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Epilogue

It is evident from the preceding papers that the POWADIMA research project has achieved its prime objective of demonstrating that real-time, near-optimal control of water-distribution networks is a feasible proposition. Having applied the control system that has been developed to two very different networks, one requiring a high degree of pumping, the other involving a significant amount of valving, there is an air of confidence that it can be applied to most if not all networks, on a city-wide basis. The potential reduction in operating costs obviously depends on how well the network is currently managed but for the majority, the expected savings are in the order of 20 percent. This is a result of not only exploiting the energy tariff structure to the full but also lowering the hydrostatic pressures in the network to the minimum required, thereby reducing the overall amount of energy consumed. At the same time, improved pressure management within the network ensures a better standard of service to customers, be they domestic, commercial or industrial. Additionally, where there is more than one source of supply with different production costs, the control system is also capable of including the best combination of treatment plants at any one time, to meet the current and projected demands.

Clearly, there are a number of improvements that could be introduced to meet the practical considerations of the operators, the first being the size of the time-step adopted for updating the control settings. In practice, if an unexpected situation arose, be it a surge in demand or a component failure, the operators would be unwilling to wait for up to an hour before altering the control settings. However, if, say, a 15-minute time step were adopted, then the present number of decision variables would need to be quadrupled and the number of GA generations required for convergence could also increase. With the present generation of control computers, it would appear that the maximum number of decision variables that can be handled computationally within the 15 minutes between updates is about 1,500. Large as this may seem, it has to be remembered that each fixed-rate pump requires 96 decision variables to cater for a 24-hour operating horizon with a 15-minute time step: the corresponding number for a variable-speed pump or an operating valve is at least 384 decision variables. An alternative would be to use a 15-minute time-step for the first hour, before reverting to an hourly time-step for the remainder of the control strategy up to the operating horizon. After all, an hourly time-step is more than adequate to ensure the selected pumping regime takes full advantage of the energy tariff structure. Implementation of a 15-minute time-step for the first hour and one hour thereafter would require training two ANN-predictors, one for each time-step, and modifying the GA-ANN control process accordingly.

Having an initial time-step of 15-minutes would exacerbate an existing issue relating to the frequency of adjusting the control apparatus. As most of the pumps that have been installed to date tend to be fixed-rate rather than variable-speed, operators are reluctant to switch them off or on at short time intervals. At the present time, the DRAGA-ANN control system places no restrictions on the frequency that pump settings can be changed, other than those imposed by the time-step chosen. However, it would be possible to limit the number of switches within a specified period of time by including that as an additional operational constraint. Alternatively, a penalty function could be invoked every time a pump is switched on or off, thereby persuading the control system to try other possible solutions which involved less switching. Either way, this would almost certainly reduce the savings on operating costs as a result of curtailing operational flexibility. Nevertheless, the expected size of the potential savings is sufficiently large to absorb what should be a nominal reduction.

Therefore, looking to the future, it should be possible to adapt the DRAGA-ANN control system to meet the operators' needs, rather than having a 'one-size-fits-all' approach. However, this does not detract from its wide-ranging applicability: it simply means that there is the prospect of including operators' preferences within the capability provided.

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