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Nanotechnology and the built environment



Building intelligence

As the vertical construction boom in the UK shows no signs of stopping, one British nanotechnology company has created a revolutionary system aimed at saving lives in the event of fire in tall buildings



DataTecnics, an award-winning company based in Birmingham, has developed a nanosensor system designed to safeguard the inhabitants of high-rise buildings in the event of a fire. The smart cladding system, which monitors and assists the safety of those involved, is currently in production, and the company is now also exploring solutions to enable the safe evacuation of trapped inhabitants.

This is a welcome development at a time when vertical construction is booming, thanks to the spiralling cost of UK land, the value of which has risen by £450 billion in the past twelve months alone. There are currently 500 high-rise structures in the UK's construction pipeline, of which 70 per cent are destined for use as homes. This reliance on tower block buildings has led to heightened risk and safety concerns, something tragically underlined by the recent Grenfell disaster.

The incident, which claimed the lives of 72 people in 2017, focussed

global attention on the safety issues of living in high-rise structures. Worldwide, there are 211,722 tower blocks in the largest 100 cities and with global urbanisation gathering pace – and heading skywards – residential health and safety has become more relevant than ever.

The sheer scale of the Grenfell tragedy was blamed on two main factors: the installation of combustible cladding due to poor regulation and the inability of the emergency services to reach those trapped inside. Inadequate legislation was also widely criticised.

Incredibly, issues with cladding were known long before the 2017 disaster: a report published in April 2016 by the Building Research Establishment (BRE), working on fire investigations for the Department of Communities and Local Government, cited a growth in the volume of "potentially combustible materials" being applied to tower blocks. "The problem with cladding is that it will, if it is able, spread fire and it will spread it vertically," Fire Brigades Union

official Glyn Evans warned the House of Commons. "If you get multi-storey buildings you will get fire spread up the outside if the cladding will permit it."

The second risk factor in such vulnerable structures centres on accessibility. Fire services are unable to reach floors over 32 metres high (ten storeys) yet British planning regulations state that only one staircase is needed in a high-rise, leaving just one major point of exit.

An interim report by the Health & Safety Executive was scathing about the UK's current fire safety regulations, condemning them as "not fit for purpose". It is widely hoped that there will be some legislative changes to boost current standards, however, the logistics of accessibility and evacuation remain a pressing concern.

Small things, big visions

Spurred on by the aftermath of Grenfell, DataTecnics began to explore how nanotechnology might be used to overcome the inherent dangers of tower blocks. Nanotechnology is a scientific field which involves the study and application of tiny atoms and nanostructures and is fast emerging as a promising technology for innovation in sustainability, health and safety.

Nanotechnology is extremely technically efficient; for example, the correct arrangement of atoms can help create carbon nanotubes hundreds of

times stronger than steel, yet six times lighter. This technology has generated a new world of possibilities in today's disruptive landscape: engineers are currently exploring carbon nanotubes as an efficient and sustainable source of construction material such as cars and aircraft, which would lead to economic and sustainable products. One of the key developments are nanosensors, which have long been used in space, medical and military fields and rely on wireless technology.

DataTecnics has embraced the use of these nanosensors – to develop Intelliclad, a system of non-combustible cladding panels which contain smart micro-sensors designed to monitor the safety of buildings through three core modules.

Firstly, micro-sensors monitor the safety and integrity of the tower block in real time, with inbuilt multiple failsafe systems. In the event of an emergency, Intelliclad triggers an alert to emergency services, followed by a sequence of automated SMS messages to residents and fire marshals.

In the event of a fire, Intelliclad sends risk data (on people count, location and hazard conditions) to emergency response services in advance of their arrival, allowing them to manage both the situation and the safety of those involved, saving them crucial time and allowing them to attend the scene prepared.

Intelliclad's system simultaneously activates 'Smart Hydrants': externally positioned rapid response hydrants acting as force multipliers for emergency fire services, through their completely autonomous assistance. The hydrants travel directly to the fire within seconds to extinguish the flames – a revolutionary approach to dealing with the early stages of high-rise fires.

