

# USING GREEN WALLS TO HELP REDUCE POLLUTION AND ENERGY CONSUMPTION IN CITIES

## Research Method

Reviews of existing literature will be the primary source of research for the paper. Qualitative research will be explored and analysed to provide the reader with an understanding of the theory behind green walls and what their benefits claim to be. A background of the history of green walls and the types of green walls available will be used to introduce the subject and give the following research context. In addition to this, secondary quantitative data will be gathered and reviewed to back up the alleged benefits. Using case studies, information and data collected during the research, the theory behind each benefit will be backed up by numerical data that has been gained from existing experiments. The findings will then be discussed, and a conclusion will be made about how beneficial green walls can be.

## Background

A green façade refers to a system where self-climbing plants grow from the ground, usually up a trellis and cling to the wall or a cable and rope system that keeps it away from the wall to prevent damage. Green walls, which can also be referred to as living walls or vertical gardens differ as they use a system where plants are integrated into the façade construction in which plant and plant media are both placed on the vertical surface of the exterior wall. Green walls can be hydroponic or soil based. The first consists of two layers of fabric with pockets filled with the pre-grown plants and growing media. The fabric walls are supported on a framework and backed by a waterproof membrane against the building wall. Water and nutrients are delivered through an irrigation system at the top of the wall. The latter system uses metal boxes or trays which are filled with the growing medium, these are planted then hung vertically on the support system. These can often be a lot heavier and the size of the box restricts how far the roots can grow. These also use an integrated irrigation system to provide the plants with nutrients and water.

## Outdoor Air Pollution

Transportation is causing the majority of the air pollution by releasing carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter. They are then trapped in, by what is known as an 'urban street canyon'. An urban street canyon is a place where a street has tall buildings on both sides creating a canyon-like environment. When these harmful pollutants are deposited onto a green wall, they are absorbed by the plants. A study carried out in 2012 took into account the urban street canyon effect, estimated that street level concentrations of nitrogen dioxide could be reduced by up to 40% and particulate matter reduced by 60% due to the enhanced time that the air stays in the street canyon.

In 2011 a green wall was installed at Edgware tube station in London as it was an area with high levels of particulate matter in the air. 15 different species of plants were chosen based on their ability to a certain type of particulate matter. There was a great difference in the performance of each species and it was found that the smaller, hairy leaves had a greater ability to trap the pollutants.

## Indoor Air Pollution

As well as outdoor air pollution, indoor air quality can be detrimental to people's health and even more so as most people spend up to 80% of their day in an indoor environment where pollutant levels can be higher. These types of pollutants can come from mould, tobacco smoke, household products, carbon monoxide and more. Volatile Organic Compounds (VOC's) are air pollutants which are found at high concentrations indoors as they are emitted from every day items such as furniture, electrical equipment, perfumes etc.

An experiment conducted which studied the effectiveness living walls had in reducing carbon dioxide concentration levels indoors. Data was collected from the type of living wall, the plants species and the CO<sub>2</sub> concentration levels from the subject building. This was then input into a computer model and the results showed that CO<sub>2</sub> was reduced by 56%.

A study on a real green wall was carried out to assess the reduction of CO<sub>2</sub> in a test room. They found that increasing the light intensity significantly increased the green walls ability to reduce CO<sub>2</sub> concentrations. The findings indicated that a 5m<sup>2</sup> green wall of the plant species used could balance respiratory emissions of a full-time occupant.

## Reducing Energy Consumption

In hot climates, buildings heat up due to solar radiation, which means they then need to be cooled down mechanically, using up large amounts of energy. Unfortunately, in a city where there is lots of concrete and little vegetation it results in the cities being much hotter than the surrounding countryside, which is known as the Urban Heat Island effect.

Plants can absorb 50% of the sunlight they receive and reflect a further 30%. An experiment carried out in Spain, published in 2017 looked into the thermal performance of a green façade and a green wall. They were tested through heating and cooling periods where heat pumps were used to maintain the internal temperature during the test. The electrical consumption of the heating, ventilation and air conditioning was recorded throughout the study. It was found (Figure 2) that the cubicle with the green wall was able to make energy savings of 59% compared to the bare wall. The green façade achieved 33% for the same period. The temperature reduction of the outside wall surface of the green façade was between 7-12 °C whereas the green wall achieved up to 17 °C.

A year-long study in 2012 which placed green wall systems on the exterior of one of their buildings to test the thermal benefits of them. During the summer the external walls without the system on reached 45 °C but the wall behind the systems managed to reduce in temperature by 20 °C. During the winter the wall temperature behind the systems with plants was 4-7 °C higher than the wall with no system which meant that the plants did provide insulation.

## Can Green Walls Produce Energy?

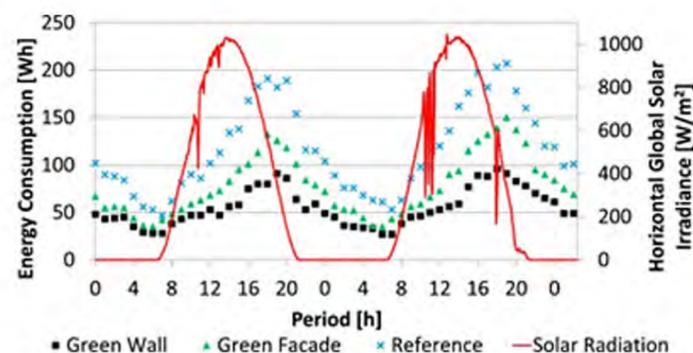
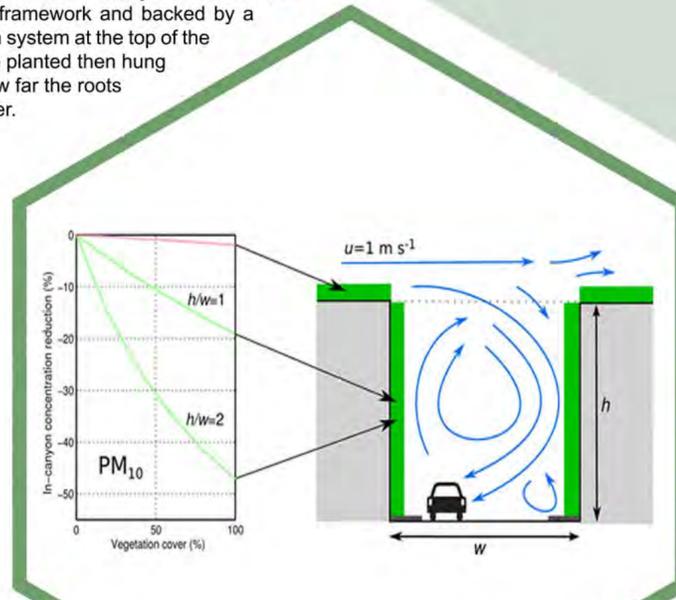
Researchers at the University of Cambridge have developed a green wall that can actually create energy. The prototype has been developed between scientists and eco-companies. The green walls have been adapted so that they can harvest electrons which are produced naturally as a by-product of photosynthesis and metabolic activity, and turn them into an electrical current.

## Conclusion

There are many known advantages to green walls, but this study focused on their ability to reduce air pollution and energy consumption. The research found that there was a large quantity of literature that explained the theory of how green walls work. However, in comparison there was not as many case studies to prove this. This may be due to the lack of funding, or the time it takes to carry out a comprehensive study on a green wall. Another factor could be that there are many variables in the air pollution tests and it would be difficult to provide conclusive outcome which applies to more than one green wall. Overall it could be concluded that from the information that is available, that green walls can be successful in reducing a small amount of outdoor air pollution, but more studies need to be carried out in a variety of places to see how they perform. For indoor green walls to be most effective they should be soil based to benefit from the microorganisms removing VOC's. Energy savings on mechanical heating and ventilation have been the best outcome of this study, the case studies proved how well the green walls worked both in summer and winter and was an excellent example of the benefits they can offer. In regard to the future of green walls producing their own energy, it may or may not lead to a significant source of energy but even enough energy to power themselves would make a contribution to energy savings.

## Introduction

There are over 3.5 billion people living in cities today, which is half of the world's population. In 2016 the Sustainable Development Agenda stated that by 2030, nearly 60 percent of the world will live within urban areas. With the clear majority of energy consumption and carbon emissions coming from cities, it is important to combine all the resources available to tackle climate change within urban areas, to really make a difference. This study will explore green walls to see how they can clean air pollution and reduce energy consumption. Using research collated from books, journals and online sources the study aims to investigate how well green walls actually work in practice in benefitting people and the environment and how to advance them for the future.





FIND OUT MORE ↑  
'THROUGH THESE DOORS'



## DESIGN, INNOVATION AND CREATIVITY: ALLAM MEDICAL BUILDING



### BACKGROUND AND CHALLENGES

This unique £26m investment brings together the Hull York Medical School, with the Faculty of Health to create a world class facility. Designed to attract and develop students and staff to shape the healthcare workforce of the future and address the critical local healthcare shortages. The building is rich in technology, sustainable and highly efficient to operate. It provides an innovative and practical environment to train future healthcare workers including a full mock hospital ward, operating theatre and intensive care nursing facilities. There are state of the art working areas for researchers as well as a large lecture theatre, an atrium housing a café, fully equipped meeting rooms, a think pod and 'green roofs' with external terrace areas. The contract also included the sensitive redevelopment of the Loxley research building.

