# Strategic Use of Genetic Algorithms
brings 11% cost savings to Mid Kent Water

by
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With the UK water industry regulator Ofwat applying new efficiency targets every five years, water companies across the country are looking for and applying new tools to help them deliver reliable services to all their customers whilst keeping costs minimised. This can only be done by using smart design and efficient procedures. Genetic algorithms previously had a proven record in Australia and North America for assisting in the planning of water networks and reducing costs. Mid Kent Water (MKW) was, therefore, keen to apply this technology to the area within the company that is experiencing some of the fastest growth in the UK, Ashford and surrounding areas. Before describing the project and its results however, a brief description of genetic algorithms is given and how they work.
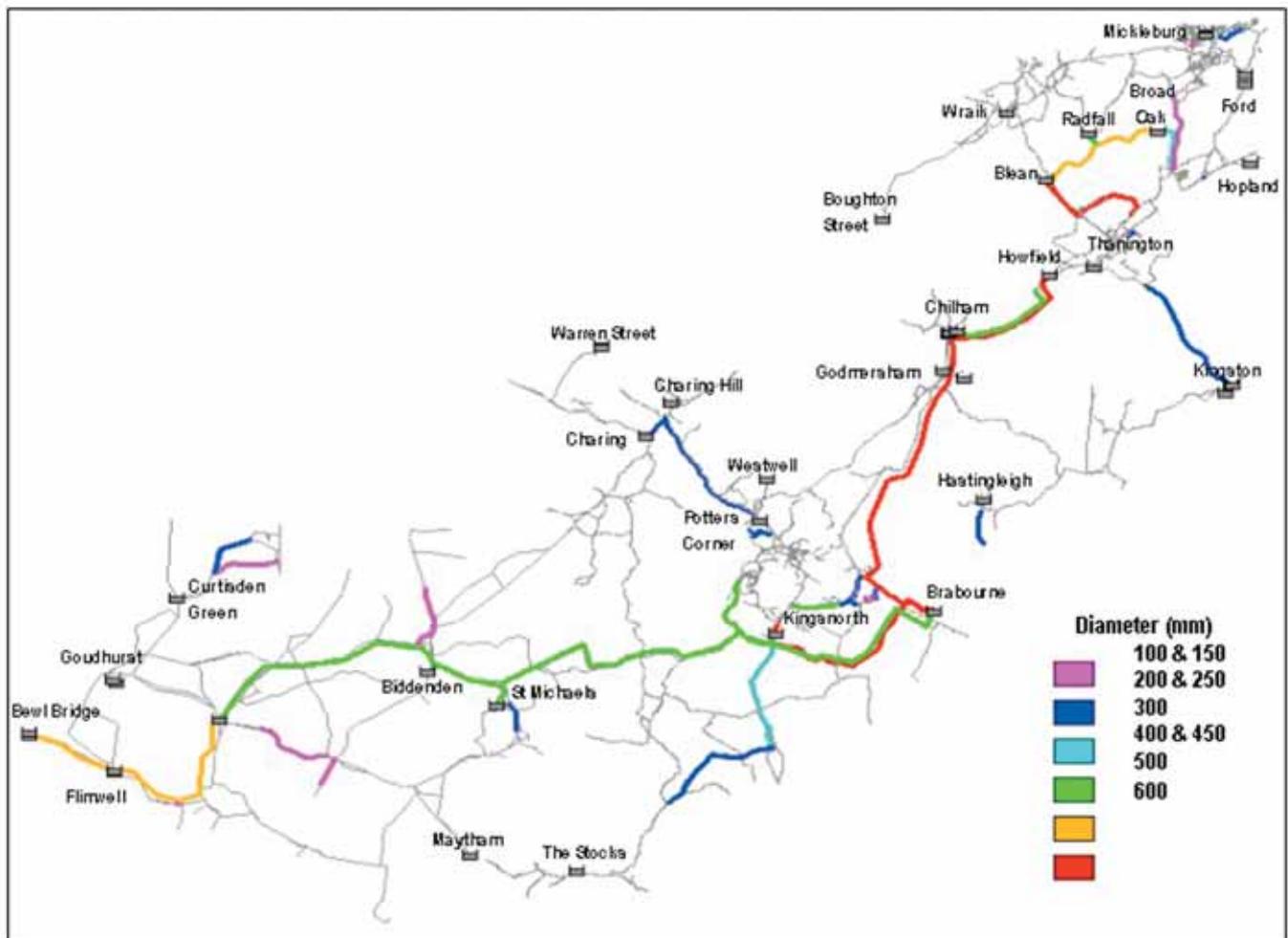
Final pipe solution layout for 2030

courtesy: Optimatics & Halcrow Services

What is a genetic algorithm?

