

The Edge, Amsterdam

Showcasing an exemplary IoT building



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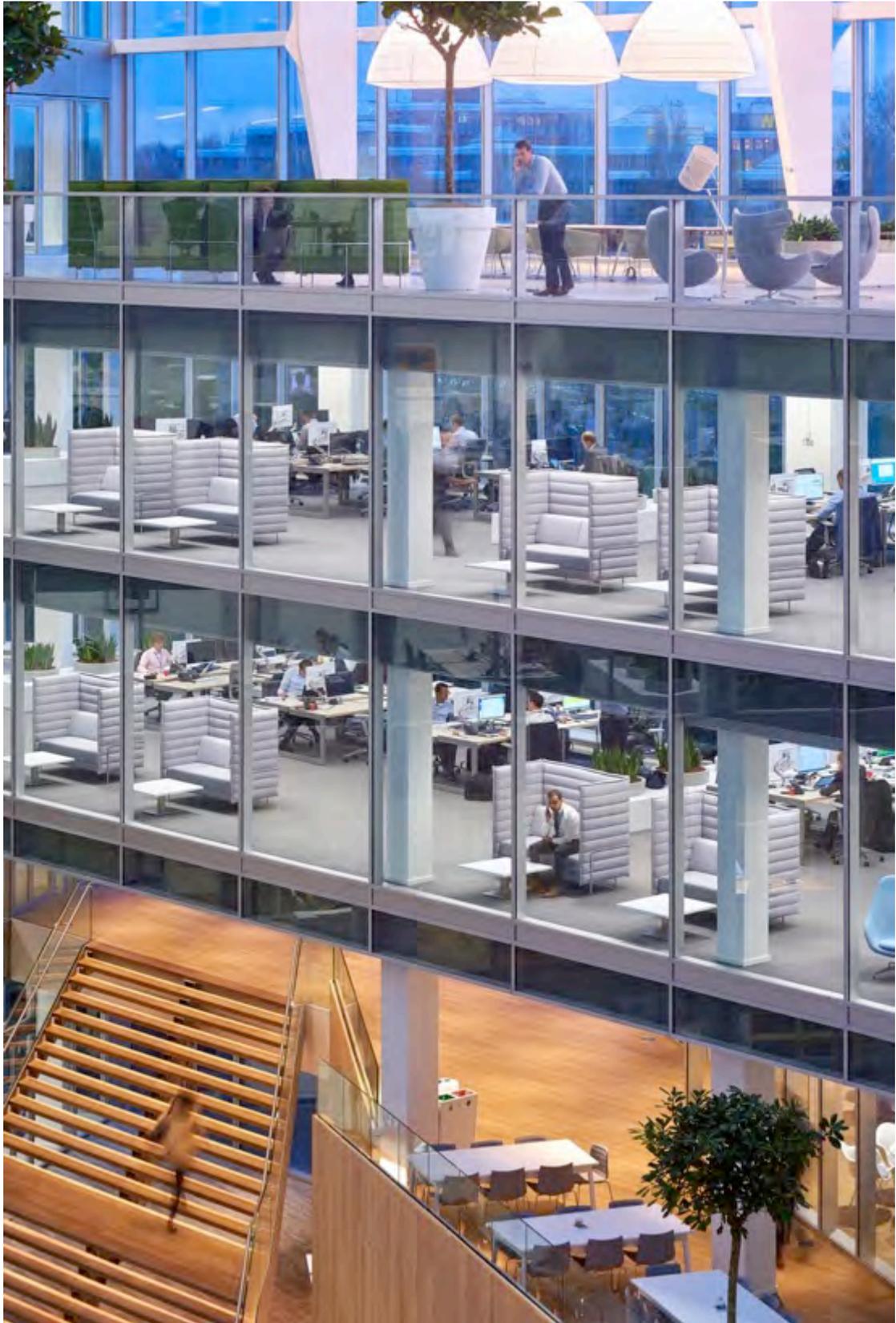


Photo: Ronald Tilleman

Cover illustration: PLP Architecture

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Introduction

“Building Information Modelling (BIM) is a collaborative process that seeks to add value throughout the life-cycle of an asset.”

- British Standards Institution (BSI).

Buildings pose complex design problems that require the harmonious synthesis of aesthetics, function and digital capabilities.

In its resolute promotion of BIM and progression from Level 2 to Level 3 over the coming years, the Government of the United Kingdom is promoting an inclusive working process that provides a single platform to key stakeholders involved in the design and construction of buildings to speak the same language. Communication lies at the heart of BIM with proven advantages in process-flows leading to work efficiencies and cost savings.

The Edge is an office building in Amsterdam, The Netherlands that showcases the benefits of BIM. Completed in November 2014, The Edge was built with the Internet of Things (IoT) as its foundational principle. Its design and construction did not use BIM in the prescribed sense but its implementation of smart technologies enables The Edge to achieve many of BIM’s benefits and it perhaps even serves as an exemplar for a few. Some of these are: automated energy performance visualisation¹, building usage monitoring and post-processing for energy analysis.

Since its completion, The Edge has been internationally admired as the smartest building in the world and has also been called a computer with a roof.²



The Edge seen from the motorway. Photo: Ronald Tilleman



The atrium is the social heart of The Edge with its café, tiered workspaces lit by diffused north light. Photo: Ronald Tilleman

However, the success of The Edge goes beyond its use of cutting-edge technologies and instead lies in effective communication between key drivers who championed diverse and original ideas.

This report identifies those key drivers, elucidates the synergy of their communication and presents lessons and limitations of this pioneering building in the context of digital built Britain.