### KEY CHALLENGES:

- Delivery on time for the new academic year, in Hull's City of Culture, with HRH the Queen also booked to open the building!
- Multiple stakeholder management including major benefactors
- High quality exposed concrete finishes (BS8500 standard)
- Working safely and at height within a complex, busy and live university campus, home to almost 20,000 students and staff, with a school located 25m from the site
- The scheme was £1.7m over budget at tender stage.
- Co-ordination of a complex structure and palette of materials, including over a 1000 tonnes of steel, curves, a green roof and specialist concrete panels
- Piling contractor delayed by 5-weeks due to an overrun on a previous project
- Major flood on-site, six-weeks from completion
- Asbestos removal and maintaining research activities



WHAT END USERS THINK →



### INNOVATIONS, APPROACH AND RESULTS ACHIEVED



**EARLY CONTRACTOR INVOLVEMENT:** A collaborative approach to drive value and work smarter, including back to back agreements with key suppliers IES and Moortown. This was paramount in key product selection including DSD couplers, continuity connectors, insulation and shear rails. Their expertise helped improve buildability, lifecycle costs and provide certainty of delivery. This included identifying £1.7m of savings to ensure the project was delivered within budget, safely and on time, without affecting the functionality or aesthetics of the building.



**PRODUCT DEVELOPMENT:** We worked with SpeedClad to develop an innovative aluminium plank rain-screen system with acoustic planks and light boxes, which improved the overall impact of the architectural design of the façade as well as the airtightness of the building.



**IDENTIFICATION OF MMC OPPORTUNITIES:** Exemplar project and factory visits were undertaken. This resulted in the development of an off-site pre-cast concrete panel solution with Techcrete. This reduced the programme period, whilst improving quality and reducing H&S risks. This also reduced the number of wagon journey's from 632 to 398.



**THE USE OF BIM LEVEL 2:** On the site team's tablets and mobile devices. This was invaluable in helping to phase the works safely, as the site team could 'look ahead' in the programme and view the progress of the concrete frame and panels. Stakeholders could also see how the space would be used, and produced detailed site logistic plans.



ProjectVault

**INVESTMENT IN DIGITAL TECHNOLOGIES:** Including 'Project Vault' collaborative software to improve transparency, progress reporting and exchange of information and ideas. 'Fieldview' CDA also used and during the final 12 weeks commissioning, soft landings meetings were held to ensure smooth snagging, inspection and handover outcomes by a dedicated commissioning team.



USE OF BIM →



**COMMITMENT TO SUSTAINABILITY:** We implemented a 100% green ISO 14001 purchasing policy. Innovations to protect the ecology, landscape and water courses included 'Silt-Buster', an on-site water treatment system. The project also included a low maintenance sedum roof and 80 tonnes of wood were recycled. The scheme achieved a CCS 'Beyond Compliance'.



**IMPLEMENTATION OF 4D PROGRAMMING:** To develop an efficient programme to improve co-ordination and minimise disruption. Ensured the works were delivered safely over three phases, ensuring business as usual, and staff and student safety 24/7.

The Allam Medical Building is transforming the way we teach the next generation of health professionals, giving them the very best opportunities and training to deliver the healthcare of the future.

Professor Julie Jomeen, University of Hull

£45m contributed to the local economy

2 Social Enterprises supported

99% of waste recycled

56 New jobs, apprentices and training opportunities provided

62% of orders placed locally

## COLLABORATIVE WORKING

### BACKGROUND AND CHALLENGES



In the 70th anniversary year of the NHS, our 13 year relationship with the specialist mental health service provider South West Yorkshire NHS Foundation Trust, highlights what can be achieved by creating a unified team and true collaboration.

The Trust like many others is challenged to deliver more with less to improve the quality of their estate as well as improving their staff, patient and visitor experience.

Trust challenges included delivering £9m of savings to meet their financial plan, providing high levels of care and 24/7 access for over 10,000 service users and maintaining a safe environment for 4,400 employees over 12 sites. The team have responded and flexed to deliver projects ranging from £100 to £18m in value.



### OUR APPROACH TO BUILD A UNIFIED TEAM

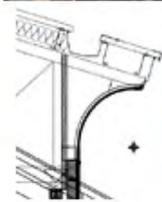


Our approach from day one was to develop a unified team, with aligned values and shared objectives. We have also invested in technology, tools and training to promote collaboration, and worked together as a unified team to develop processes.



**EARLY STAKEHOLDER ENGAGEMENT:** We have successfully implemented BIM Level 2 and used BIM visualisation workshops, design critique exercises, mood-boards; customer journey mapping, road-shows and sample-areas to improve stakeholder engagement. This has helped to get better feedback and streamlined the historic process by 27%. We are now able to communicate technical information to non-technical people more efficiently; clinicians time is expensive and this enables them to concentrate on their core business of treating patients.

**TEAMWORK, JOINT RESEARCH AND CONTINUOUS FEEDBACK:** To build a team quickly, we co-located all parties and used 'Project Vault' and 'Mentor' cloud based collaborative working software to share information more efficiently. We also invested jointly in product research and at the end of each project undertook a post occupancy evaluation, to feed lessons learnt back into the next project to achieve marginal gains.



### INNOVATION – WHERE TECHNICAL AND CLINICAL MET



**Delineated flooring at the entrance to bedrooms**  
BENEFITS: Service user behavioural management

**Electronic swiping for the switchable glass vision panel**  
BENEFITS: Audit of observations. Service users can't operate it



**Mock ups and rigorous testing**  
BENEFITS: Fully testing out new ideas/components to be used

**Programmable sensor**  
BENEFITS: Easily adjust the settings on sanitary ware



KPI	Customer Satisfaction Score									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Safety	100%									
Client Satisfaction	98%									
Product Satisfaction	94%									
Predictability Cost	98%									
Predictability Time	97%									
Defects	95%									



### WHAT COLLABORATION HAS ACHIEVED!



**PARTNERSHIP:** This is a genuine partnership we share risks and support each other, including the Trust charities and staff 'Excellence' awards.

- 100+ PROJECTS DELIVERED ON TIME AND TO BUDGET**
- 13 YEAR COLLABORATIVE RELATIONSHIP**
- 45 STAKEHOLDERS SUCCESSFULLY ENGAGED**
- 85 ENGAGEMENT WORKSHOPS HELD**
- UPTO 22% COST SAVINGS**
- Upto 32% programme savings**
- 11 APPRENTICESHIPS SUPPORTED**
- 40 APPRENTICESHIPS SUPPORTED**
- 9.7/10 AVERAGE CLIENT SATISFACTION RATING**
- 81% OF SUB-CONTRACTS PLACED LOCALLY**
- ADDITIONAL £150M GENERATED WITHIN THE LOCAL COMMUNITY**
- £800k SURPLUS**
- HELPED THE TRUST GAIN A FURTHER £2.5M OF DH FUNDING**
- AVERAGE SCORE 39.9**
- Care Quality Commission AUDIT IDENTIFIED: IMPROVED ENVIRONMENTS FOR BOTH STAFF AND PATIENTS – GIVEN A 'GOOD' RATING**
- 22 NEW JOBS CREATED**
- ACCIDENT FREE**

**LONG TERM PLANNING:** This framework agreement has enabled us to develop a masterplan together, prioritising work, mitigating risks, delivering work safely whilst, decanting efficiently, standardising products and components and reusing materials to generate over £2.4m of savings. We have invested in joint training up and down the supply chain, achieved the BS11000 collaborative working and customer service excellence standards. All KPI's have been exceeded, standards raised and investment in CDA software and a customer feedback app have ensured seamless defect free delivery with an improved experience. Improved sustainability, CO2 reduced by 18% (2407.14 tonnes) providing a £1.9m per annum financial savings. 68% of general waste now being recycled.

*This is a genuine partnership, Interserve has taken the time to understand our organisation and the smallest job is equally as important to them as the largest. This is very relevant to the Trust so the ethos of the two partners is very much shared ownership of all projects.*

**Nick Phillips, Head of Estates and Facilities, South West Yorkshire Partnership NHS Foundation Trust**

**FIND OUT MORE** →



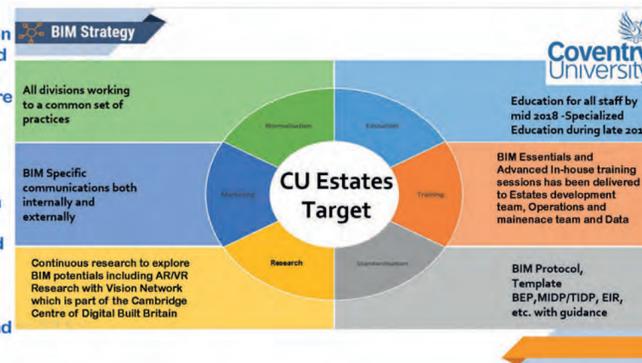
# BIM in Estates Building Information Management

BIM is one of the digital technologies that will help the university to grow. Coventry University Group is rapidly expanding and has multiple development projects in multiple campuses across the UK including Coventry, London and Scarborough. BIM is an integrated process that enables projects to be designed, constructed and maintained more efficiently and effectively than projects that do not employ this process. At its core it is a single information source accessible by all parties involved in the delivery process. All UK government departments and agencies are required to phase-in adoption of fully compatible 3D BIM on all projects by 2016 (Government Construction Strategy, May 2011). Therefore Coventry University Estates Department has formed a BIM strategy and implementation plan to meet the BIM Level 2 requirements.

