

Data, data everywhere but not a drop to...

Nearly everything I do these days is measured, quantified and displayed. From the number of steps I walk, my calorie count, the amount of electricity or water I use, the swathes of information my car tells me on fuel consumption and the escalating amount of “real time” data provided in my work. I have access to much of this information at the touch of a button as many of my home devices are now connected to the internet. So my ability to make data driven decisions which change my behaviour and effectiveness is increasing exponentially.

As an engineer data is something I crave as it helps me get better at what I do. But it's not just me – there's a global data revolution happening around us and every day we hear phrases such as “internet of things”, “Big Data”, “Predictive Analytics” and “the cloud” and are told that those who take advantage of these data revolutions will become stronger in the business world.

So what's the big deal? After all we already collect a lot of data. Rohit Banerji, leading Data Analyst at Accenture says the rapidly emerging cloud-based technologies have disrupted the way information is managed. Our new capabilities to efficiently source, integrate, and process information at scale means less capital hungry, systems integration investment. Plus computing power has reached the tipping point, storage is no longer an issue and the ability to extract data in real time, using wireless technology makes for exciting new possibilities.

Put simply, data is so much cheaper to get and analyse it has created a real revolution. I think this new landscape could really help address our issues in the water industry today and tomorrow. Before I outline some examples of the benefits and differences it could make, here's a quick explanation of the data revolution buzz words:

Big Data is the ability to capture and analyse large volumes of data to find relationships on which future decisions can be made. These couldn't be identified previously as data was not available or usable because of its sheer volume. The three V's of Big Data are Velocity (how fast I can get it), The Volume and the Variety (being able to measure the previously unmeasurable). Together these three elements move us into new possibilities.

A great example of using data intelligence is Adidas installing “spin” sensors into footballs, which coupled with smart phones can help

those wanting to “bend it like Beckham”. The data can also be sent back to Adidas who will make suggestions on improvements and more importantly for them, equipment.

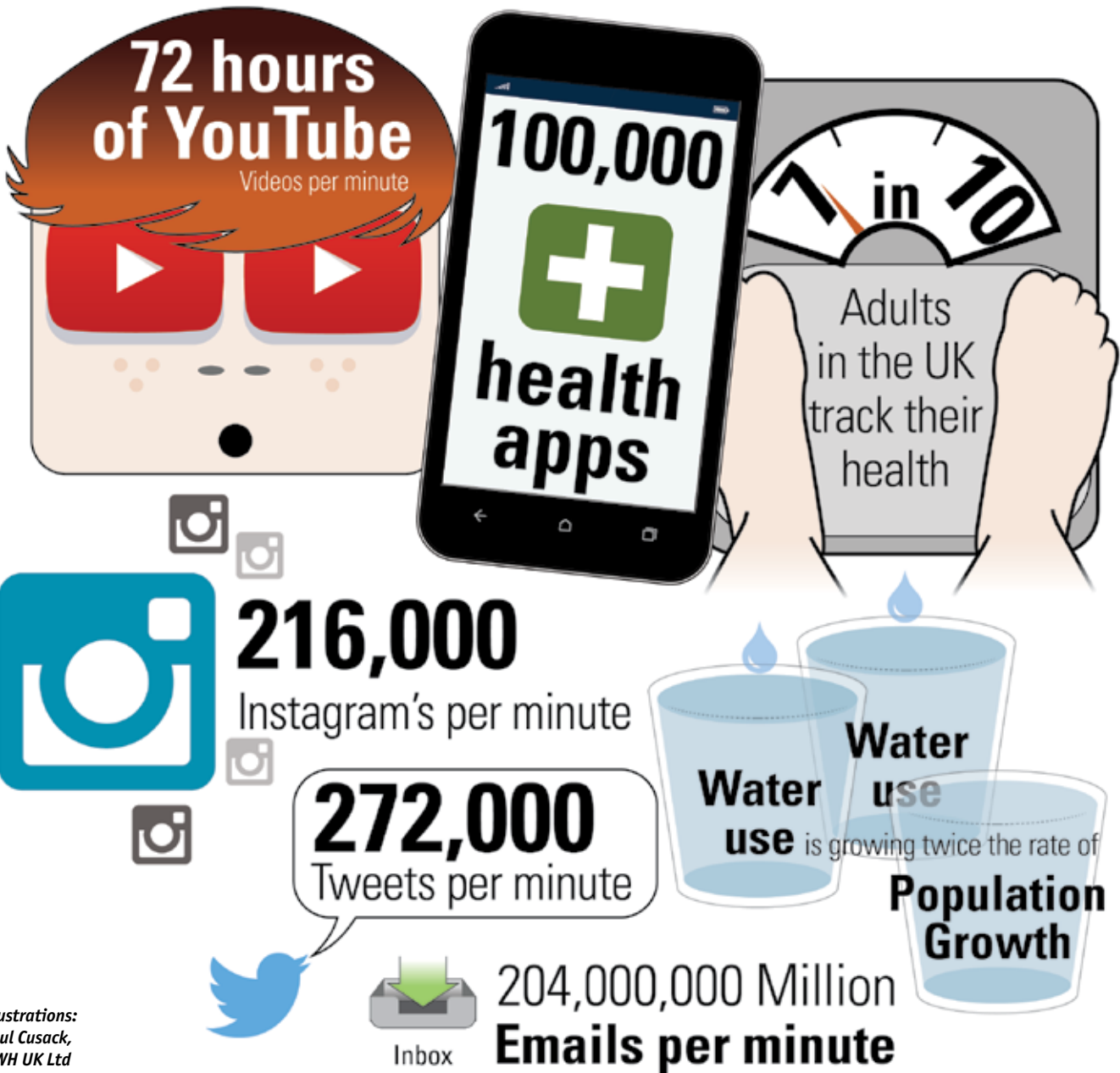
Predictive Analytics allow us to intervene before an event occurs or to be able to manipulate the outcome for some benefit. It occurs when we “mine” large data sets to find relationships. It allows us to understand the impact of different variables and react to them before they happen for some degree of benefit. The revolution comes from our ability to analyse terabytes of data to find these relationships using subject matter experts and statistics and then apply them in real time to change or enhance an outcome.