¹ (Sanguentti, Paasiala and Eastman 2014)

² (Randall 2015)

Key drivers

Deloitte

The Edge was the brainchild of developer OVG Real Estate and Deloitte and continues to serve today as one of its most important Dutch locations. Following years of reflective research at the turn of the millennium, Deloitte's portfolio was expanding beyond Audit and Tax to one that offered advisory services with a broad range of expertise. Coupled with the imminent role that IT and big data would play in office environments, Deloitte were determined to use technology to make a statement with their new office building.

Their Chief Information Officer of 20 years, Erik Ubels played a key role in executing the company's vision of an IoT building by establishing linkages with leading technologists and working with them to push the envelope on existing capacities.

OVG Real Estate

OVG's CEO, Coen van Oostrom was influenced by Al Gore's compelling rhetoric on climate change. Convinced that a real estate company could make a difference to environmental sustainability, in 2007 Oostrom pledged to the Clinton Global Initiative for the creation of \$1 billion worth of sustainable buildings that used up to 60% less energy over a period of five years and was able to achieve this feat in just three.³ The Edge remains a keystone in OVG's portfolio having influenced their thinking for deploying smart technologies for environmental sustainability with their new projects building upon these principles.

PLP Architecture

London-based architecture firm PLP brought with them years of international expertise in office design that emphasized

interaction and passive technologies. Combined with their extensive experience in The Netherlands this was the reason for OVG to invite them to lead the Design Team.

PLP's original design for the building's massing and façade architecture was already aimed at high sustainability levels when BREEAM.NL was adopted in 2010, and OVG instructed the design team to aim for an 'Excellent' rating which was easily achieved. The Edge was eventually able to attain 'Outstanding' rating of 98.36% upon completion, making it the highest rated office building in the world at the time.

Technology Firms

Each of the three technology firms: Philips, Mapiq and Schneider Electric played vital roles in delivering the energy efficiency services and an unprecedented post-occupancy experience at The Edge.

They were brought on early in the project, which helped the clients explain their requirements and the architects to integrate their respective technologies into the building; ultimately resulting in a sophisticated product that blended functional architectural solutions on a digital backbone.

³ (Rotterdam Climate Initiative 2011)

Conception of The Edge

Around the turn of the millennium, Deloitte were conducting extensive in-house surveys across various departments to record how much time its employees typically spent at their desks. As different kinds of work required varying amounts of time to be spent at individual desks, the results revealed that less than 50% of their employee desks were occupied all the time. Consulting personnel in particular were shown to have a high desk-sharing ratio of 3.85.⁴

Deloitte also predicted that their employee numbers would increase by 78% by 2020. However, they sought to effectively reduce 36% desks by innovating a task and activity-based assignment system rather than person-based one, thereby accommodating more employees on a smaller footprint.

With this guiding principle in mind, Deloitte floated a competition for their new office, The Edge in Amsterdam. The team comprising OVG and PLP Architects won this competition in 2007 for their impressive design solution. The site for the project was an abandoned tram terminus in Amsterdam's upcoming business district of Zuidas.

It must be noted that before coming up with their designs for The Edge, PLP were encouraged to interact with Deloitte to fully understand their requirements. Deloitte's CIO, Erik Ubels thus had the opportunity to lay out his ideas for The Edge to be an intensely IoT product built from bottom up.

Bakker recalls that the conversations between Deloitte OVG and PLP were predominantly about people and the kind of experiences they would seek from new workspaces. It was important to provide

social spaces for colleagues to meet, exchange ideas and collaborate to innovate. Technology was seen as an enabler in the process.

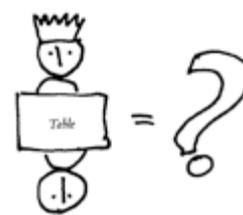
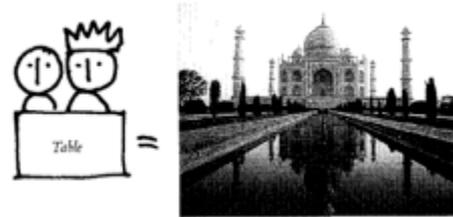


Image: Charles Correa, The New Landscape: Urbanisation in the Third World, 1989. Page 111

Architect and client on the same side of the table, Charles Correa.

With the client, developer and architect working transparently towards the same vision, gaining consensus was not a hurdle. This model of **same-side-of-the-table** interaction is an important requirement in the creation of remarkable architecture.

While architectural demands have greatly changed over the decades, the essence of being able to work with the client to fully appreciate unprecedented ideas remains a fundamental necessity for effective collaboration.

For a building like The Edge, a task of this scale mandated various partners come aboard at an early stage and identify overlapping areas that would require them to work collaboratively.

With a clear commitment to such an effort, the key drivers co-created the necessary conducive conditions for executing many new ideas which The Edge showcases today.

⁴ Source: Deloitte

Design Development and Construction

Bottom-up approach for an IoT building

Shortly after The Edge's concept design was completed, the 2008 financial downturn hit the world. At this stage, Deloitte wished to explore other tenancy models for The Edge in case it could no longer serve as its main tenant. A case was made for the neighbouring Vrije Universiteit to rent part of the building. Any tenancy permutation explored was likely to result in a different architectural design solution.

Throughout these combinations, the design team were keen on retaining the atrium at the heart of the building. A recurring theme in PLP's work, the atrium has particularly served well in office buildings Unilever in London, Danube and Nile Houses in Prague and the Heron Tower in London. PLP maintain that the atrium is a vital, unifying element of office architecture that can serve a social purpose as well as offer visual relief.

Sustainability and flexible working continued to guide the design. But a clear understanding also emerged among designers of The Edge that for the technology to work optimally, the architectural design of would also need to seamlessly synthesize passive, active and digital solutions across the 40,000 sq.m office.