"DataTecnics' singular vision is to achieve zero loss of human life in high-rise buildings"

Following rigorous testing of Intelliclad, DataTecnics has entered into partnership with Metalline, a leading architectural cladding manufacturer based in Staffordshire. Metalline has worked on many award-winning buildings such as The Curve in Slough and Number One Valentine Place, winner of the 2013 New London Architectural Award for an office building. Darren Brough, managing director of Metalline Services hails Intelliclad as a "real game changer, setting new standards for high rise buildings. Together, DataTecnics and Metalline are defining the future of building envelopes". Metalline's management is committed to its partnership and is expanding its product offerings into smart technologies.

DataTecnics founder, Mohammed Zulfiquar, explains: "The use of dynamic nanotechnology to provide these 'Smart Buildings' could be economically efficient, and projects that overall costs could be offset by reasonable insurance costs – while at the same time saving lives."

One obstacle to upgrading safety features can be particularly costly. Zulfiquar says that if just 10 per cent of high-rise structures globally were found to be lacking, there would still be an 'at-risk' high-rise pool of more than 21,000 buildings.

He estimates that using current technology, upgrades would require investment exceeding £42 billion at around £2 million per block, just to align them with current global safety standards. This is hugely significant as reluctance to invest is often cited as a cause of insufficient safety standards

and indeed was said to be one of the underlying causes of the Grenfell tragedy. Moreover, many tower block are run by cash strapped councils who may not be particularly amenable to such an expense.

DataTecnics is now investigating the speedy evacuation of those trapped inside via a series of pods or smart lifts situated on the roof of the high-rise. Although still in the concept phase, the company hopes to use kinetic and friction energy-controlled intelligent software to permit the movement of pods to the affected areas once the fire has been extinguished. It is hoped that residents or workers could then leave the high-rise and be transported down 50 floors in under two minutes.

Future vision

Zulfiquar believes that Intelliclad is a remarkable innovation and potentially a major contributor to saving lives in tower blocks. He states that DataTecnics' singular vision is "to achieve zero loss of human life in high-rise buildings, and low risk to buildings".

Creeping urbanisation across the globe will lead inevitably to greater pressure on that scarce resource, land. A comfortable and sustainable urban existence for the majority of us will rely on harnessing initiatives like renewable energy sources, the retrofitting of homes and offices linked to green areas; improved waste and recycling systems, advances in improved ergonomic design and cleaner and reliable transport to efficient use of utilities.

There is much talk of future smart cities – but tantamount is the health and safety of inhabitants: surely residents must first be able to live safely – in smart buildings – and that is where DataTecnics is the true innovator and pioneer of the 21st century urban vision.

Among the established trends of the 21st century is greater urbanisation. It's estimated that around 55 per cent of the world's population now live in urban settlements and by 2030 that figure will have reached 60 per cent.

As cities continue to expand, the safe and swift evacuation of its citizens becomes a challenge – one made even greater by the increasing impact of natural catastrophes. The Brussels-based Centre for Research on the Epidemiology of Disasters (CRED) reports that the global toll over the past 20 years has been more than 600,000 deaths, while 4.1 billion people needed emergency assistance either for injuries or because they were homeless.

However, while the number of natural catastrophes and resulting deaths and calls for assistance in 2017 was below the average for recent years, the total annual economic loss suffered from such events was almost 50 per cent more than over the previous 10 years.

Much of that increase is due to urbanisation. Not only are people moving to more densely populated cities, but more is being expended on infrastructure developments such as buildings, roads and bridges. These can add to both the number of casualties and the repair bill if an earthquake or typhoon strikes.

The growing importance of evacuating citizens promptly when a catastrophe is imminent was underlined in August 2005 when hurricane Katrina struck the city of New Orleans and the hurricane and subsequent floods killed upwards of 1,836 people. A succession of natural disasters in 2018 included last summer's Attica wildfires in Greece, which caused nearly 100 fatalities as the blaze spread before many people could be rescued.

The new urban vision

As cities continue to grow, the challenge of safe and fast evacuation becomes ever greater. Graham Buck looks at how nanotechnology and connected sensors be deployed in initiatives to save lives and reduce economic loss

By contrast, recent wildfires that devastated the Canadian provinces of Alberta and British Columbia destroyed thousands of buildings but resulted in few fatalities. The May 2016 fires saw the town of Fort McMurray, at the centre of Alberta's oil sands region, effect an emergency evacuation of all its 88,000 citizens.