We manage our information in a CAFM system and aim to link it to a CDE system and our existing BMS systems, a common data environment allows early, accurate and efficient sharing of information between team members working on a collaborative project. The process ensures that information is only generated once and then re-used as necessary, thereby avoiding duplication of effort and cost whilst ensuring quality standardisation. COBie is the Estates required information exchange schema for asset and operational data and information. The asset includes the Facility as a whole (as defined in our EIR's) and its constituent Spaces and Components. Spaces are grouped into Zones and Floors. For the schema, Components are grouped into Types and Systems and are allocated to a Space. We are providing a structure to get COBie data into a format acceptable by our CAFM system Planon and we provide our external consultants with details about this structure. In accordance with BS 1192-4 COBie worksheets are categorised into Core Asset information Operational information and Supplementary information. Estates use asset data and information for the following purposes in accordance with BS 1192-4 as a register of assets to support accurate auditing and reporting. For Maintenance and repair and capture Information on recommended maintenance tasks including planned preventative maintenance to enable the Estates to understand the anticipated cost of maintenance. Also Information about expected service life and costs to enable the Estates to understand the anticipated costs of replacement.

The use of BIM Models has enabled the university and the appointed project teams not only to capture asset information for operation and maintenance but also to perform clash detection to prevent clashes on site. And also to run energy analysis to meet projected sustainability targets.

Work to enhance the Estates BIM processes included research on the application of advanced visualisation technologies such as virtual reality and augmented reality and also the use of new technologies such as 3D Point cloud surveys instead of traditional methods. Also as part of the Estates aim to digitise all information a Digital Campus map has been created and Building models has been linked that have been received from consultants working on new building, refurbishment and accommodation projects around the university. Also work is ongoing to retrospectively model the existing buildings



**Virtual Reality & Augmented Reality**

VR ready models from BIM allow to demonstrate an immersive experience inside the building model. Work is ongoing to explore the use of VR/AR technologies in facilities management and information management.

- Enhanced Project team and Client Engagement
- Repetitive process training
- Site Simulation
- H&S process training

**Processes / Standards**

**EIR : Employer's Information Requirements**  
**AIR: Asset Information Requirements**  
**BEP: BIM Execution Plan**

**BIM In-House/Onsite 3D Point Cloud Surveying**

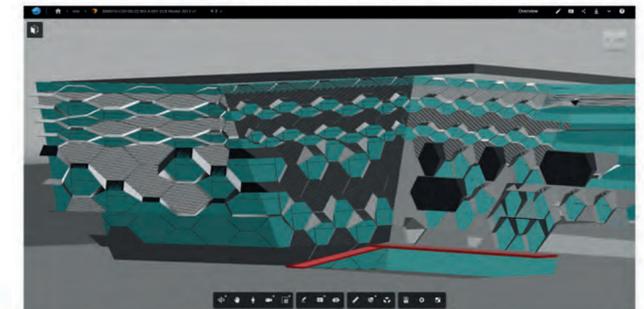
Ongoing work to take BIM on site by connecting information from our CAFM system PLANON into the Field apps and also connect to a CDE to implement best ways of using the digital technology to benefit all stages of project lifecycle from design to construction.

BIM has been used for modelling, Clash detection between models of different disciplines and also for energy analysis.

## Coventry University Estates Digital Campus Map + Digital Building Models



Engineering and Computing Building - Coventry University



# Developing a psychological safety measurement toolkit in a large safety critical organisation

Knowledge Transfer Partnerships

Rajkiran Kandola, KTP Research Associate



## The KTP project

Amey, a leading organisation in consulting and infrastructure support services has attempted to implement a strategic level intervention as the first step to understand psychological/human factor variables that could be associated with accident risk using an in house 'toolkit' made up various scales that are related to well-being (e.g. stress) and organisational priorities (e.g. production pressure)

Data derived from the 'toolkit' can be used to gather a detailed understanding of safety beyond traditional in-house safety indicators



A bottom-up approach was adopted in the development of safety 'toolkit' and the application of its accompanying framework

## Academic outputs

- Testing the factor structure of Zohar & Luria (2005) multilevel safety climate with other organisational variables in Amey rail and consulting employees (Kandola, Curcuruto, Morgan, 2017)
- Validation of Zohar & Luria (2005) multilevel safety climate measure using Amey participant data (Curcuruto, Griffin, Kandola, Morgan, 2018)
- Testing the mediation effects of organisational safety climate and group level safety climate on wellbeing factors and organisational priority factors (Kandola, Curcuruto, Griffin, Morgan, 2018) using Amey participants which are seldom researched with safety climate

## Challenges

- Data collection is complex
- Measures are mistreated, misinterpreted, under analysed and/or administered incorrectly
- Client demands
- Time required to research new, long term safety solutions
- No standardised procedure, process or support in place to measure psychological/human factor variables associated with safety
- Use of under researched variables (e.g. wellbeing)

## Benefits

- Knowledge transfer of data collection & analysis
- Involvement of workforce
- Ownership of data
- Ensures consistency across the business unit
- Allows better management/control of data
- Provides reliable, valid and better managed foundations
- Consistent BID knowledge
- Long term collaboration between LBU & Amey

## Company outputs

- Safety toolkit bespoke to Amey developed with access to recent measures of psychological/human factor measures
- Less reliance on external consultants
- Testing to enhance toolkit function and usability
- A behavioural safety framework developed by the workforce
- Scientific attitudes & opinions of safety from over 1,800 employees
- Intervention(s) developed based on results & analysis

# DEVISING AND DELIVERING AN URBAN CITY AT COMMUNITY LEVEL



**Planning  
to the  
people**



**The overall blueprint  
of any city begins at  
community level**

**Power  
to the  
people**

**Master-  
planning**

## INTRODUCTION

Over the last decade, it has become obvious the continual developments and building taking place within the inner areas of many cities and towns in the United Kingdom. Anyone living or even visiting any city in the UK will be familiar with construction sites that seem to spring up new buildings overnight. Plus, the sight of numerous cranes towering the skyline, as buildings are constantly being pulled down and built anew. Such is the scale of the regeneration agenda that will help transform towns and cities in the UK; both in terms of the way people will live in them and its overall appearance.

Masterplanning is defined as the overall blueprint for the future of any city. It has moved beyond the parameter of a conventional land-use plan to an approach that conveys a vision for the future of an area. (Ardron et al., 2008). The implementation of this device establishes a guideline for the city in question towards urban regeneration. However, the problem with delivering this 'refined city', is the thorough neglect of the communities that will be affected by the change. This study will explore briefly the effectiveness of local community participation as an integral strategy to masterplanning.

## LITERATURE REVIEW AND METHODOLOGY

For the literature review I looked at various policies and guidance which encourage public consultation in planning. Some of which include;

- The localism Act 2011
- Code of Practice 2008
- The local Planning Act 2008
- The National Planning Policy Framework
- Pre-application consultation with communities' guide,
- Statement of community involvement and
- Neighbourhood planning

**Community**

The intention of these policies is for decision-making to be passed down to a more local level, from local government to local communities. Residents and businesses are given opportunities to make planning policies that reflect their priorities, deliver tangible local benefits that have real weight in the planning system. However, having all these policies in place, why then is the public still unaware of the urban changes in the city?, why then do developers still carry on developing without consulting local communities?, why are communities' opinions neglected in certain planning decisions?, why is it that some communities are still struggling compared to the wider city? These questions serve as the rationale for adopting the questionnaire research approach to evaluate this study.

Furthermore, the primary data was obtained via an online questionnaire consisting of 10 questions emailed and (hardcopy) handed out to a total of 102 participants, comprising of members of the public, Individuals in architectural and construction sector, building regulations team, local authorities, private developers and local communities.

## DISCUSSION & CONCLUSION

The results from the survey were quite interesting, in the sense that it contradicted slightly with the policies reviewed.

From the survey, it was established that,

- The public claim to be unaware of the city's regeneration plans. As you can see from the chart here, majority claim to be unaware of the progression of their city towards regeneration
- They blame their obliviousness for public neglect. When reviewing why the people claim to be unaware of their city's progression towards sustainability/urban design/innovation, The main reason identified was public neglect. With a little over 50% responding that the public has not been made aware of its regeneration plans. On the other hand, almost half of the total respondents claimed to be ignorant and less interested in the urban happenings of the city. Further investigation involving the wider city is advised to determine that if some policies regarding consultation were legally required/mandatory, the public would not be ignorant of their right thereby avoiding the claimed neglect
- They feel their inputs, contributions and engagement matters
- They consider themselves to be the primary factor in any development plan
- Finally, they want to participate.