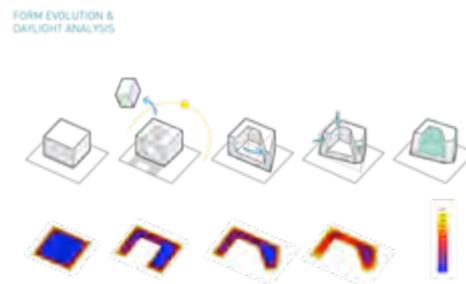
The design for The Edge was assisted at least in part by Dutch building bye-laws. One such directly applicable dictates that every employee has a right to daylight and needs to sit close to a window. Broadly interpreted, a window could be opening into a naturally lit atrium – like that at The Edge – or it could be one with an external view.



The atrium stretches 15 stories at The Edge with skybridges and balconies maintaining visual sight lines.

Photo: Ronald Tilleman

By differentiating between daylight and sunlight, the atrium at The Edge was oriented facing north. Solar path studies on 3-D computer models helped PLP explore several form iterations before arriving at an ideal shape for the building's footprint. By slicing parts of the northern faces, diffused natural light was drawn deeper into the floorplates and workspaces were organized to face a tiered atrium.



Solar and massing studies by the architects for determining the ideal form of the building.

Image: PLP Architecture

Passive and Active Design Features

Several other passive and active design features help make The Edge a sustainable building. The basement has parking for 500 bicycles as well as electric charging units for cars – a regular feature in The Netherlands. The south façade of the building has heavy load bearing walls that provide effective thermal mass through heat gain. When it was found that solar panels on the south would not generate enough energy for The Edge, rooftops of neighbouring buildings were rented to install additional panels that make up for the difference. The drive to achieve this was so clear that The Edge has only 1920 sq.m. of solar panels while another 2280 sq.m. of panels have been installed on other rooftops to make it a zero energy building.



Main entrance to The Edge. Photo: Ronald Tilleman

Ventilation systems installed at The Edge circulate air through rooms pushing used air into the atrium and eventually back into a central air handling unit on the roof. Rainwater is harvested and recycled to flush toilets and irrigate the surrounding landscape.

One of the most committed features pursued was to use the earth as a battery. An aquifer, 130 m below ground level, was bored into to trap heat which is stored over the summer and used to heat interior spaces in winter. Thus, by capitalising on geothermal energy differentials and other sustainable solutions, The Edge is estimated to have reduced its impact on the environment by 42 million kg

of CO₂ over a decade⁵ while continuously making remarkable energy savings.

During its construction phase, discussions between architects, engineers and contractors resulted in an optimal mix of prefabricated elements that would be assembled at site with efficiency thereby saving on time.

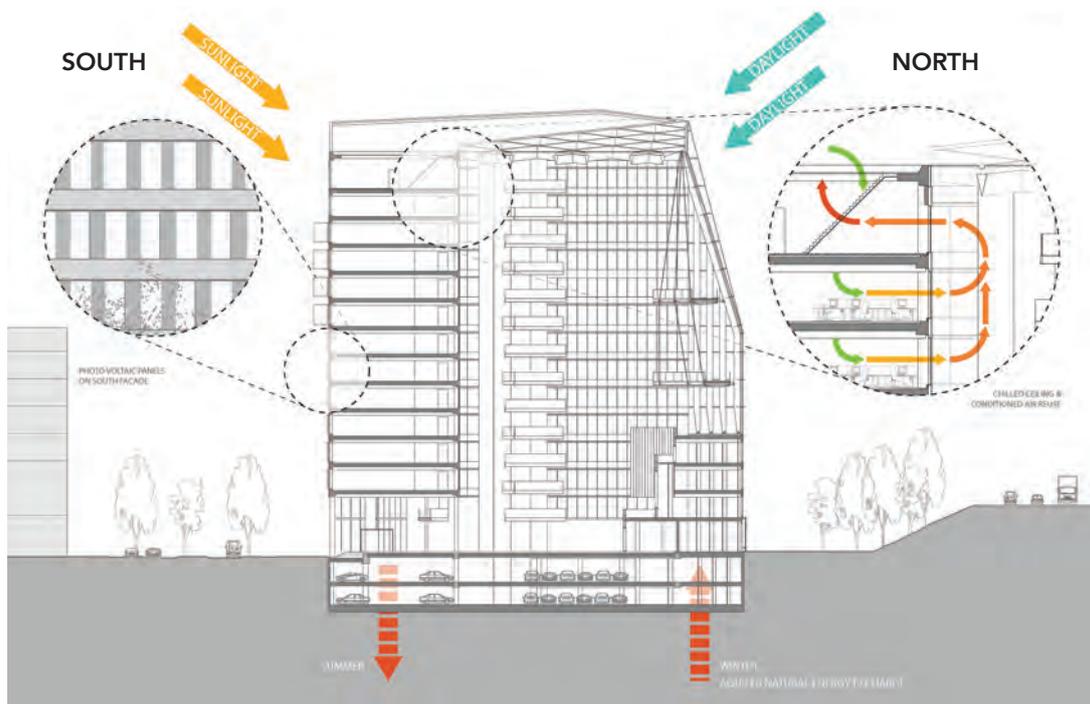
Digital Competence and Development of IoT concepts

While the sustainable strategies were being developed between the design team, external contractors and specialist consultants, Deloitte's Erik Ubels was keen on deriving data from all possible sources within the building post occupancy. Initially, there was only an idea for how this data might be used in the long-term, especially for predictive maintenance and occupancy monitoring, but the team prudently decided to future-proof its specifications for unforeseen, yet expected, upgrades in technology.