The power of Genetic Algorithm (GA) techniques can be seen by taking a very simple example. For a distribution network of 10 pipes, where each pipe can take one of seven sizes (50, 75, 100, 150, 200, 250 or 300mm) there are 7^{10} or 282, 475, 249 potential solutions to this simple network.

GA Optimisation is an evolutionary, directed search technique that evaluates millions of possible solutions as it narrows in on the best alternative to achieve the desired outcome. The process replicates evolution in that parts of a good solution are mixed with parts of another good solution to create a member of a new population that is, hopefully, even better than its parent solutions.

From a myriad of design variables, the *Optimatics GA* process selects the best arrangements that allow the development of optimal water distribution systems. Complex planning, design and operations problems can be tackled more easily through the use of GA to quickly identify solutions in an optimal way.

Using the joint expertise of *Halcrow Water Services (HWS)* and *Optimatics* (who pioneered the application of *Genetic Algorithms*), engineering specifications, technical data and design criteria are loaded into the software's database in preparation for GA optimisation runs. A specialist design engineer then uses this data source in operating GA software. Millions of computer simulations are then performed to achieve the optimum network design.

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courtesy: Halcrow Water Serices

Typically, an *Optimatics* design is around 20% less expensive to implement than alternative designs developed using traditional methods. In addition, the designs can be focused on delivering more reliability, greater flexibility, higher levels of robustness and streamlined operational procedures. These features of a smart design minimise security risks to the network because they provide scope to isolate damaged zones and to re-route water through alternative pipes

The Ashford Study

Halcrow Water Services, in partnership with *Optimatics Pty Ltd.,* were commissioned in 2004 by *Mid Kent Water* to carry out a study to optimise the water distribution system in Ashford, Kent. The area is undergoing rapid expansion (under the UK governments' plan to increase housing in the South East) in an area of limited water resources.

The main study activities include:

* HWS prepared a strategic distribution model using *Infoworks* software to represent Ashford Town and its surrounding environment. Resource options rely heavily on water supplies from Bewl Reservoir and Broad Oak Reservoir.;

* future demand models were established to represent 2010, 2015 and 2030 planning horizons and for average day and peak day demand;

* the models were converted to *EPAnet* to run on the *Optimatics Genetic Algorithm* package. A large series of runs were carried out to evaluate the optimum arrangement of pipeline and pump scheme combinations required to satisfy all the hydraulic constraints in the model;

* the initial solutions were presented to *MKW* in November 2004 for review and feedback. A further optimisation was carried out to refine the optimisation for 2030;

* a set of phased solutions were developed for years 2010 and 2015 that were consistent with the 2030 solutions;

* the final solutions were reported to MKW and fed back into the *Infoworks* strategic model.

Note on the authors: *Khaled Jame & Dr Alan Donald are with Halcrow Water Services; Peter Radcliffe is with Optimatics.*

A particular feature of this work was MKW's desire to reduce their operational cost, in addition to capital cost. Operational costs were computed in the models using an energy tariff projection provided by the client. From a comparison of the 2030 model with the baseline model, a **5% cost saving was achieved in operational cost together with a 13% saving in capital cost, giving an overall cost saving of 11%,**

Development of the strategy has been carried out in consultation with *MKW's* senior management team through a series of presentations and reviews. This process has been instrumental in producing preferred solutions and facilitating the development of a robust strategic plan.
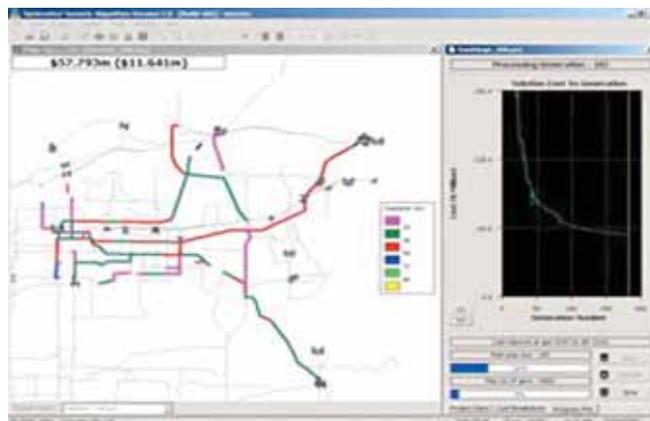
GA Solver

courtesy: Optimatics & Halcrow

MKW are now reviewing other areas in which the *OGA* may be put to a similar use. These include DMA rezoning studies and company wide bulk mains distribution. Genetic Algorithms are also catching on in other parts of the country with pilot studies currently being undertaken in Thames Water, Anglian Water and Severn Trent Water.

By working together, the UK water industry is acquiring the tools that will allow them to meet the requirements that they have undertaken with the UK regulator and deliver better quality of service to households and businesses across the UK. ∎

For further information visit http://www.halcrowws.com or contact Vijay Jain, Public Relations at info@halcrows.com