In conclusion, the effect of public participation on urban regeneration in the UK are the following,

- Local users are regarded as a bundles of information which cannot be obtained elsewhere.
- They hold insights as to the livelihood and what might not work in an area.
- Engaging the public can construct the awareness of matters that are not expressed by traditional 'data-gathering exercises
- The research highlights that public consultation is a determinant factor in urban planning processes. successful masterplans are brought about from involving the community and other stakeholders
- The end users are at the heart of masterplanning, as they play an integral role in their city's future development plan.
- They consider themselves as a factor which influences regeneration

Having said that, there are many benefits of public participation in the UK, but its effectiveness as an integral scheme to masterplanning is most essential. Developments don't necessarily have to be community-led or community-driven to be successful, it is the participation/consultation that counts. Devising this strategy of involving the community in city matters, will in turn stir its plans towards the delivery of a renewed setting.

**URBAN RENEWAL**

61%

39%

**Community Planning**

**WE THE PEOPLE  
WANT TO PARTICIPATE**

# RISEAWARDS 2018

## E.ON CHP PROJECT

### SUSTAINABILITY AWARD



E.ON Connecting Energies (E.ON) selected leading national engineering specialist, SES Engineering Services (SES) to deliver M&E design and installation services on the largest combined heat and power (CHP) project to be undertaken by E.ON in the UK. The scheme comprises design, supply and installation of new power, steam, low temperature hot water (LTHW) and chilled water generation plant.



This type of project has been a great opportunity to showcase SES' technical engineering expertise and collaborative approach. Further to the M&E work that is currently being carried out on the extension, as principal contractor, SES is overseeing the associated building works and the interconnection of the building services to the existing building. The works focus mainly on supplying renewable power sources to the plant, consisting of substantial high voltage (HV) power and protection improvements and upgrading the 60 year old boiler system for more efficient steam energy generation. All works are being undertaken whilst ensuring there is no interruption to the manufacturing and bottling processes.



This major building services project benefitted from SES' innovative pre-construction engineering and its adaption of a new and enhanced approach to Digital Engineering combined with its bespoke offsite manufacturing facility, Prism. The project, also sees SES acting as the principal contractor on an extension to the bottling plant in Rugby which is operated by a major soft drinks manufacturer.



Specialising in integrated energy solutions, E.ON provides tailored solutions in energy efficiency including on-site generation, virtual power plants and battery storage for industrial, commercial and public sector customers.




The new energy centre is capable of generating 9MWe electricity and 30MWt steam for drinks processing. The project comprises of:

- 2 No. 11kV 4.5MW natural gas-fired CHP units
- 1 No. 4.5MW Rotary Uninterruptible Power Supply (RUPS)
- 3 No. gas-fired 15T/hr package steam boilers
- 2 No. containerised 2.5MW standby diesel generators
- 1 No. 16T/hr Waste Heat Recovery Boiler (WHRB)



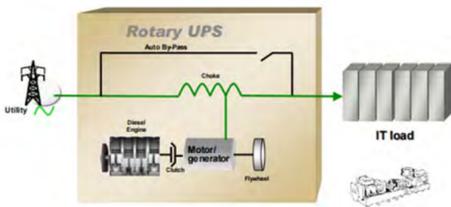
## ENERGY GENERATION

As an energy generation process, CHP is fuel neutral. CHP which is sometimes known as Cogeneration, is the use of a single piece of plant to generate both heat and electricity. In conventional power generation large quantities of energy in the form of heat are wasted.

The minimal waste heat from CHP exhaust systems will be recovered to steam using a twin stream heat recovery steam generator. Waste heat from the engine cooling circuits will be recovered and utilised in the bottling plant as LTHW and as the heat source for absorption chilling.

Two Rotary Uninterruptible Power Supplies (RUPS) provide power quality assurance.

The RUPS take the name "rotary" simply because of the rotating components within the UPS which are used to transfer power to the load.



Rotary technology has been utilised for many years and came into prominence at a time when loads would commonly exhibit a low power factor resulting in increased energy costs; leading to high harmonics which prematurely shortened the life of transformers and capacitors. The use of the RUPS on this project addresses those issues, and also prevents unacceptable/calamitous voltage dips and sags when large motors are turned on.



## BACKUP GENERATION

The two stand-by diesel generators, which are purely a backup power source, are limited to run only 500 hours per year due to environmental constraints. They will only be used in a worst-case scenario to keep the factory powered up in the event of total mains failure.

There is an environmental agreement in place that the plant, when fully operational, will create no more than 75Db of noise pollution. Engineering measures, such as attenuator installation, are in place alongside astute research and procurement of all plant and equipment SES has installed; ensuring they meet both the bottling plant requirements and environmental constraints.

## SERVICES AND BUILDING SYSTEMS

The facility comprises a dedicated two-storey electrical building complete with ground floor RUPS and a choke and transformer room, with High Voltage (HV) and Low Voltage (LV) electrical switch rooms located at first floor level.

Dedicated CHP plantrooms and boiler rooms are provided in separate fire compartments, whilst a new absorption chiller is containerised. The CHP coolers are located on a new mezzanine plant deck.

The system is controlled by a Power Management System (PMS) and off-site monitoring is provided to E.ON's Hamburg Remote Control Centre (RCC) via a dedicated Supervisory Control and Data Acquisition (SCADA) system. A SCADA system is an industrial control system that organises multiple technologies allowing the processing, gathering and monitoring of data at the same time to send instructions to the plant and equipment, allowing them to work collaboratively and utilise the energy in the most efficient manner.

The energy centre will be commissioned in late 2018 and will be fully operational in Spring 2019.

## OFFSITE MANUFACTURING

The two-part modular plantroom was manufactured offsite, at SES' offsite manufacturing facility in York, and delivered to site ready to connect to main incomers.

The plantroom contains; pumps, plate heat exchange and expansion vessels.

Benefits of offsite manufacturing include:



SES Engineering Services, Moorside, Monks Cross Drive, Huntington, York YO32 9LB Tel: 01904 437340



## Impact

Software development is a high-pressure, high-value business. Time to market is critical and developer time is expensive, so it makes sense to reuse existing code wherever possible. In such situations, developers tend to choose the first solution which “gets the job done”, often with little consideration of the broader effects of such decisions. Modern “web” and “cloud” software may easily be replicated to hundreds of machines, and be executed millions of times per day. Even small differences in resource usage can be magnified hugely, requiring more servers in larger data centres, needing more cooling, using more power and costing everyone more.

This PhD research aims to find ways to encourage software developers and stakeholders to make smarter choices about the long-term global impact of their work.

## Method

An initial feasibility study to investigate the range of differences between solutions to a common problem: generating web pages from templates. After selecting a popular programming language (Java), a representative sample of libraries was put through a series of capability and performance test scenarios. The results were analysed and compared with the claims from the documentation for each implementation. Tests were run multiple times under different loads to reduce the impact of systematic and “warm up” issues.

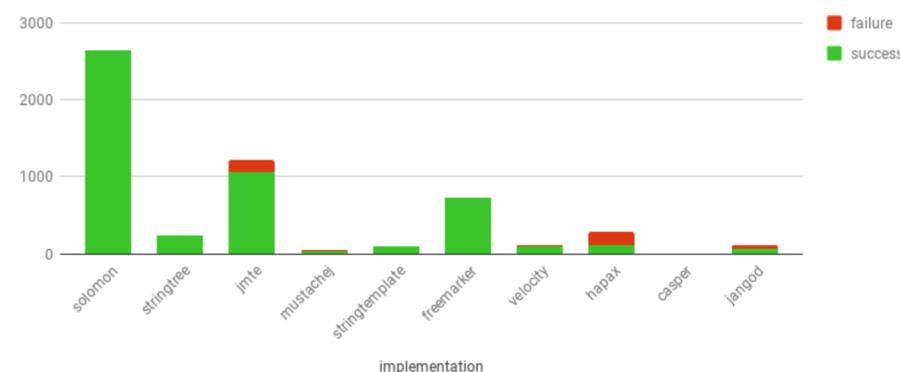
The *Indexed Web* contains at least **4.26 billion pages**. Intranets and “dark web” add many more. <http://www.worldwidewebsize.com/> as of 27 February, 2018

Templates represent **40–50% of the total bytes on the web**, and this fraction continues to grow at a rate of approximately 6% per year. Gibson et al. 2005

In 2016, US government estimated “it takes **70 billion kilowatt hours a year** to run the [US] Internet” Lawrence Berkeley National Laboratory, LBNL-1005775

In 2017 there were **22 million software developers** worldwide, a number that is due to rise to **26 million by 2022** Evans Data Corporation 2017

Normalised Average Speed vs Implementation Library



## Discussion

The most significant finding to arise from the work so far is the surprising variety in capabilities and performance between apparently similar software libraries. For some common operations in the feasibility study there was over *10,000 times* difference between the best and the worst performers. Averaged across different operations, the difference is still over 2,500x. Such stark contrast is nowhere to be found in the documentation, though. Even free software, without direct financial incentives, has documentation which usually reads like optimistic and unsubstantiated advertising copy. This in turn leaves developers unable to make informed choices.