Evidently the technology to cater to such a requirement did not exist and would have to be invented. Ubels took this upon himself and liaised with Dutch appliances giant Philips to create a light fixture that was wired to the Internet. Philips was eventually coaxed into developing a brand new product with OVG, Deloitte and Philips co-investing towards its research and development.

This new panel has LEDs that are powered by low energy transmitted by Ethernet cables and has embedded sensors for motion, temperature, light and air. The panels were installed throughout the building with a unique IP address for each fixture thus enabling their remote monitoring. These panels are now part of the standard Philips catalogue and capable of accommodating several more sensors.

⁵ (Boston Consulting Group and World Economic Forum, Feb 2017)



A host of sustainable design solutions and technologies make The Edge a success. *Illustration: PLP Architecture*



Efficient construction of The Edge comprised prefabricated building assembled at site. *Illustration: PLP Architecture*



Above: North-facing atrium at night. *Photo: Ronald Tillemans*

Left: Solar panels on the south facade. *Photo: Aftab Jalia*

Ubels simultaneously reached out to Delft-based company Mapiq to collaborate with Philips for linking the smart light panels with an app that was user-friendly. Mapiq was then a young company specialising in IT-driven workplace occupancy services and used their expertise to develop a customised tool which is today used by all Deloitte employees at The Edge.

To seal the feedback circle, Schneider Electric, Mapiq and Philips were all brought together to identify areas of overlaps where each could inform more integrated delivery of their services while getting users onto the same platform – thereby saving the need for having to move between various programmes or APIs.

This synergy between key drivers at The Edge was instrumental in the final product that they were each able to deliver.

Post Occupancy

Sensing Intelligence

Navigating The Edge on Mapiq

The Edge has received widespread attention for its novel approach to occupancy and sharing of workspaces.

None of Deloitte's employees at The Edge have an assigned desk. They are all expected to use Mapiq's custom-built app for booking their desks based on the kind of work they need to do on a particular day. Mapiq provides a navigable floor-wise 3-dimensional model of the building to employees in order to choose from a variety of available desks and rooms. You can also see which of your colleagues have checked

into work and can find them in the building should you prefer to work near them.

As the Philips panels are integrated to communicate with Mapiq, users can further personalise their micro-environments to preferred lighting and thermal comfort settings. The app even remembers users' preferences so that they do not need to be re-entered each time you change desks.



Mapiq's customised app for Deloitte guides users to their destinations with a 3-D model of The Edge. *Image: Mapiq*

Understandably, such a uniform platform for bookings was only achievable with some level of standardisation. Deloitte provided all its employees with Apple iPhones and Mapiq's app was optimised for it.

Furthermore, by not assigning anyone desks, The Edge can accommodate 2850 employees across 1080 desks, i.e. more than twice the number of people than available desks. However, there are limitations. Many of Deloitte's personnel who liaise with the government find themselves back at The Edge on a weekday when the latter's offices are closed. These tend to typically be Fridays which are therefore exceptionally busy with the café and common areas being fully occupied as personnel are not able to find unreserved desks in main workspaces. But this only validates how efficiently The Edge houses its employees on other days.

Deloitte has further made its own tweaks to Mapiq's app. When using meeting rooms, lights flicker 15 minutes before the end of the booking to indicate wrapping up in time for the next one. This timer function, the

result of a simple script, has been much appreciated by employees and proven to be an effective indicator that re-asserts the app's use for making bookings.

Mapiq's app is also used by TU Delft for its Central Library and Industrial Design Engineering buildings. In Delft's university setting, Mapiq personalised the booking systems to have time limits which prevent users from monopolising any particular space for extended periods. At both The Edge and TU Delft users can find suitable spaces for work, check its booking schedules for the day and get even directions to their assigned destination.

Mapiq's app showing occupancy and room bookings across various floors superimposed on a 3-D model of TU Delft's Industrial Design Engineering Building. *Image: Mapiq and TU Delft*



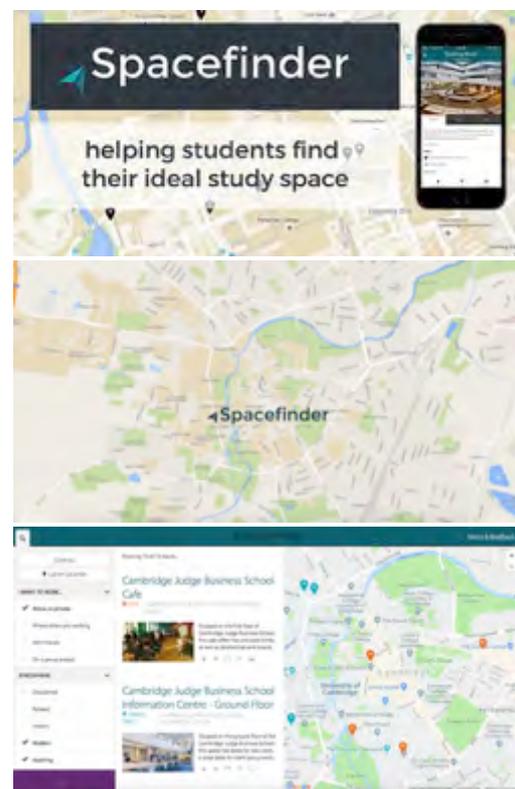
By having schedules readily available, students are likely to also stumble across lectures of interest rather than simply attending the ones they signed up for. Also, the routes from origin to destination are indicated for disabled-friendly options

where applicable or available making it more inclusive across a wider user group.

