

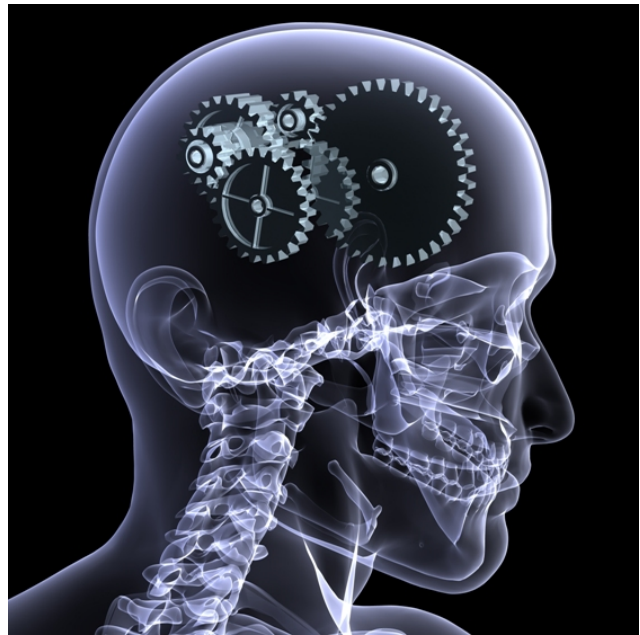
# AI and the water industry – The next wave

At the turn of the last century, a major shift in the way business is conducted was underway in the world--the shift was outsourcing. The concept was discussed by Thomas L Friedman in his book "*The World Is Flat – The Globalized World In The Twenty First Century*"<sup>1</sup>. There is now another movement similar to outsourcing which is further increasing the efficiency of companies – the application of artificial intelligence to enhance and support decision makers to do things faster, better and cheaper. In this paper, we draw a comparison between outsourcing and artificial intelligence.

## Outsourcing

The advances in communication and the enormous amount of optical fibre cable that was laid during the 'dot com bubble' provided access to a vast pool of relatively cheap skills in regions such as China, Russia and India. Software companies and call centres were developed in these places to service western companies in many facets of business. This reduced costs making the mother company leaner and more efficient.

An example to demonstrate that services are now moving offshore is that of the accounting industry in the US. According to Friedman<sup>1</sup>, in 2003, India completed 23,000 US tax returns on behalf of American tax agents. By 2005 this number had skyrocketed to 400,000. The outsourcing of these tax returns by American tax agents not only provides a cheaper service for the American population, it also enables the American tax agents to focus on other more creative aspects of accountancy (such as tax sheltering or tax minimization) for their clients that they may not otherwise have had time to do. The result for the client is a maximised income.



As can be seen from this example, outsourcing does not replace the need of developing strong client relationships, but by offloading the "grunt work" it increases the available free time for expert staff to work on other things. This time can then be spent improving other facets of business.

Outsourcing in this way can justifiably be called a revolution in the business world. However, there is a less well known revolution taking shape on our doorstep, one that seems more commonly discussed in the realms

of science fiction. This “revolution” is the use by organizations of computer powered Artificial Intelligence (AI) to undertake work in place of human brain power.

By using computer “brain power” to undertake a large amount of the process work, employees in these new organizations are likewise freeing up work time, allowing them to become more creative and to gain a better understanding of their customer’s needs. This will be true in all forms of business but let us take a particular look at the water sector.

## **AI in the water sector**

As the water industry continues to search for ever more efficient ways to use water, the nature of the design problems is becoming more complex. Water utilities are now looking to integrate water, wastewater, recycled water and even storm water into a single network to minimize wastage and improve security of supply. This increased complexity is further influencing the need to incorporate AI into all aspects of water system design and operations.

New ways of working with water such as sewer mining, desalination, aquifer storage and recovery (ASR), and giant transport pipelines are being developed and constructed around the world. How can a water utility choose what to build, where infrastructure should go and how large to build a system? The number of permutations of how this jigsaw can possibly fit together is endless. This is where the use of AI is significant in developing the optimal solution.

While a human mind can use engineering judgement to do a good job and arrive at a solution, the engineer is still limited to only being able to carefully analyse relatively few possibilities in the time available to arrive at a solution. In contrast, software that utilizes AI can work 24 hours a day across multiple computers at much less cost than a human engineer and with very few complaints! And the results speak for themselves.

When applied to the water industry, the different forms of AI such as genetic algorithms, ant colony optimization, particle swarm optimization and neural networks are enhancing the planning, design and operations of water systems like never before. The use of genetic algorithms alone has enhanced the planning of new water systems by simultaneously improving the hydraulics, and thus levels of customer service, while reducing cost. Savings in the order of 15% and more are typical in most instances where genetic algorithms have been applied in the planning process of a project.



Below is a list of water and wastewater project plans that were initially developed manually by a modeller using engineering judgement and a traditional simulation model. The project plans were then independently developed using a genetic algorithm approach that resulted in significant cost savings. It is noteworthy that on all of these projects, the levels of service provided by the system also improved so there was no compromise on quality.

