes to the way the plant operates. Specifically, for the bioreactor section, operators are given a stylised 'birds-eye-view' of the two ditches and are able to view the temperature, pH and dissolved oxygen readings at various points (corresponding to the location of sensors), as well as online ammonia, nitrate and phosphorus concentrations in the effluent. Additionally, the current operation of the each aerator can be viewed (i.e. on or off).
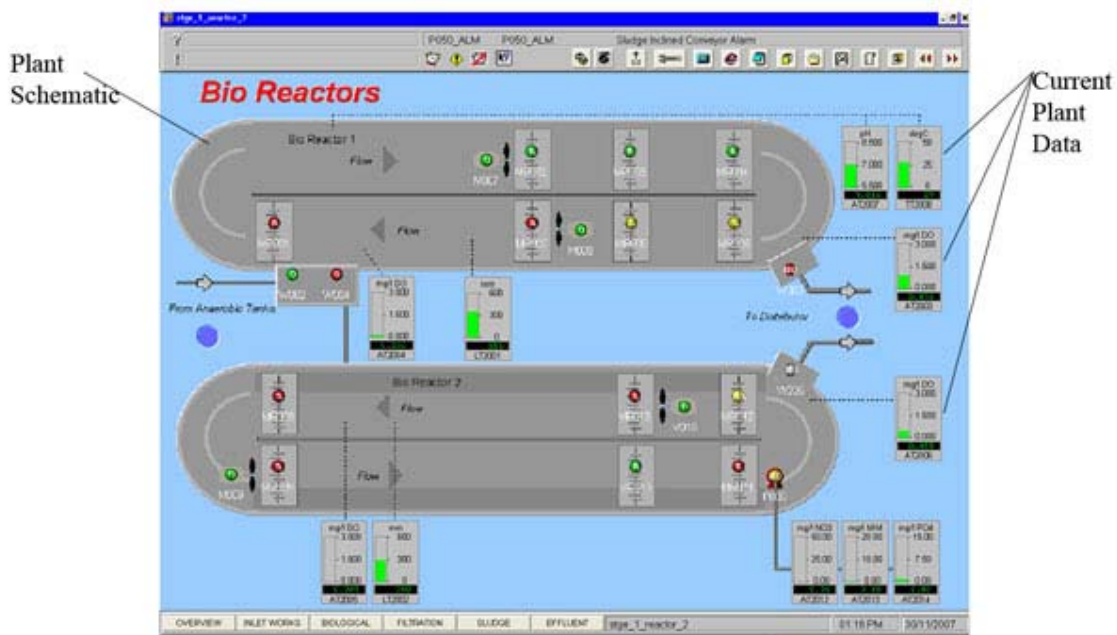
Figure 2:   *Beenleigh WWTP current CITECT control system*

3.2   Methods

The model front end needs to be a graphical user interface able to remotely 'connect' with the WEST model. Visual Basic (VB) was chosen as the programming language for use in developing the interface because of its high degree of graphical usability. The current version of WEST (3.7.5) has been designed to allow remote interfacing with VB using a set of Application Program Interfaces (APIs).

Visual basic is an object orientated programming language and an event driven language, meaning that as a program runs, changes in objects (i.e. WEST model parameters) are triggered by different events (e.g. mouse clicks or timer ticks). VB can be used to control the WEST simulation in the following way (Figure 3).
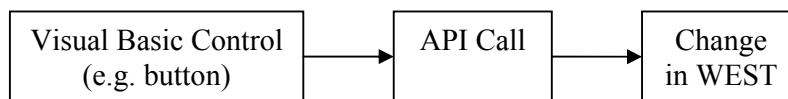

Figure 3:   *Schematic of data flow in the training interface*

The interface has two main purposes: to control the simulation and to gather and present data from the simulation. Controlling the simulation involves starting and stopping the simulation, and changing inputs (including control system set-points) while the simulation is running. Gathering data means repeatedly reading the current variable values (DO, TSS, VSS etc), storing them and presenting them on the screen as graphs or numerical values when required. Operational staff can then use these "what if" scenarios to predict potentially variable influent quality on process performance. Which in turn allows operators to respond with key operational control measures to counter the predicted impact, hence increasing operators knowledge of control options under varying circumstances.