Comparing *Mapiq* with Cambridge University's *Spacefinder*

Similar to Mapiq's app, the University of Cambridge has created a web-based search to help students find suitable study spaces near them.

University of Cambridge's Spacefinder application uses filters to narrow down search results and finding a match. *Image: FutureLib, Cambridge University*



Developed by the university's FutureLib programme and launched in October 2015, a host of deductive filters allow users to select from a collection of possible workspaces to suit their mood, purpose and personalities. However, lacking sensors that could feed real-time data of actual occupancy or working status of those spaces, Spacefinder is limited to being a modest previous-generation substitute of its Dutch counterpart.

An assessment survey in 2016 revealed that surprisingly for an app that is meant to offer services ‘on-the-go’, 66% users accessed Spacefinder through desktops.⁶ Nonetheless, the search facility is accessible to users from within and outside the university with 14% visitors found to be using it from outside the UK in 2016.

Lockers & Coffee at The Edge

Two other effective examples of The Edge’s IoT at work are showcased through its locker facilities and maintenance of coffee machines. Automated lockers, offered by Vecos, are also integrated with the Mapiq app. Users reserve a locker using the app and are informed when they have not attended to their belongings for considerable time. Forgotten passwords are also easily reset thereby freeing up facilities management personnel, CBRE, for more pressing tasks.

Deloitte uses coffee machines installed by Swiss-based Schaerer at The Edge. As expected, all machines are connected to the Deloitte’s server via Ethernet and have individual IP addresses. When it was found that scheduled refills and servicing were not sufficient to provide uninterrupted coffee supply, Deloitte and Schaerer agreed to install a predictive algorithm that now prompts The Edge’s building maintenance team to attend to coffee refills *before* running out.

Data from the coffee machines must here be seen as a model that helps CBRE plan and organise their tasks for general maintenance of facilities through predictive models of management.

Technology and the Psychology of Ownership

An interesting observation from the post-occupancy scenario at The Edge is that of

the users’ psychology of ‘claiming and sharing’. This is at the core of Mapiq’s thinking and psychology experts at the company talk about how *bricks, bytes and behaviour* are interconnected.⁷

By promoting the idea of not having dedicated desks, Mapiq has observed that this makes clients confront issues of claiming territory and having to change habits. According to Mapiq, the key to space sharing lies in taking away the fear of change, and in particular, taking away the loss of ownership.⁸

Of course, The Edge had to first ensure that employees would be able to reserve desks or rooms using Mapiq before launching them into uncharted waters of a large office building without assigned desks. But by boldly exploring this notion at The Edge, Deloitte, OVG and Mapiq have set a trend that each is determined to capitalise on from a pioneer’s vantage point.

Benefits of BIM for Facilities Management

Each floor on The Edge is equipped with building management computers that are connected to zone controllers. Understandably, resources dedicated to facilities management by CBRE, occupy a sizable footprint.

Having centred its demonstration of smart technologies on a virtual 3-dimensional model, The Edge also successfully showcases the applications of BIM.

Through localised mapping of its users, occupancies and use of facilities across the building, The Edge deploys intelligent digital cartography. Deloitte continuously collects data on staff activities and

⁶ (Andy Priestner 2016)

⁷ (Mapiq 2018)

⁸ Ibid.

interaction. This data generated over longer durations is beneficial for CBRE who can observe and predict areas within the office that require more upkeep than others. Knowing which days of the week or month will staff not be using certain parts of the building, these can be closed off with employees concentrated on a smaller footprint thereby leading to energy savings. Similarly cleaning staff are informed of which areas need more attention making them more efficient in delivering services.

Over shorter periods, this showcases excellent application of BIM that embeds occupancy data through a simplified graphical interface for a variety of users to access. Typically, front-end users are offered an interactive 3-dimensional model of the building that allows them to achieve relevant tasks while back-end users oversee its operations and structure data according to performance, function or arising discrepancies.

Therefore, what may have traditionally been a response-based service industry has potentially been turned on its head through the new opportunities provided by having to work with data on daily basis.

BIM for safety

The Edge's holistic application of integrated technologies can also be extended beyond benefits in locating people or desks and for facilities management. The focus of the latest BSI document for BIM PAS 1192-6 (2018) release is that of Health and Safety. By integrating strategies for emergency response and public announcement systems, the aim is to provide safer built environments.

London's celebrated smart building, The Crystal, opened in 2012, runs on Siemens' in-house BMS system and is presently testing its new upgrade – Desigo CC which

is in sync with the new Health & Safety guidelines and will integrate its building monitoring functions with emergency systems.

Technology, Construction and Engineering companies such as Autodesk, Mott Macdonald, Arup and several others serve as members of the steering group that informs the development of PAS 1192 guidelines. Their participation is expected to make the documents more industry-relevant so as to incorporate safeguards and futureproofing the BIM rollouts.

Potential and Limitations

Challenges in pioneering new thinking

Leapfrogging from vision to reality

As one enters The Edge, visitors will see Deloitte's promotional video of an envisioned situation where two kinds of users demonstrate the potential of an IoT building. One employee is shown using Mapiq to check into work and find a desk while facilities management personnel review the office occupancy in real-time on a particular floor. While much of this has been realised at The Edge, the film is an idealised vision of what The Edge continues to work towards realising.

At the time of writing this report, The Edge uses separate dashboarding for office occupancy and building management systems. This of course makes sense as not only are the two services distinct but they are also of varying degrees of importance to

different people. For example, users of the building have little to do with how much energy is being generated by the solar panels installed, which is important for the maintenance crew to know.