The Cloud allows us to disconnect from physical data servers and access information anywhere, on a variety of different devices. It reduces data storage costs, and removes the need for owning and maintaining data storage servers. It means we can analyse data and search for insights when we have the time, in any location with the right people.

The **internet of things** means it is easier to collect data from pretty much anything, and at a fraction of previous costs thus providing us with data we didn't previously have.

Some examples and benefits of real world big data and analytics include:

- Consumer product companies and retail organisations are monitoring social media like Facebook and Twitter to get unprecedented insights into customer behaviour, preferences, and product perception. Manufacturers also monitor social networks, to detect aftermarket support issues before a warranty failure becomes publicly detrimental.
- Manufacturers are monitoring minute vibration data from their equipment to predict the optimal time to replace or maintain. Too soon wastes money; too late triggers an expensive work stoppage



Illustrations:
Paul Cusack,
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- Financial Services organizations are using data mined from customer interactions to place users into finely tuned segments. This enables these financial institutions to create increasingly relevant and sophisticated offers.
- Hospitals are analysing medical data and patient records to predict patients likely to seek readmission a few months after discharge. The hospital can then intervene to hopefully prevent another costly hospital stay.

The difference Big Data makes

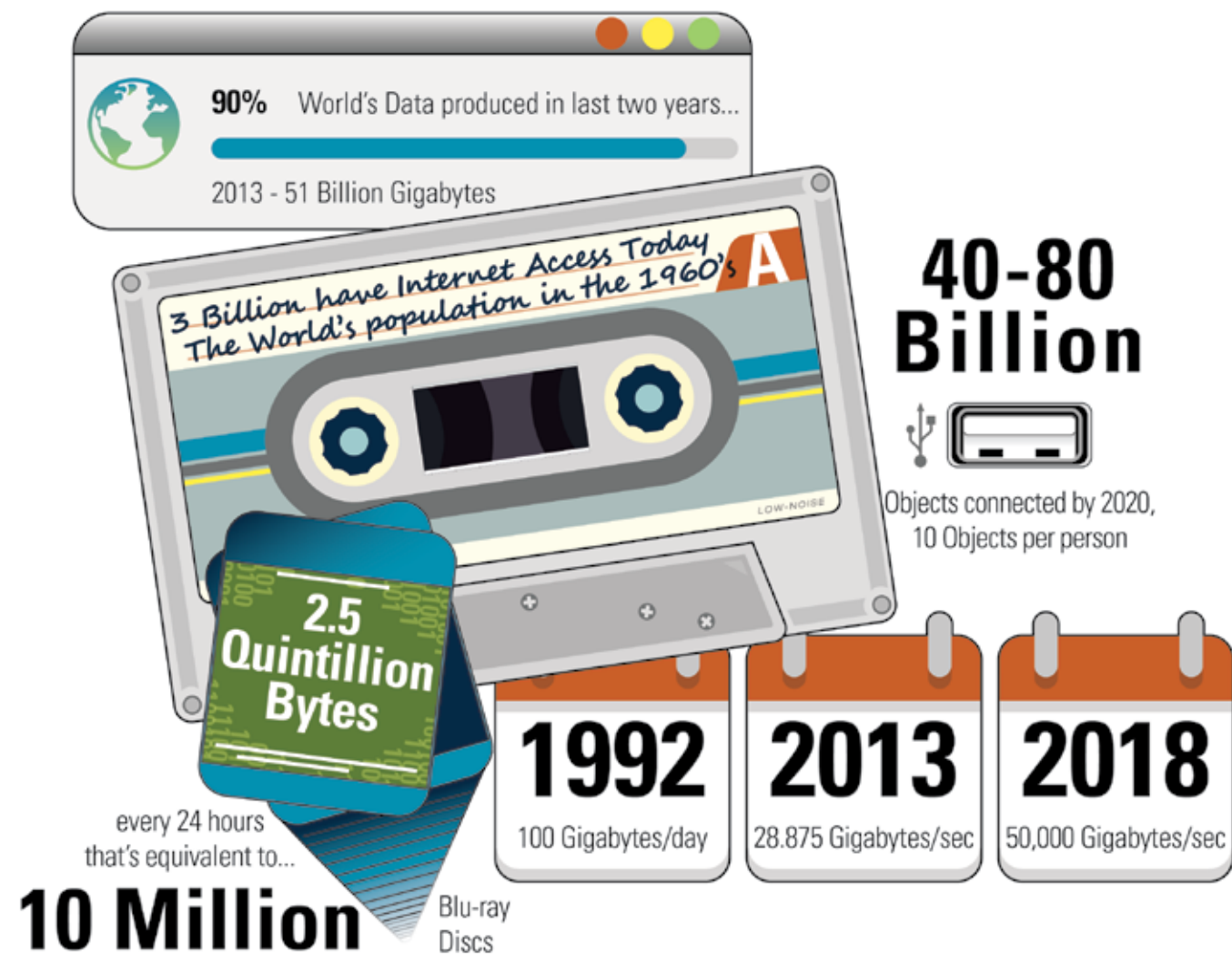
Data Analytics can really make a difference in sport, as improved performance is realised in minutes not weeks or months. I'm a huge

Formula 1 fan - their use of data analytics is unprecedented in improving performance and we can learn a lot about predictive component failure from these F1 teams. Similarly, the 2014 World Cup winners, Germany, used extensive Big Data and analytics to help improve their performance ahead of the tournament. Using extensive HD cameras they gathered large amounts of information on player's performance and reduced average time between passes from 3.4 seconds to 1.1 seconds. Other great examples of reusing existing big data to provide predictive analytics includes one American city police force, who can predict crime before it occurs and place a police presence at the predicted location to prevent it. This was achieved by analysing huge quantities of existing crime data and developing

'relationships', using a model similar to that predicting earthquake aftershocks. Another powerful example is the use of data analytics and statistics on shoppers buying habits by large US retailer Target. They can identify pregnant customers and in which trimester using current shopping habits and offer appropriate baby related purchases pre and post birth.

Should the water industry embrace Data Revolution and Do more with Less?