4.0   RESULTS

4.1   Control

Figure 4 shows the start-up screen which users initially see when the program opens. Only the first bioreactor is shown as bioreactor 2 does not change and the additional screen space is needed for user input. At the bottom of the screen is the control system where users run the simulation and access the control system. Also displayed on the screen is the current DO measurement from the simulation.
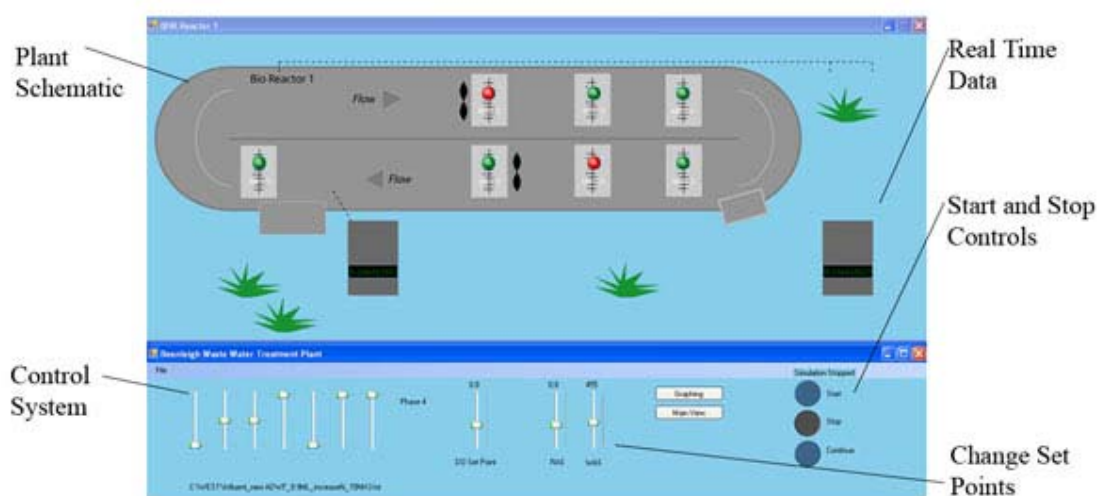

<u>Figure 3:</u>   *Overview of the training interface*

Conceivably, any parameters or variables included in the model can be accessed and changed using the interface. The items chosen in the interface are to reflect what is seen in the actual interface, but the data being displayed is not limited to what is available in real life. It is therefore possible to have extra data not normally available to operators included in the simulation, to aid in understanding of the process and the plant.

4.2   Different input files

One major feature of the interface is the ability to simulate different scenarios (e.g. pH spikes). This is achieved using different influent files. Influent files are tab separated text documents which contain influent data against time, they can be real or fictitious. Generation of influent files, using a spreadsheet program, is relatively easy.
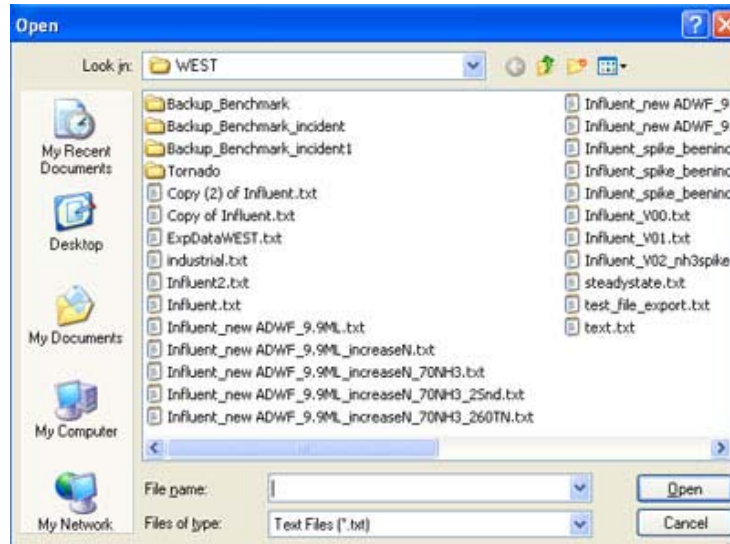
Figure 4: *File open dialogue box, showing different influent file*