Study Location	Savings	Original Cost Manual Method	Genetic Algorithm Plan Cost
San Diego, CA, USA	\$19.7m (36%)	\$55.0m	\$35.3m
Reno, NV, USA	\$9.0m (30%)	\$26.0m	\$17.0m
Gold Coast, QLD, AUS	\$11.7m (40%)	\$29.5m	\$17.8m
Wimmera M., VIC, AUS	\$3.3m (23%)	\$14.3m	\$11.0m
Las Vegas, NV, USA	\$1.7m (19%)	\$9.1m	\$7.4m
London, UK	£1.1m (16%)	£7.2m	£6.9m
Ft.Collins, CO, USA	\$2.9m (49%)	\$5.9m	\$3.0m
Lyons Road, SA, AUS	\$1.1m (50%)	\$2.2m	\$1.1m
Ashford, Kent, UK	£7.6m (13%)	£57.5m	£49.9m
Melbourne, VIC, AUS	\$66m (45%)	\$147m	\$81m
Providence RI, USA	\$8.5m (15%)	\$60.0m	\$51.5m
Melbourne, VIC, AUS	\$6m (14%)	\$37m	\$31m

Table 1: - Identified savings on project plans using genetic algorithm optimization

### Will this spell the end of the Engineer?

The answer to this question is a firm 'No'. This is because the pace of change is also increasing and engineers today must manage far more projects in less time than ever before. There will still be plenty of jobs for young creative engineers and those with experience who know how to do the job right.

The AI approach, in fact, offers significant benefits to today's engineers and clients. As in the accounting example above where the use of outsourcing allowed the American accountant to focus time and energy on improving services in other areas of the business, the AI approach frees up time and resources for the engineer to develop ever more innovative and more powerful ways to solve problems. And just as a tax accountant must ensure quality control over the work prepared offshore, so too the engineer remains responsible for quality control of the solutions identified by the AI and for ensuring that the right questions are asked.

## Integration of man and machine

Water planning specialists today provide advisory roles to water authorities worldwide. Rather than see a replacement of these specialists with adoption of AI, we are going to see an integration of the ideas, experience and creativity of these specialists with the processing and modelling power of tomorrow's computers and AI. This will happen in the following way. Once areas of a water business have been targeted for improvement, the current state will be modelled and the desired objectives will be determined. Experienced consultants will then be called upon to



recommend solution options to this business objective. Each solution option will be input into the “intelligent model” along with the associated data such as cost of infrastructure, impact on the system and the environment. In this way numerous ideas can be rigorously tested and optimized against the performance requirements quickly and efficiently to give accurate feedback to the engineer about the benefits and costs of each.

The platform also allows all parties whether they are planners, operators, politicians or finance people to have a say in the constraints and rules that the optimization process is working to satisfy. This allows for transparency of results, “buy in” from all parties and a closer collaboration between them.

## AI in operations

The need to incorporate AI is also important in the area of water system operations where decisions need to be made quickly, accurately and reliably. With the rising cost of power, labour and maintenance, utilities need to improve the efficiency and effectiveness of already established infrastructure. Technologies such as demand prediction, pressure reduction, pump control and water quality control need to be continuously improved so that power usage can be minimized, the life of existing assets be extended, and, security of supply is maintained. AI is able to provide the greater level of control that is necessary for optimizing system operations.

Imagine an operations model that gradually adapts itself to the aging of pipes, changing weather predictions and various day to day incidents (planned and unplanned) occurring in a system. An intelligent model that can recommend when assets need to be replaced, when, where and how much water to pump, and also predict when an emergency event is likely. A model that automatically springs into action when an emergency incident does occur, providing immediate details to the operators of what the symptoms are, what the most probable cause is and the recommended course of action. The idea is not to remove operators from operations activities, but to greatly enhance the effectiveness of the operators.

## The skills shortage

There is an obvious skills shortage in many countries today. Engineers are in demand like never before. One of the most common reasons for delays to projects is lack of skilled people. The answer to this skills shortage may not be to train and hire more skilled staff, which is a huge challenge. Instead of simply seeking more people to fill the skills shortage, the best solution may be to better utilize the skills of people currently employed by providing them with more powerful decision support systems. At present, a large proportion of an engineer's time is typically spent on the technical "grunt" work, in particular "number crunching". By incorporating the use of AI to more effectively accomplish the laborious tasks, an engineer is freed up to work at a "higher plane" on a given project and to attend to even more projects. Employee satisfaction also increases as the engineer is called upon to tackle more creative aspects of a project rather than getting bogged down in the tedious aspects of the technical work. This improves their effectiveness at work while creating a more rewarding career resulting in higher employee retention.



## Conclusion

The convergence of increased computer power, AI technology and robust wireless communications is paving the way to establish changes in every industry, to become more effective and efficient than ever before. These changes have paved the way for outsourcing and are now doing the same for the automation of work by computers running powerful new intelligent programs. The gains in productivity for engineers in the water and wastewater industry will flow on to customers bringing lower costs and higher levels of service. Those engineers directly utilising AI technology will be empowered to fulfil their highest potential in the innovative management of our water systems.

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## References

1. Thomas L Friedman: "*The World Is Flat – The Globalized World In The Twenty First Century*".