We operate in a capital constrained world where customers are reluctant to pay more for utilities and media who will jump at every price rise. We face increasing pressures from an ageing asset



base, the need to tighten environmental consents because of new legislation or growth, increasing plant capacities, rising power and chemical costs, increasing maintenance costs and a reducing skill base in plant operations and design. These are all reasons why the water industry should adopt the Data revolution and do "More with Less for Less" by using old and new data.

We already collect huge swathes of Data, across networks, treatment plants, customers and catchments. Most treatment plants have SCADA systems which retrieve information on plant operation and other systems to collect maintenance and financial records. The problem is the data is isolated, too large and where we have multiple versions hard to handle. Additionally, we don't have the right people with time and expertise to use data to make sound decisions. So what can we use this information for?

Predicting pipe failure - Using historical failure, pressure, material, age and condition data we have been able to develop predictive models showing where future pipe bursts are likely to happen, enabling replacement works to be made

prior to any occurrence, reducing undetected leakage and reducing the cost to serve (planned maintenance is always cheaper than reactive).

Managing water costs - The Australian, water stressed city of Adelaide uses real time water network and consumption data to manage production costs and keep down costs by maximising the use of the cheapest treated water sources. Similarly, Thames Water have undertaken an extensive pilot project making use of real time data, coupled with statistical models to ensure the most resilient and lowest cost water is produced and supplied into the water grid.

Measuring asset condition - asset component data which measure vibration, heat or power consumption can be used to measure the asset condition allowing proper condition-based monitoring. Taking that further allows us to understand what operating factors create increased stress on components, impacting on failure rates. By avoiding these periods we can understand how to use them effectively.

Predictive weather data - wastewater transport and treatment is heavily impacted by weather as

are certain drinking water sources. It can make unusual and seemingly unpredictable changes to how a network or treatment plant behaves. In September 2014, we saw unusually low wastewater flows across the UK, which led to some interesting impacts like reduced solid loads being received at treatment plants. Using predictive weather data, with flow data and inlet flow data we can set up changes to operating regimes which helps manage risks caused by environmental impacts. For example, we can inform operators to manage their screening plants in preparation of a rag deluge because of predicted settlement in the network as a function of time since the last storm event. Alternatively, knowing the capacity of the works, and to ensure a proper feed-stock of fuel to power production, we can flush networks when we know we will have periods of substantial load drop off. This would maximise and balance power production at treatment plants.

Energy management is a key area for big data. Energy monitoring can be used to help understand and quickly intervene when energy consumption at plant or component level increases. Data analytics can then be used

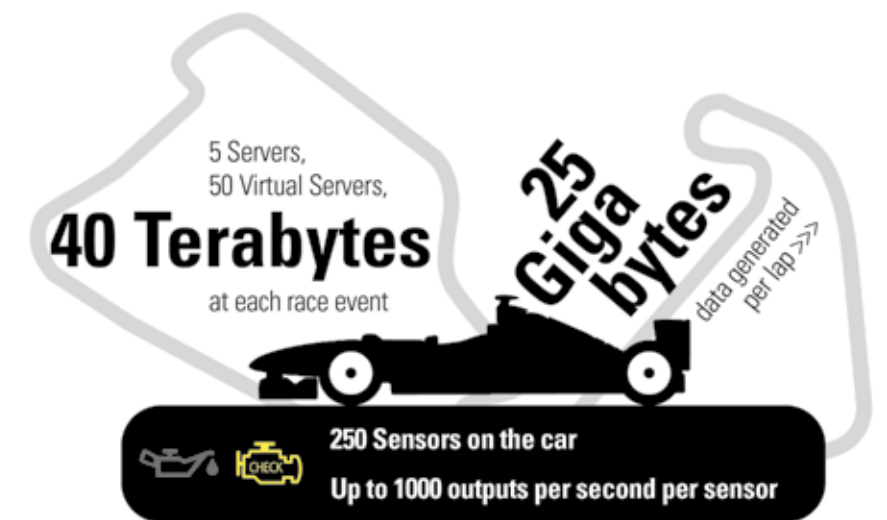
to prevent efficiency excursions before they happen and to identify further reductions by a change of operation or equipment. Many water companies have extensive energy data at plant level, but rarely at component level, but this is improving. The trend has been to base energy management on mechanical efficiency i.e. has it used the same energy to deliver the same flow? We then compare it to historical trends and alert and fix on deviation. This is great for preventing gradual performance deterioration, but little consideration is given to process efficiency. Asking questions such as should we be pumping that much? Can we reduce it? Change the time of day? or alter set-points can make us more energy effective.