4.3   Graphing

Visualisation of data generated by WEST simulation is very important, and the best way of doing this is using graphs. In the Beenleigh interface, graphs displaying the effluent profile (ammonia and nitrate), dissolved oxygen, sludge retention time and total and volatile suspended solids are available.

For each of these, the user can opt to view data showing the most recent 24 hours to 7 days or data from the entire simulation. The graphs showing the historical data automatically re-scale themselves in **real time**. The data for these graphs is stored in arrays and can be presented in different ways depending the user's requirements. In the Beenleigh interface time-series charts have been used.
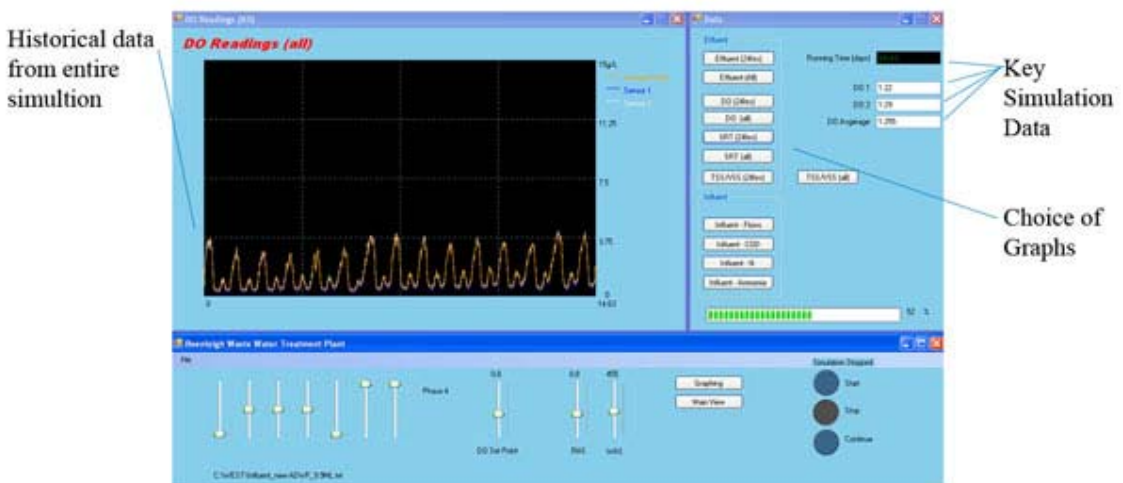

Figure 5: *Example of graphing in the training interface*

Influent data can viewed (based on the influent file) and the user is able to zoom and rescale these graphs, in a similar way to the existing Citect interface. Any data which is contained in the influent file can be graphed.

5.0 CONCLUSION

Initial response from the operators has been very positive, with strong recognition of the key outputs, and informed feedback, without substantial explanation of the design. Current work is focusing on finalising the interface, attempting to "fit" / calibrate the underlying model to current operations, and will assess whether the operators can use the model to gain some more value in excess of their already extensive experience.

For those operational staff that are relatively new to the industry or a particular plant, this tool, may accelerate their learning curve by exposing them to a wide variety of potential operating scenarios that otherwise they may only be exposed to over a longer period of time ie scenarios that may have been triggered by weather related or trade waste influences.