Most recently, the quake and ensuing tsunami that struck the Indonesian island of Sulawesi on September 28 killed more than 1,200 people. Yet a decade earlier Indonesia had installed an early warning system of seismographic sensors, buoys, global positioning system (GPS) and tidal gauges. In the event, this failed to predict the scale of the catastrophe in which waves reached heights of 20 feet.

The system was developed and installed following the Boxing Day 2004 tsunami triggered by an earthquake near Sumatra. Reports stated that the deep ocean tsunami buoys designed to detect tsunamis in the open ocean had been subject to theft and vandalism and hadn't worked effectively for the past six years. However, it was also reported that only a more hi-tech system could have potentially saved lives.

Early warnings

CRED partnered with the United Nations Office for Disaster Reduction (UNISDR) in producing a report on 'Economic Losses, Poverty & Disasters' to complement the 2018 International Day for Disaster

Reduction (IDDR) held on 13th October. Launched 25 years ago, IDDR has become a global awareness event aimed at developing more disaster-resilient countries and communities. The World Tsunami Awareness Day followed this month on November 5, while The National Safety Day on December 26 will remember victims of the 2004 tsunami.

This year's IDDR was linked to the 2015-2030 Sendai Framework for Disaster Risk Reduction, aka the Sendai Seven Campaign, adopted three years ago as a global plan to "reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030" in UN member states.

The Sendai Framework established seven global targets and four priorities for action: understanding disaster risk, strengthening disaster risk governance, investing in disaster risk reduction for resilience, and enhancing disaster preparedness for effective response.

Reports on the disaster in Sulawesi suggested that it served to remind the world of a need for innovative new technologies on which effective early warning systems and quicker response strategies could be developed. Among examples of the potential benefits, an improved early warning system introduced 25 years ago is credited with giving Mexico City's residents almost two minutes of warning in September 2017 before strong seismic waves struck from the Tehuantepec earthquake centred off Mexico's

southern coast.

Nanotechnology, the branch of engineering that deals with the manipulation of individual atoms and molecules, is being successfully deployed in assisting the early detection and treatment of life-threatening medical conditions. Could it also play a greater role in facilitating the swift and safe evacuation of cities when an imminent natural catastrophe threatens?

Nanotechnology has already been incorporated as part of 'smart city' initiatives, which now number around 150 and have been adopted by centres ranging from London to Singapore. Their focus is on improving the quality of life of a city's citizens, increasing its efficiency and stimulating new economic activity. As part of the initiative, nanotechnology gas sensors can be deployed to monitor air pollution and the leakage of greenhouse gases, identify problems relating to ageing infrastructure such as gas leaks, and improve security by alerting the authorities when suspicious chemicals, possible explosives or poisons are detected.

Companies developing nanotechnology report that microscopic, but powerful, gas sensors can now be embedded into everyday items such as smart appliances, wearables, smartphones and smoke detectors. At the same time individuals are now developing their own sensors – often via smart phone – to monitor their environment and share information, which has seen the development of features such as crowd-sourced noise pollution maps.

"Nanotechnology has already been incorporated as part of smart city initiatives, which now number around 150"



Earlier this year, Dubai announced that it would employ nanotechnology as part of an initiative to make the United Arab Emirates' (UAE) biggest and most populous city the world's fastest in responding to fire incidents; reducing the typical response time from eight minutes to 30 seconds.

Dubai's civil defence says that it plans to install nanotechnology in the Emirate's commercial buildings and complete the project by the time the city hosts the Expo 2020 event in October 2020. According to reports, the technology is based around a material comprised of a solid layer with inlaid moisture, which will produce water vapour when the solid begins to melt in heat. The device stifles the three elements – heat, fuel and oxygen – needed to ignite a fire.

On the premise that most fires are electrical and triggered by causes such as short circuits and poor connections, the initiative aims to fix technology inside sockets and will initially focus on commercial buildings such as malls and warehouses before being extended to residential buildings.

A degree of hype?

Against the claims made for new technology's ability to provide effective early warning, academics such as Dr Simon Bennett, director of the civil safety and security unit at the University of Leicester, suggest that there is more than a degree of hype.

"Ask what practical benefits these systems can actually bring in the event of, say, a major event such as the 1994 Northridge quake," he suggests. "Failure to evacuate New Orleans in the wake of Katrina showed the impossibility of promptly clearing a major city – even in the world's richest, most powerful nation – and the authorities are lying if they try to pretend otherwise."