While dashboarding for office occupancy is supplied by Mapiq, information from Schneider Electric's Building Management System is visualised through Microsoft's Power Business Intelligence (Power BI) platform – an interactive data visualisation tool. The preference for using Power BI was simply its ready availability and robust offering. Ubels did not see the need to have these integrated onto one platform especially since the required data could very easily be synthesized through Power BI.



The Edge uses Microsoft PowerBI to analyse data generated from building usage. *Image: Microsoft, Deloitte and Bloomberg*

Upgrades are inevitable in the Digital Age

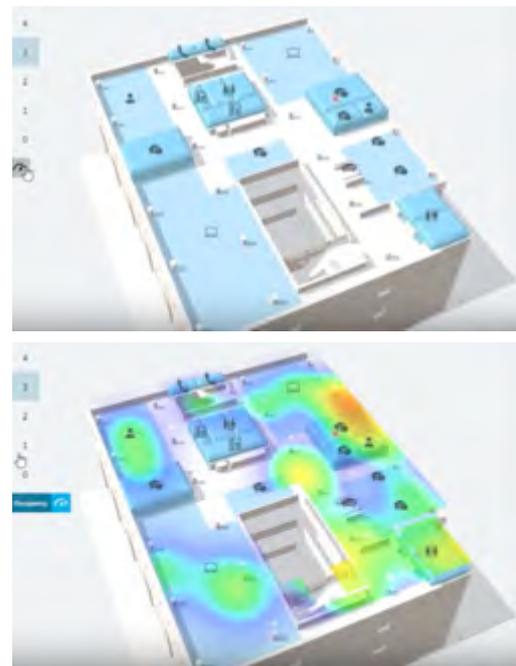
Even for human capacities

Going digital involves constant learning and improving. This is a quintessentially two-way process between service provider and client. For example, Mapiq have continued to make improvements to its app for other clients.

At TU Delft, Mapiq uses a more responsive cloud-based app compared to the Internet-based one at The Edge. Mapiq has even gone a step further and introduced a new

offering: heatmap visualisation – which allows users to understand the volume of people in any particular floor and zone at a given time. Over a period, researchers can analyse such data to assess floorwise occupancy trends and identify potential vacancies, preferences, as well as problems that may warrant attention.

Though superseded at present, The Edge's version of Mapiq is easily upgradable when necessary or desired.



Heat maps are Mapiq's new offering giving real-time data on group occupancy in buildings. *Image: Mapiq*

Deloitte are also determined to build upon their expertise in smart building and an IoT integrated Edge offers them excellent foundation to build upon and test any new ideas. The Edge sets an unprecedented example in the application of IoT to an office building. And yet, having studied how it draws information from various user activities and sensors, it can be stated that despite the technology in place to harness its potential, the data generated is massive and its collation not fully engaged with. This is not unknown to The Edge's key drivers and for a building that has reinvented the future of workspace its full potential is yet to be unleashed.

Big Data from Small Buildings

Quantifiable data and implications

Data from the nearly 28,000 I/O points at The Edge is constantly fed into a ‘data lake’. It is thus vital that systems engineers know what exact data is one seeking to analyse. Data at The Edge from BMS and Mapiq is also not analysed in real-time but is stored and ready for reference when required.

Despite the many advantages of an IoT building, technology is not always perceived as a friend or an enabler by users. Deloitte’s employees can select, and often do, to not be tracked by their Mapiq apps. This has to do with the mind-set of not wanting to be followed within the building while opting out also disables some of the responsive features of the building for you. The question of how much telecommunication companies and IT giants such as Google already know about users through their phones is a highly relevant issue of our time worthy of appropriate measures for protecting citizens’ privacy and data.

Let’s take this a step further. The Netherlands has been promoting smart technologies at the city scale for many years now. Its transport services receive data from travellers using the Amsterdam City Pass on the local train network and from attendance at museums. Programmes in other Dutch cities like Stratumseind in Eindhoven and Utrecht have also been piloting large-scale exercises in smart cities.⁹ The article further states: *“Utrecht keeps track of the number of boys and girls hanging in the streets, their age and whether they are acquaintances.”*

Users’ concerns with surveillance therefore have to do with privacy and transparency. As long as companies collecting such data assure users of safe handling without unexpected personal consequences, with

governments ensuring that these promises are upheld, users will be less hesitant to share such data on their movements.

Addressing this to some extent, Mapiq are now exploring products that use Bluetooth Low Energy (BLE) sensors which track larger user groups indoors through low-resolution cameras. Due to the low resolution, faces of subjects are adequately blurred to remain anonymous while supplying data on occupancy.

This is of particular note as the European Union’s General Data Protection Regulation (GDPR) is set to be enforceable from May 2018 following a two-year transition period. The GDPR will put into perspective another important issue that The Edge has been addressing: *who owns the data generated by the building and its users?*