## Future Research

Following the feasibility study it is planned to situate the results by a qualitative study into how developers select and evaluate library code and then investigate which approaches might effectively be improved. Quantitative experiments will continue, and include evaluation of external factors such as memory/CPU use and power consumption, all of which directly affect financial and environmental impact, as well as broadening the scope of the measurements to include code in other languages.

Are You Interested? Can You Help?

**f.carver@uos.ac.uk**

# Sustainable Concrete

29 billion tonnes of carbon dioxide is currently released into the atmosphere ever year

24% increase in global concentration of CO<sub>2</sub> (Since 1958)

Portland Cement Industry Second Largest Producer Of Carbon Dioxide And Its Accountable For 7% Of CO<sub>2</sub> Emissions Globally

## Approach

The approach was to make material substitutions so that the environmental and CO<sub>2</sub>-impact of concrete would be reduced. This can be accomplished by partial replacement of cement with large volumes of fly ash and recycled concrete aggregate. The implementation of fly ash into concrete reduces the water demand, increases the workability, reduces cracking due to thermal and drying shrinkage, and enhances durability to corrosion and sulfate attack (McKenzie, B. 2008). A comprehensive comparison between traditional concrete and sustainable concrete will be needed to educate the construction industry of the products advantages, both during the manufacturing process and construction on site.

## Climate Change

The concentration of carbon dioxide has dramatically increased over the pass years and approximately 29 billion tonnes of carbon dioxide is currently released into the atmosphere ever year. The global concentration of carbon dioxide in the atmosphere has increased by about 24% since 1958. This increase has a direct relationship to the Portland cement industry as its the second largest producer of carbon dioxide and its accountable for approximately 7% of the world's carbon dioxide emissions.

## Benefits of Fly Ash in Concrete

### Thermal Cracking

Thermal cracking is when cracks form within the first two or three weeks after casting caused by restraint to early thermal movements. The reaction between cement and water generates heat. The amount of heat and the peak temperature depend on many factors including the type of initial temperature, ambient conditions and type of formwork. As the concrete heats up it expands. Once the peak temperature has been reached, at around 12 to 18 hours after placing, the concrete starts to cool. Restraint to contraction causes the development of tensile

### Drying Shrinkage

Drying shrinkage is defined as the contracting of a hardened concrete mixture due to the loss of capillary water. This shrinkage causes an increase in tensile stress, which may lead to cracking, internal warping, and external deflection, before the concrete is subjected to any kind of loading. All Portland cement concrete undergoes drying shrinkage therefore being one of it's greatest disadvantage associated with the use of portland-cement concrete. This means that the water-reducing property of fly ash can be advantageously used for achieving a considerable reduction in the drying shrinkage of concrete mixtures.

### Water Reduction

Large amounts of mixing-water within the concrete mixture will cause many problems to the overall mixture. The link between water demand and workability are directly influenced by the particle size distribution and build-up of the mixture, which can trap volumes of the mixing water within the mixture and lead to undesirably high water requirement to achieve certain workability and optimum hydration of Portland cement particle. This can be resolved by partial substitution of portland cement with fly ash into the concrete mixture to reduce that water requirement for obtaining a decided consistency. Depending on the standard of fly ash and the amount of cement substituted, there can be up to 20% reduction in water requirements during this process.

### Water-Tightness & Durability

The limiting factor that causes reinforced-concrete structure to corrode from chemical attack, is mainly dependent on the water-tightness of the concrete. This effect is influenced by the mixing-water, materials and resistance of the concrete too cracking. Unlike conventional Portland concrete, a high volume fly ash mixture has the ability to yield substantial water-tightness and durability due to the different properties within the mixture.

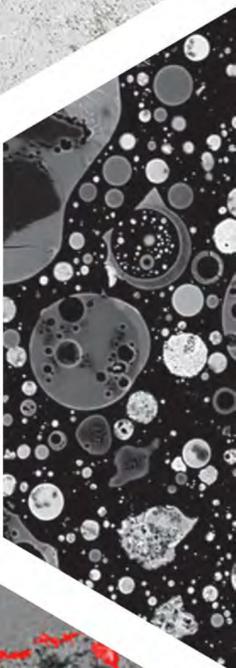
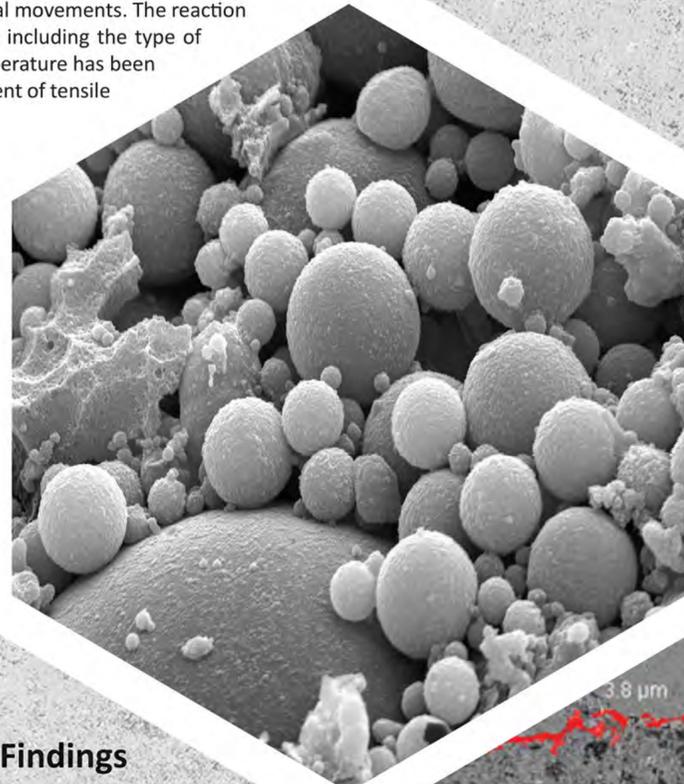
### Concrete Workability

Due to the high volume of fine particle in fly ash and low water content, this enables the concrete mixture to be very cohesive and show little water bleed and segregation. The factors enable good pumpability and workability. The wet consistency means that the material acts like a self-consolidating concrete. With the surface finish being smooth without honeycombs and bugholes.

### Conclusion

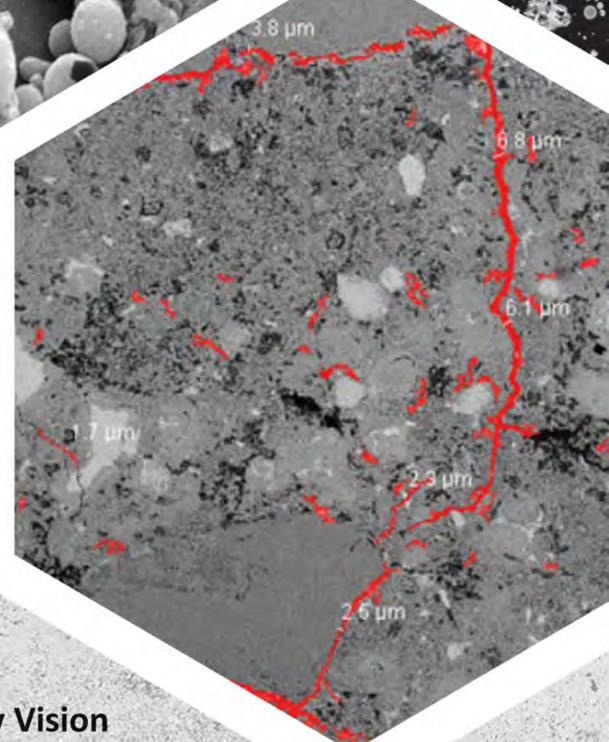
High volume fly ash concrete is one of the main platforms that the concrete industry can rely on to reduce it's environmental impact. Due to the increasing demands for concrete world-wide, it represents the only feasible solution that can reduce its dependency on natural resources. Another supporting factor for its use, is that fly ash is a by-product of the power industry and this method has the ability to reduce the environmental impact of two of the UK large industries.

Due to the growing demand for concrete globally, conflicts will start to develop between the economic benefits involved in developing infrastructure and the need to protect nature resources therefore a paradigm shift in scientific research and education is needed to change to a holistic model that puts cost-effectiveness and environmental benefit on a level playing field.