Wastewater treatment is highly dynamic in nature. We can create sophisticated process models and calibrate them with huge amounts of data and link it together. In near real time, we can accurately predict plant process efficiency and make dramatic performance improvements in energy and consumable costs. In time, this sort of analysis may enable us to establish trends and insights which allow us to make interventions before efficiency declines. We can apply the same thinking to process compliance and maximise inherent plant capacity. Energy and compliance data can provide us with exceptional insight into asset condition and be used as means of instigating maintenance in time. Having proactive maintenance again reduces operational costs and increases available headroom.

Collecting performance data and using it to establish how we can prepare a treatment plant to "stress perform" (how far we push a plant for short periods to mitigate against load increases or plant outages); big data can give us insight into the factors which impact this and allow us to extract greater capital headroom than previously thought possible. All of these ideas are possible with either data we have now and with an understanding of what the influencing factors are. The problem is, who in a water utility has the time and the expertise to analyse their data?

In the future we need to decide what data we'd like to collect that will support the industry and its consumers. For example is there value in having household wastewater meters to better understand people's habits? Should we have an "internet of things" on toilets so we know how many times a flush occurs? I'm pretty sure that water consumption devices such as washing machines, dishwashers and even showers and taps will soon be factory fitted with data chips, allowing manufacturers to understand performance and failure rates. This same data could be used by the water industry to help us understand and alter behaviours to improve performance.

We don't know what we don't know... Data variety is critical in this new data revolution. We mustn't limit ourselves to conventional thinking. It's not just collecting the obvious, but capturing everything that may or may not have an influence on an outcome. I find the example of the reintroduction of wolves into Yellowstone Park



and the extent of the unexpected and beneficial impacts on the whole eco-system fascinating and inspiring. The ultimate aim is for treatment systems to be operating with maximum reliability at the lowest cost to treat. For us to do that, we need to make sure our understanding of the whole water "Eco-system" is understood and continue to extend the boundaries of influence against which we constrain ourselves.

What does the future hold? How will industry and society change with our new found wisdom from data? Will we see a change in how water companies manage their assets? Indeed will we see the shift to service provision rather than equipment sales from manufacturers? Will we see more following the lead of Roll Royce, who rather than sell an engine can provide a lease service and charge on a \$/engine flying hours? This ability is based on Roll Royce having total confidence on performance through data analytics on their engines and using this information to minimise off-aircraft downtime. Do we see a future where water companies buy services based upon \$/m³ of water moved or \$ per kg of oxygen supplied rather than buying and maintaining their own equipment?

The equipment suppliers ultimately must cover all capital and operating cost so the use of data

analytics to maximise performance at lowest cost is vital. There have been examples where entire plants have been built for a client who pays on volume treated (and these are arguably the most efficiently operated) and we see examples of upfront capital investment by third parties, with benefits sharing on "spend to save" projects.

Big Data + Predictive Analytics = Improved Customer Outcomes and Reduced Cost to Serve. Big Data needs IT masters, Predictive Analytics need subject matter experts with statisticians and the whole requires our imagination and willingness to embrace a new tool kit to craft a new set of data based processes - rather than concrete based. The outcomes won't necessarily be new physical assets, but ways of behaving differently to get better results with what we have already. An open mind is critical and we shouldn't dismiss this amazing new set of tools which could create significant value enhancing products.

Collaboration with other, diverse industries will also be key to success. As experts on water and wastewater, MWH has teamed up with Accenture, a data and transformation expert provide the right mix of knowledge and capabilities to meet this new challenge. We invite other water industry protagonists to join in the revolution and deliver something truly masterful.



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