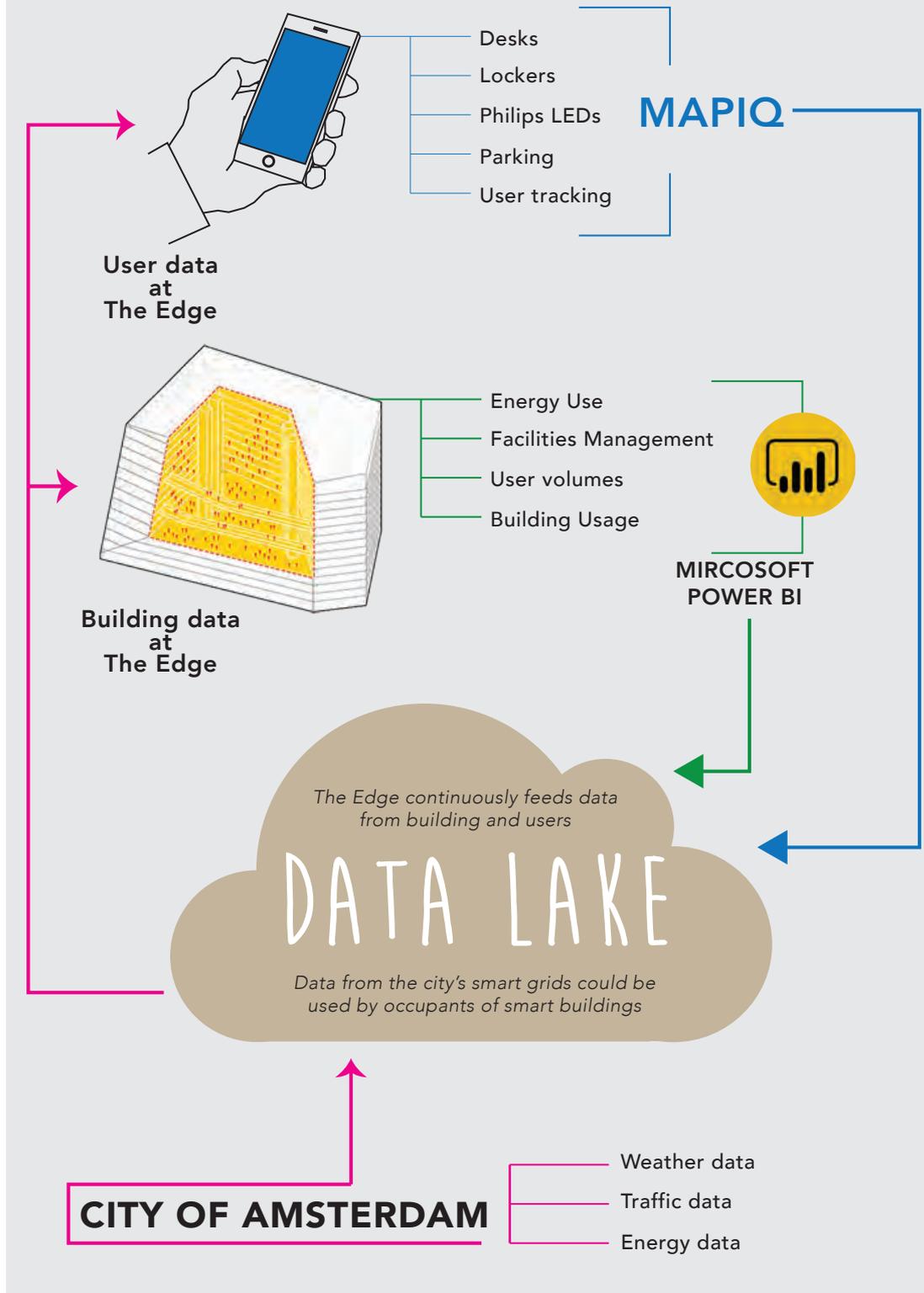
Also, Deloitte are not the only tenants at The Edge, which includes Salesforce, AKD, Henkel, Edelman, Sandvik and the building’s developers OVG.

As the standard Philips light panels were wired via Ethernet, they generate data irrespective of tenant. Similarly, all building occupants feed energy usage data into Schneider Electric’s BMS. Who then can claim the data as theirs? Is it the building’s owners – Deka, a German Real Estate company, The Edge’s original developers OVG or is it Deloitte, who masterminded The Edge’s IoT characteristics?

As the data lake server belongs to Deloitte, the data goes through them at present. But it still does not make the data theirs. Also, should Deloitte choose to leave the building altogether or the ownership change hands, would the data be sold off to the new owners?

⁹ (Naafs 2018)

BIG DATA FROM SMALL BUILDINGS



Although at present Deloitte's Data Lake is not connected to the city's smart grid, with the eventual proliferation of IT across scales this remains a likely reality. *Illustration: Aftab Jalia*

These are not straightforward questions and the GDPR's enforcement will prompt answers and perhaps also offer more clarity for future endeavours.

Undoubtedly, clarity on laws regulating use of data will ensure that more buildings confidently choose to become IoT buildings.

“Data is the answer, but what was the question?”¹⁰

In a building where you could quantify just about any activity or energy usage of any appliance, it is important to know what exactly it is that you are looking for. The ‘data lake’ may just be a misnomer to what really is an ocean of big data. And it is only by asking the right questions can one receive required answers.

Bearing in mind questions raised from the ownership of data, OVG and Deloitte have only recently reached an understanding to share the data generated at The Edge for statistical purposes. In January 2018, OVG launched a subsidiary called Edge Technologies to assert its focus on the high-tech smart building market.

OVG is also months away from inaugurating Edge Olympic, located across the motorway from The Edge; and Unilever's Headquarters in New Jersey, U.S.A. With each building expected to flaunt unique sustainable features, Erik Ubels, now Chief Technology Officer at OVG is keen to see how data from the two buildings compares with The Edge.

Similarly, just about any smart building in the world can be connected to those above and establish a network real-time data

relative to their own architectures and contexts.

In context of BIM environments that allow you to generate and categorise data and data sets, users are able to further create hierarchies within data sets and also assign different values to each set at different points of time: short-term ones for daily and weekly patterns and long-term ones for seasonal and annual variances. Identifying these with dexterity is vital to maintain clarity on what can ultimately be done with the data in hand.

Lessons from The Edge

Flexing BIM's potential

The Edge adopted a complementary path to BIM i.e. one of IoT which has helped it deliver most of BIM's promised post-occupancy benefits. It must be maintained that BIM is but one tool for communication, which continues to evolve as we witness its rollout in industry.