## Research Findings

- Easier flowability, pumpability, and compactability.
- Better surface finish and quicker finishing time
- Early-strength up to 7 days
- Much later strength gain between 28 days and 90 days or more
- Superior dimensional stability and resistance to cracking from thermal shrinkage and drying shrinkage.
- After three to six months of curing, much higher electrical resistivity
- Very high durability to chemical attack
- Better cost economy due to lower material cost and favourable life-cycle cost.
- Superior environmental friendliness due to ecological disposal of large quantities of fly ash



## Industry Vision

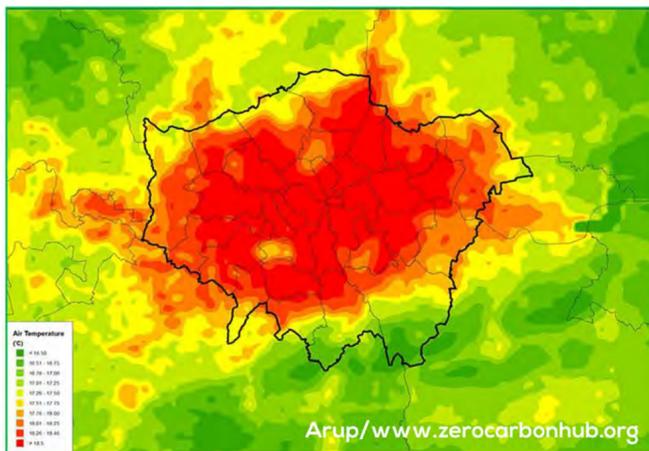
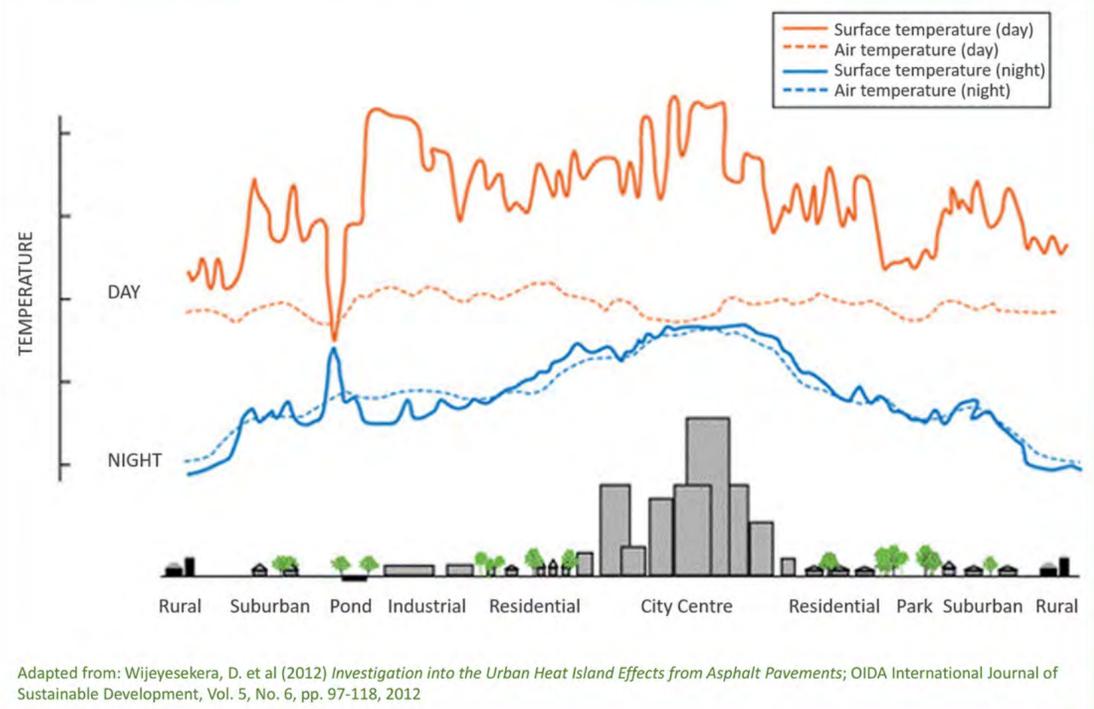
- 90% reduction in waste to landfill by 2020 (from 2008 baseline)
- 30% reduction in CO<sub>2</sub> emissions from concrete production by 2020 (from 1990 baseline)
- 95% of production certified to responsible sourcing standard BES 6001 by 2020
- 100% of relevant production sites with action plans for site stewardship and biodiversity
- The industry will facilitate further engagement with the broader supply chain for concrete
- The industry offer opportunity to inform development of the strategy and supporting initiatives



# GIAUrban:

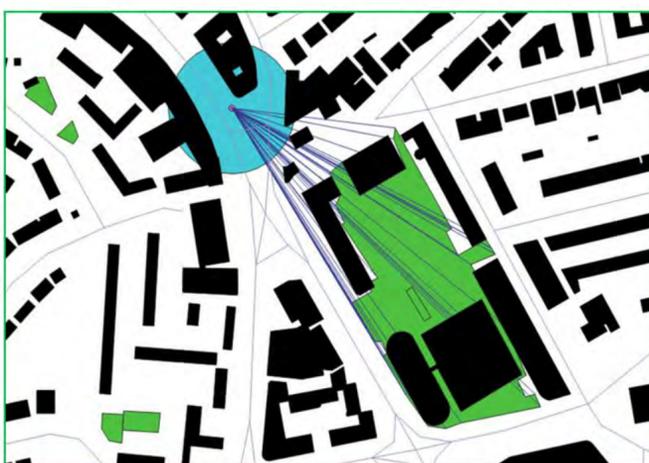
## Green Infrastructure Assets in Urban Heat Islands

Urban Heat Islands (UHI) will adversely affect billions of people in the future if forecasted increases in population, urban migration and global warming are all realised. UHI effects are site specific therefore an assessment of potential mitigation strategies must be carried out using local research. The use of green infrastructure assets (GIAs) in cities can help to mitigate the impact of UHIs through the provision of shade and by helping to cool air through their natural evapotranspiration processes. There is however limited data available relating to the localised performance of GIAs in UHIs and even less of this type of data is available to the citizens adversely affected. The GIAUrban project aims to apply a low-cost, flexible methodology that integrates a variety of novel imaging sensors with real-time environmental data to quantify the effects of different GIA layouts.

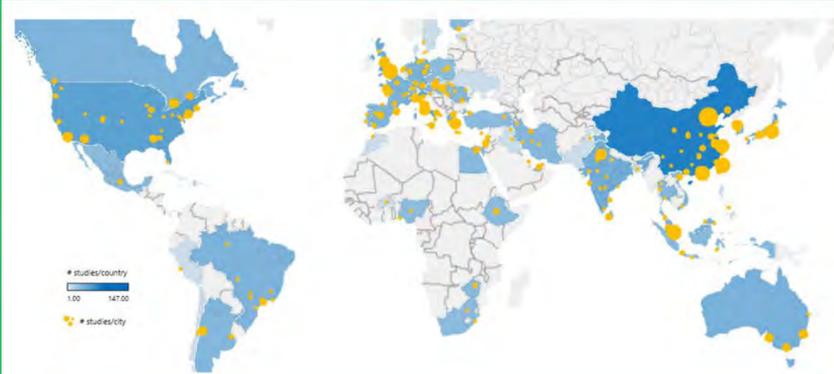


VRM Tech are working in partnership with Leeds Beckett University and the University of Hull, along with a team of partners in Shanghai, to visualise the benefits of GIAs for multiple urban stakeholders.

The project will use advanced Visible to Near- InfraRed (VNIR) and Thermal-InfraRed (TIR) Imaging-based spectroscopy and live environmental data to develop a suite of applications that quantify the impacts and aid the management of GIAs within UHI areas. Primary data will be enhanced through the use of machine learning, big-data analysis, 3D modelling, data visualisation and thermal simulation to improve the quality of life for citizens, provide developers and business with investment case data and allow city planners to account for quantified benefits of GIAs. The database will include meteorological data, such as: air temperatures, wind speed and precipitation, to evaluate their impact on thermal comfort. A data-rich digital model and software application will be developed that collates data from spectrometric surveys and environmental sensor networks. The data model will be used to develop citizen-centric apps, visualising air temperatures and pollutant levels within and around GIAs, with a focus on providing relief from peak temperatures and pollution levels. The model of green infrastructure patterns will be developed to evaluate impacts of GIAs on urban thermal environments. The distribution of building heat sources and its impact on UHI effects will also be analysed. Data will provide developers and owner/operators with a means of quantifying financial, environmental and societal returns on investment in GIAs.



This project will bring together a wealth of academic understanding drawing upon existing publications and empirical data to enhance VRMs existing Clarity product to offer real world solutions to a global problem that continues to be exacerbated by climate change and global warming.



# HAHN PLASTICS

## Proud To Be Putting Waste Plastic Into Rivers & Seas

### Problem

In a report for The World Economic Forum, Morgans Lykkeitof, President of the UN General Assembly, stated that "plastics have tangible and substantial benefits, but drawbacks are significant, long-term and too obvious to ignore". The report contained statistics, including:

- "after a short first-use cycle, 95% of plastic packaging material value, or \$80-120 billion annually is lost to the economy"
- "72% of plastic packaging is not recovered at all; 40% is landfilled and 32% leaks out of the collection system – that is, either it is not collected at all, or is collected but then illegally dumped or mismanaged"

One result of the failure to recover plastic packaging is the amount of plastic entering the oceans. Citing a report from J R Lambeck et al, the World Economic Forum report stated "At least 8 million tonnes of plastics leak into the oceans each year" and continued "there are over 150 million tonnes of plastic waste in the ocean today".

The World Economic Forum report stated "In a business as usual scenario, the ocean is expected to contain 1 tonne of plastics for every 3 tonnes of fish by 2025, and by 2050 more plastics than fish (by weight)".

### Do you know where your waste plastic ends up?

One of the frustrations felt by the general public is the lack of information concerning the final location or use of the waste plastic that they are encouraged to collect and recycle. Local and central governments are keen to publish statistics reflecting their success in collecting waste plastic from domestic sources but less transparent when it comes to information on what happens to that waste.

