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IN

104 PAGES OF
IDEAS TO
FUTURE-PROOF
YOURSELF &
YOUR BUSINESS

2015

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ON THE YEAR
OF THE ROBOT

SAUL KLEIN
ON THE CREATIVE
ECONOMY

CARLO RATTI
ON DRIVERLESS
FUTURE CITIES

PLUS 101 MORE IDEAS THAT WILL CHANGE THE WORLD

applications not only for post-surgery monitoring but will also allow the internal monitoring and treatment of cardiac problems, cancer, diabetes, arthritis, infection and other ailments.

The sensors are essentially nano-size electrical circuits that can identify bacteria, blood components, cellular mutations, bone-density loss and, if necessary, can apply treatment. Because of their size, they can probe tissues and cells, collecting information and making real-time diagnoses. If they detect a problem they can communicate with a smartphone and report if an ailment has been sensed. In the event that sensors themselves cannot treat the ailment, they will provide detailed information for clinical intervention at a much earlier time than if traditional methods were used.

Although these nanosensors can be placed directly into the body to gather data, their clinical application in 2015 will centre primarily around their incorporation into traditional implants, such as artificial hips or vascular stents. If the sensors pick up anything untoward, they can be programmed through a handheld device to release a drug to kill bacteria or reduce scar-tissue growth so that bone can grow healthily next to the implant. By releasing drugs, or in some cases by

SETTING THE PACE

A team from Korea Advanced Institute of Science and Technology has proven its pacemaker, a flexible semiconductor film, can harness enough energy from a rat's movement to stimulate its heart. LC

releasing a small voltage at the site, healthy-cell toxicity can be avoided and a more effective treatment can result. The same approach can be used to monitor the state of vascular stents. Most are made of metal and can induce an inflammatory response and cause the artery to clog again. Sensors can be placed on the stents to report back if tissue growth occurs and to release a drug that makes clots decompose.

These are early days for internal nanosensors, but the concept has a lot of potential. In the longer-term future, the technique could be used to treat cancerous cells. A tumour can be treated more effectively with minimal toxic side effects if a chemotherapeutic drug is released next to or inside the cell.

We are entering a new era of personalised medicine, in which we can detect changes in biological functions and fix them before they lead to complications. *Thomas Webster is professor of bio-engineering at Northeastern University*



THE RETURN OF DEEP SLEEP

We will wake up to the huge importance of slumber for our mental and physical wellbeing

By **Russell G Foster**



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SLEEP REMAINS THE BEST AND MOST effective way to enhance our cognitive abilities and health. In 2015, we will recognise that the way we have downgraded it is dangerous.

Throughout the 20th century, humans in the developed world abandoned sleep. Thomas Edison introduced commercially viable incandescent light bulbs in 1879; by the time artificial lighting proliferated 50 years later, our work and leisure time had been transformed. Today, extended working hours, long commutes, 24-hour social media, distractions from multiple electronic devices and the alerting effects of light on the brain's arousal systems all conspire to distort our ability to experience sufficient biological sleep. In an attempt to cope with tiredness, many individuals have fallen into a stimulant/sedation feedback loop whereby stimulants

such as caffeine and nicotine perk us up during the day; at night, sedatives such as alcohol and sleeping pills are used to calm us back down again.

Research tells us that a huge amount of essential physiology occurs during slumber. The pathways linked to carbohydrate metabolism, "stress" hormone release and inflammatory and immune responses are all rebuilt during sleep. It is also critical for memory consolidation and information-processing by the brain. We have all benefited from sleeping on a problem. Disrupted sleep, by contrast, contributes to a broad range of interconnected health problems such as type-2 diabetes, reduced immunity, poor decision-making, anxiety and depression.

In 2015 there will be widespread recognition that sleep is the best health and cognitive enhancer available. In the UK, funds from the Wellcome Trust, the Sir Jules Thorn Charitable Trust and Oxford University will enable the launch of the first institute dedicated to understanding the fundamental neuroscience of sleep. It will raise awareness about the importance of sleep and initiate several major studies - for example, the impact of a later school start time will be assessed on the health and educational performance in large numbers of teenagers. A major survey will define sleep disruption in individuals with eye diseases, correlating their severity with an individual's ability to align their sleep to the natural cycle of light and dark. Another study will investigate sleep in patients with bipolar disorder and schizophrenia.

In the commercial sector we will begin to see new devices to measure sleep and its related behaviours. Plenty of apps and sensors are available which are supposed to measure sleep, but few have been rigorously validated and some may even be misleading. But companies such as Jawbone, Philips and Apple are working closely with sleep researchers to ensure that the next generation of devices provide accurate and robust measures of sleep. And these will not only tell us about our sleep, but also give us an excellent metric of our physical and mental health.

Russell G Foster is professor of circadian neuroscience at the University of Oxford



SUPERBUG SPREAD

Ongoing research could make superbugs a thing of the past. A team at Queen's University, Belfast, is testing an antibacterial gel that breaks the bacterium's biofilm coating, one of its key defences. Microbiologists have isolated a fungus molecule that, when combined with antibiotics, disables the bacteria. And a Lund University team is exploring antibacterial effects of 13 lactic-acid bacteria from bees' stomachs. LC