"Technocrats treat people as factors of production, who behave – or can be made to behave – in predictable ways. The assumption is that we're now all middle class, on our mobile phones and Twitter and if instructed to get out we'll comply. But as Katrina and other incidents demonstrate, citizens decline to leave their properties unoccupied for fear they would be looted."

"And to answer the question why Indonesia's complex early warning system didn't sound an alert on the tsunami, it's because second and third-world countries don't have the money or resources to maintain and operate the tech solutions donated to them by the developed world. So when nanotechnology companies claim their solution can accomplish various things, ask whether it would actually work in reality."

"We're led to believe that technology is the solution to complex and difficult problems, but very often the best solutions are the simplest ones and involve more money and 'boots on the ground'."

Building Intelligence

The world's first 'smart' cladding system



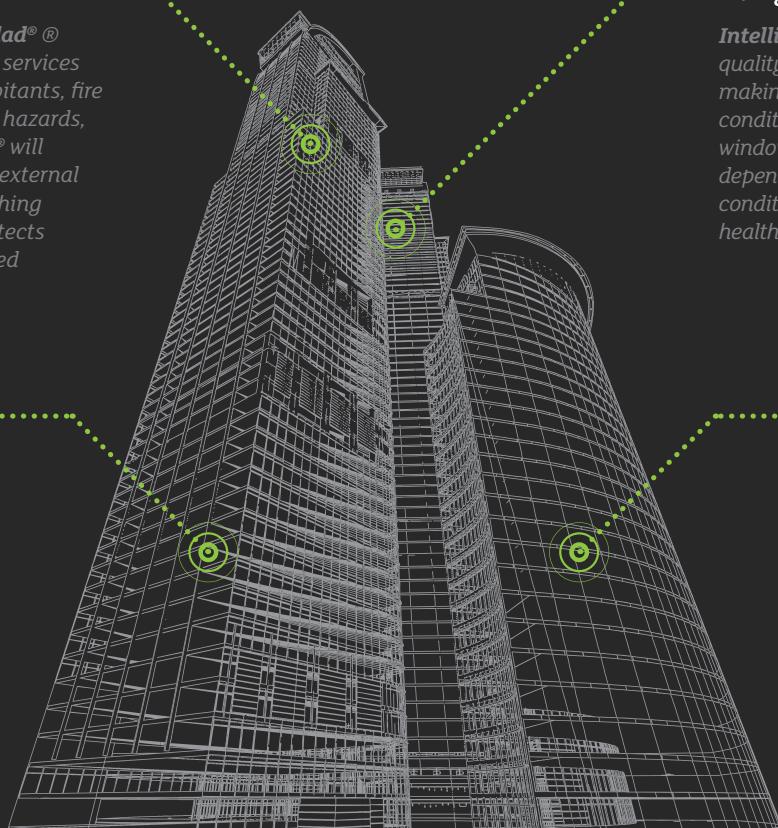
Fire

In the event of fire, **Intelliclad®** instantly alerts emergency services with relevant data on inhabitants, fire locations and other critical hazards, simultaneously **Intelliclad®** will launch **Smart Hydrant**: an external based robotic fire extinguishing unit that autonomously detects and responds to the localised fires instantly.



Evacuation

Through the use of our revolutionary **EE-Pods** (**Emergency Exit Pods**). These are externally positioned smart elevators which travel directly to the point of fire automatically (once safe) so residents can be evacuated from the building within minutes.



Air Quality

Intelliclad® monitors outside air quality in real time automatically making adjustment to air conditioning systems, closing windows and vent systems depending on the environmental conditions. Clean Air means healthy living.



Movement

Intelliclad® monitors the structural integrity of the building in real-time, ensuring safety. Structural weakness will be detected months before total failure.



Intelliclad® is the world's first 'smart' cladding system – building intelligence into buildings using smart sensors. The system monitors structural integrity and outside air quality in real-time to create dynamic, graphical maps of tower blocks and their surrounding environment. If fire breaks out, **Intelliclad®** uses its mapping system to instantly alert emergency services to its exact location and launch **Smart Hydrant**: a robotic fire extinguishing unit that autonomously detects and responds to localised fires. Evacuation Pods then travel to the fire point to help residents evacuate the building safely. **Intelliclad®** is here to catalyse the Smart Cities revolution by connecting buildings to the intelligence infrastructure, keeping a city's occupants safe and sound.

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