For years the UK has overcome the local problem of waste plastic by encouraging through Packaging Recovery Note financial incentives the export of waste plastic packaging to China, with 2.7million tonnes of waste plastic being exported to China and Hong Kong from 2012 to September 2017. China imported 7.3 million tonnes of waste plastic from developed countries in 2016 but announced in 2017 that it would ban the import of waste materials from January 2018. The decision by China appears to have resulted in the waste plastic being exported to other countries in Asia, with a potentially disastrous increase in the volume of waste plastic entering rivers and seas. Developed countries should be held to account for their waste plastic, rather than passing the problem to less developed areas of the world.

### What is Hahn doing?

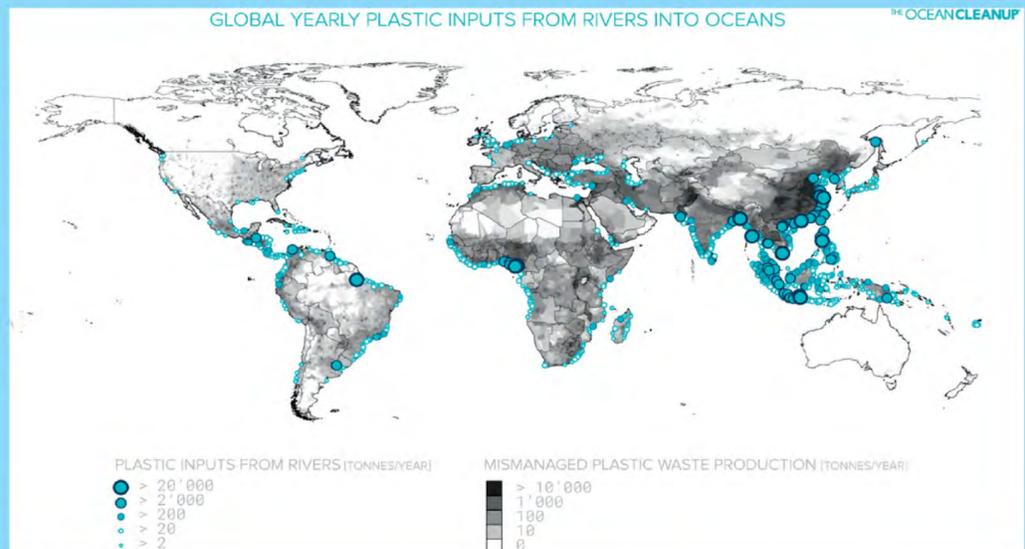
For more than 10 years, Hahn Plastics and its forerunner company have been converting waste plastic into products for the landscaping and construction industries. Using intrusion moulding technology and a proprietary blend of polymers, Hahn manufacture a wide range of products, including outdoor furniture, fencing, ground protection and products immersed or in contact with water.

### Product attributes

Hahn products are especially beneficial for projects involving contact with water, as unlike wood, the products do not rot, require no preservatives and are capable of withstanding extremely harsh environmental conditions. Leeds Beckett University conducted tests on Hahn Plastics's biofilter floor system by immersing or spraying the recycled plastic legs with acid solutions. On completion of the test period, the legs were subjected to compressive strength testing in a Denison loading frame, in accordance with methodologies stipulated in BS EN ISO 604:1997. The University's report concluded "The investigation conducted by LSI of Leeds Beckett University, has found no evidence that the compressive strength performance of Hahn Plastics Ltd's leg components of the biofilter floor system has been affected by the twelve week exposure to extremely-low pH solutions of sulphuric acid". From these tests it can be seen that recycled plastic products from Hahn Plastics are eminently suited to exposure to or immersion in sea water that would rot or corrode other construction materials such as wood or steel-reinforced concrete.



Recycled plastic products from Hahn Plastics are also lighter than traditional construction materials, resulting in lower transport costs and less costly installation. Hahn manufacture recycled plastic beams used by P C Construction for their Ecocrib retaining wall system, which has been certified by the British Board of Agreement to have a design service life of 120 years. Without the need for steel reinforcement the Ecocrib components are far lighter than their concrete equivalent, with the largest 3,000mm item weighing 16.5Kg – less than 25% of the weight of a 1,500mm concrete header component.



Asia includes only: India, Malaysia, Vietnam and Indonesia

### Environment Agency

The environment-friendly nature of the recycled plastic products from Hahn can also be demonstrated by the choice of Hahn by the UK Environment Agency to design and manufacture fish ladders, which have become increasingly important due to man-made alterations to river systems. In-river structures such as dams and weirs were introduced to exploit the water's power, however problems with the natural migration of fish occur when the water level difference is greater than 0.5m between upstream and downstream of a structure. The purpose of a fish ladder is to ensure the free passage of fish upriver. Each "rung" has a gap which is offset from the one below allowing the fish to rest before taking the next step upriver. Fish baffles are submerged in the water which caused the previous wooden material to rot very quickly.



### Republic of Ireland distributor

**Irish Recycled Products** – Unit 3-4 Syngfield Industrial Estate, Clonoghil Lower, Birr, Co.Offaly  
Tel. +35 357 912 3828 Email: [sales@irishrecycledproducts.ie](mailto:sales@irishrecycledproducts.ie) Web.: [www.irishrecycledproducts.ie](http://www.irishrecycledproducts.ie)

### Hahn global offices contact details

Hahn Plastics Ltd based in Manchester, UK is part of the Hahn group, which is a European leader in the manufacture of products from recycled plastic. The group has its headquarters and largest manufacturing site in Germany at Hahn Kunststoffe GmbH, from where recycled plastic products have been manufactured since 1993. More recently a facility has been opened in North America.

**Hahn UK Office** – Pilkington Site, Rake Lane, Swinton, Manchester, M27 8LJ UK  
Tel. +44 (0)161 850 1965 Email: [info@hahnplastics.com](mailto:info@hahnplastics.com) Web.: [www.hahnplastics.com](http://www.hahnplastics.com)

**Hahn Germany Office** – Building 1027, 55483 Hahn-Airport, Germany  
Tel.: +49 (0) 6543/9886-0 Email: [info@hahnkunststoffe.de](mailto:info@hahnkunststoffe.de) Web.: [www.hahnkunststoffe.de](http://www.hahnkunststoffe.de)

**Hahn Canada Office** – 2597 Herrgott Road, St. Clement, Ontario, N0B 2M0 Canada  
Tel. +44 (0)161 850 1965 Email: [info@hahnplastics.com](mailto:info@hahnplastics.com) Web.: [www.hahnplastics.ca](http://www.hahnplastics.ca)

# PlastiCircle - Pan European Co-operation with Practical Benefits

## Introduction

Hahn Plastics are pleased to be a member of the European Union's Horizon 2020 research and innovation programme PlastiCircle, which is attempting to revolutionise the process of recycling plastic from the domestic waste stream. PlastiCircle is a 9 country, 20 member consortium of research centres; waste management organisations, private manufacturing companies and municipal authorities, led by ITENE from Spain. The aim of PlastiCircle is to improve recycling rates, thereby reducing the volume of plastic going to landfill or entering oceans. Material collected during the project will be used by the manufacturing companies to demonstrate to citizens the practical use which can be made of their domestic waste plastic, thereby encouraging further domestic recycling.

## 3 Pilot Cities

PlastiCircle is a practical project involving citizens and municipal authorities from 3 pilot cities – Valencia in Spain, Utrecht in Holland and Alba Iulia in Romania. A further city, Velenje in Slovenia is acting as a "follower" in order to assess the possibility of rolling out the PlastiCircle methodology in that country.

The 3 pilot cities are of varying sizes and are at different stages as regards recycling. Valencia has 800,000 inhabitants, Utrecht 345,000 and Alba Iulia 74,000 inhabitants. The pilot cities will "test-drive" the facilities developed during the PlastiCircle project and will collect domestic waste plastic which will be sorted and reprocessed by other members of the consortium.

## Four Main Elements

The project has 4 main elements - Collection, Transport, Sorting and Recycling.



## Collection

One aim of PlastiCircle is to assess whether incentives for individual citizens will improve the quantity and quality of waste plastic being collected. One of the first deliverables for the project was the design of a "Smart" container used to collect domestic waste. The container utilises identification techniques compliant with GDPR to monitor and reward citizens for improving the volume and quality of the waste plastic they recycle. In order to help improve recycling rates, communication campaigns are being held in schools, local businesses and neighbourhood associations.



## Sorting

One of the problems with recycling domestic waste plastic is the variety of different polymers in use and the difficulties of separating those polymers for reprocessing. This part of the project features co-operation between Picvisa in Spain and Axion from the UK. PlastiCircle is employing optical Near-Infra-Red-Hyperspectral-Imaging technology (NIR) in order to separate waste plastic into 6 different plastic fractions. By studying different infrared spectroscopy technologies and using terahertz technology, the various plastics have been sorted with encouraging results, including multilayer PET which has been identified and separated correctly.

One of the benefits of a pan-european consortium has become evident from identification of differences between the material types from Holland and Spain, with the Dutch material having a far greater proportion of PET trays. These differences emphasise the need to avoid a "one size fits all" solution that might have resulted from a smaller study in a single country.