BIM is about People

BIM adoption is a global phenomenon with the industry set to continue growing over the coming years. The market for smart technologies in buildings and BIM is also directly related.

The focus of using smart technology in offices is not only to minimise the carbon footprint of a building but also to actively promote human interaction, collaboration and creativity among occupants. There remains little doubt of the role that IT will continue to play in the building industry and it is in this context that emerging lessons from The Edge must be duly noted.

¹⁰ (Parvin 2014)

IoT and Data

Its provisions to collect and analyse user and building energy performance data makes The Edge a pioneer of IoT buildings. As most of its specifications were future-proofed for upgrades, the IoT abilities at The Edge are themselves expandable adding a layer of adaptable intelligence in running the building for years to come.

Furthermore, data by itself may not be a valuable commodity unless applied intelligently which also demands the increased capacity of those who work with it. Also, as new data protection laws such as the GDPR come into force, companies will be driven to find ethical and intelligent ways to work with user data.

New capacities and Systems

Integration

The success of The Edge has prompted Deloitte to merge its departments of Real Estate, Facilities Management and Information Technology as they were found to now be relevant to each other and having to share expertise in unprecedented manner. Similarly, the digital synchronisation of various sub-components of building maintenance, energy use, facilities and user data is key to a successful IoT building and BIM implementation. This necessitates the setting up of software ecosystems (SECO) by different vendors and software service providers for sustained upkeep, security and data sourcing.¹¹ An integrated system is what will ultimately empower buildings to progress from being responsive to predictive.

This has required acquiring new skills and building new capacities to benefit from cross-disciplinary exchange. Furthermore, fields that have traditionally dealt with data – such as Statistics and Actuarial Sciences – factor in ‘regression’ in their predictive models for investments. These safeguards

accommodate unforeseen discrepancies when handling large data, undoubtedly offering lessons that must be incorporated as IoT buildings learn from these disciplines.

Co-operation and Risk-sharing

One of the BIM’s agenda is to push towards a Common Data Environment (CDE) for enabling a more democratic setup between architects, consultants, vendors and building contractors to share project-related information through graphical and non-graphical media. Effective communication between key drivers and various project partners, as seen at The Edge, is thus a starting point.

In the Netherlands, a consensual approach to work is fundamental and contractors typically have more say in shaping the project in its nascent stages. Bakker attributes this to the Dutch tradition of dealing with dykes and states that arriving at consensus was crucial to ensuring that the project was not simply built as drawn but instead generated iterations across different stages of design and construction. For example, when the design team laid out the blueprint for the project, the contractor was able to draw up a sound estimate for various components, while at the same time making suggestions to the architects for contextually appropriate changes. The contractor was thus a vital link between key drivers as opposed to being an outsider whose interests were limited to simply delivering the project. We have already seen how other key drivers of The Edge, led by Deloitte and OVG, communicated each other from the very earliest stages of the project, co-developing unparalleled ideas.

This is a remarkable example of **risk-sharing** which, when extrapolated, is directly applicable to the global BIM industry as it tries to bring key project partners on the same platform through better interaction and CDEs.

¹¹ (Mapiq 2017)

Deloitte and OVG's roles here are analogous to those of local and national governments who can boost the building industry's inevitable uptake of BIM, especially for public projects, by bearing the onus of risk and thus incentivising developers for exploring new ideas with confidence.

References

World Green Business Council. *The Business Case for Green Building: A Review of the Costs, Benefits for Developers, Investors and Occupants*. Toronto: WGBC, 2013.

Andy Priestner, David Marshall and Modern Human. *Spacefinder Illuminating study spaces at the University of Cambridge and matching them to user need and activity*. Assessment, FutureLib, Cambridge: University of Cambridge, 2016.

Boston Consulting Group. *The Edge: Creating the world's most sustainable and most connected office building by integrating smart technologies and collaborating with suppliers*. Case Study, Geneva: World Economic Forum, 2017.

Garber, Richard. *BIM design : realising the creative potential of building information modelling*. Chichester, West Sussex: Wiley, 2014.

BIM Design: Realising the Creative Potential of Building Information Modelling. London: John Wiley & Sons, 2014.

Naafs, Saskia. 'Living laboratories': the Dutch cities amassing data on oblivious residents. *The Guardian*. March 1, 2018. <https://www.theguardian.com/cities/2018/mar/01/smart-cities-data-privacy-eindhoven-utrecht> (accessed March 22, 2018).

Mapiq. *From Smart to Responsive*. Whitepaper Document, Delft: Mapiq , 2018.

Mapiq. *Smart Building Ecosystems*. Whitepaper Document, Delft: Mapiq, 2017.

McGraw Hill Construction. *The market for smart technologies in buildings and BIM is directly related* . SmartMarket Report, Bedford: McGraw Hill, 2014.

Parvin, Alastair. "Data is the answer, but what was the question?" *Architecture + Urbanism*, November 2014: 126.

Sanguientti, Paola, Pasi Paasiala, and Charles Eastman. "Automated Energy Performance Visualization for BIM." In *Building Information Modeling: In Current and Future*

Practice, edited by Karen M. Kensek and Douglas E. Noble, 119 - 129. New Jersey: John Wiley & Sons, 2014.

Randall, Tom. *The Smartest Building in the World: Inside the connected future of architecture*. Case Study, Bloomberg Businessweek, 2015.

Rotterdam Climate Initiative. *Honourable recognition from former president Clinton*. October 4, 2011.

http://www.rotterdamclimateinitiative.nl/en/news/honourable-recognition-from-former-president-clinton?news_id=782&p=5 (accessed March 30, 2018).

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