## Hahn Plastics

Hahn Plastics based in Manchester, UK is the only one of the 5 manufacturing companies that currently uses recycled plastic as its only raw material and has been manufacturing with recycled waste plastic for more than 10 years. Hahn Plastics can also call upon the expertise of a larger related company in Germany, Hahn Kunststoffe GmbH, who are currently celebrating 25 years in the manufacture of products from recycled waste plastic. In 2017, the two Hahn companies converted around 54,000 tonnes of waste plastic into construction and landscaping products.

The Hahn product range includes outdoor furniture; fencing, boardwalks and ground protection systems plus industrial products such as a raised biofilter flooring system and retaining walls used by highways agencies and major housebuilders. The products provide maintenance-free alternatives to wood, concrete or steel, with additional benefits including lower weight, longer life without the need for preservatives and the ability to withstand harsh environmental conditions.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730292.

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# USE OF INFORMATION MODELLING FOR EVALUATING THE SUSTAINABLE BUILDING MATERIALS

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## Abstract

Application of sustainable building materials and technology can improve the living conditions of economically weaker section (EWS) and low-income group (LIG) housing schemes in the country. The conventional practice of urban slum house design with approved materials of construction was studied. On the basis of the locally available industrial by-product, lightweight (CLW-SBA) bricks were developed, analyzed and recommended for the use as the masonry product for double storied (G+1) building. It was built in 2015 at Pandhrabodi, Nagpur (approved by Nagpur Municipal Corporation). The total construction cost of the considered building (54.45 sq. m.) as per current schedule of rates was estimated as Rs. 5,98,966 whereas for one unit (27.225 sq. m.), it was Rs. 2,99,483 (inclusive of contractor's profit and excluding land cost). The time schedule for estimated work of G+1 structure (2 units) is around 60 working days. Developed bricks were manufactured using agro-industrial waste, which makes it a sustainable product. Compared to conventional construction, the lightweight of the developed bricks causes reduction of the structural steel and increases the stability against dynamic conditions. In addition, its low thermal conductivity ( $K=0.35$  W/m-K) reduces the operational energy demand as well as increases the thermal comfort. Moreover, use of fly ash concrete instead of a conventional concrete causes reduction in cement that saves cost as well as control carbon emissions. With sustainability aspect, it is necessary to fasten the process with more accuracy. Use of information modelling which is based on the concept of integrated project delivery method helps to ease the workflow and increases coordination throughout the life cycle of the project. It is concluded that the application of novel sustainable building materials and computational approach accelerates the decision process to meet the housing demand.

## Need of the study

A momentous increase in the housing need leads to conserve the natural resources such as energy, water and soil. It emphasizes the urgent need for sustainable design, development and implementation of construction practices in the housing sector (L & Palaniappan 2014). Selection of environmentally friendly building materials has been considered as the easiest method for designers to incorporate principles of sustainability in building projects. In demand to have an efficient building, it is necessary to gather project information directly, optimize potentials and provide the appropriate efficiency actions. Building Information Modelling (BIM) is becoming a better-known established collaboration process in the construction sector. BIM, supported by appropriate technology, has the potential to reduce the cost by making the information required for sustainable design, analysis routinely available.

## Background of the considered case

There are 439 slums in the city, out of which 421 are recognized in NMC official data. Out of the 439 slums, there are 279 notified (Slum has legal status), 142 slums do not have any legal or administrative status, and 18 are newly identified slums. Slum Rehabilitation Authority (SRA) has identified slums in Nagpur city for relocation due to the reservation of land uses, ownership of land (security of tenure) and un-notified status of slums. Government of India approved the construction of 6357 dwelling units with a total project cost of Rs.402.29 crores in the 60<sup>th</sup> meeting of the Central Sanctioning and Monitoring Committee (CSMC) dated 21<sup>st</sup> Feb. 2009. Out of which, 2720 are Insitu housing and 3637 are under the flat scheme. (Rupwate, D.S. et al., 2018) The considered case was a part of in situ up gradation scheme, which consists of three types namely, A, B and C. The slum in Nagpur, Maharashtra, India (latitude: 21.1458°N, longitude: 79.0882°E) was considered as a case study. The geographic location has varying seasonal conditions as rainy (June–September), winter (October–January) and summer (February–May). The double storied (2 Units) RCC framed structure was designed according to the guidelines recommended by national building code of India (SP 7 : 2005) and IS 456. Each unit consists of five rooms as Living room, Kitchen, Bedroom, Bath and WC. The 0.15 m (external) and 0.10 m (internal) thick walls were constructed with cellular lightweight sugarcane bagasse ash (CLW-SBA) brick. Concrete mix for all elements was of M25 grade with 30 % fly ash. All reinforcing steel used was high strength deformed bars of Fe- 415 grade conforming to IS 456.

### Urban Slum Housing- Case Study: Pandhrabodi, Nagpur

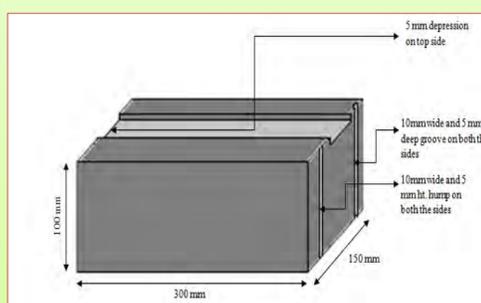
Type	Building Type	Carpet Area (sq.ft.)	Built up area (sq.ft.)
Type A	In situ upgradation on the same plot, for HH having bigger footprint and plot area	276.20	341.43
Type B	In situ upgradation by cluster formation on the same profile of footprint for HH having less footprint and ready to form cluster with butting unit	276.20	341.43
Type C	In situ redevelopment for group of houses willing to form multistoried cluster; G+2 or G+3	276.20	341.43



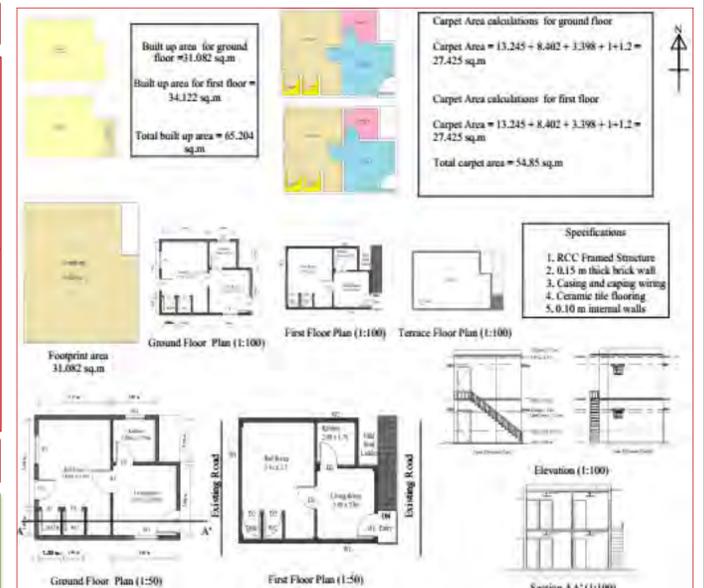
Total no. of DU proposed of type A, B and C were 324, 36 and 0 respectively.

### Proposed Alternate Building Materials Cellular lightweight Sugarcane bagasse ash bricks: CLW-SBA

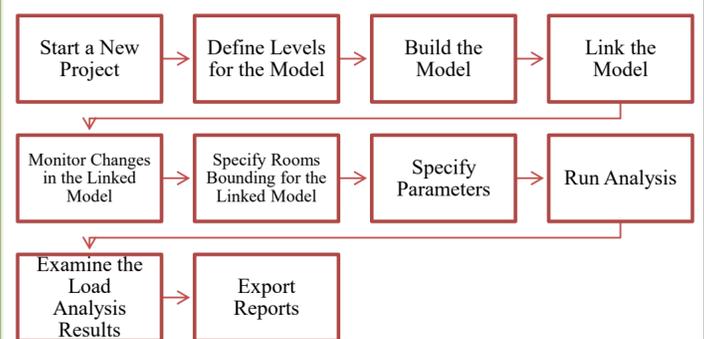
In the present study, the agro-industrial waste sugarcane bagasse ash (SBA) which is otherwise land filled was identified as a principal raw material and utilized to develop sustainable construction material that serves a purpose of disposal of solid waste management and energy efficient alternate construction material. XRF, XRD and physico-chemical properties of the SBA prove its suitability as a pozzolanic / cementitious material. TGA confirms thermal stability until 650°C. On the suitability of principal raw material, SBA bricks were developed and tested for physico-mechanical, functional, durable, and toxicity properties as per recommended Indian Standards. The cellular lightweight sugarcane ash (CLW-SBA) bricks (300 mm X 150 mm X 100 mm) were developed using OPC 53 grade cement, SBA and foaming agent. The proportion of the SBA and cement was in a ratio of 1:3 to obtain the desired density. Physico-mechanical, durability as well as thermal procedure were conducted on the CLW-SBA bricks.



Brick type (Size in mm <sup>3</sup> )	Dry density (kg/m <sup>3</sup> )	Compressive strength (MPa)	Water absorption (%)	Drying shrinkage	Thermal conductivity (W/mK)
IS 2185 (4): 2008 requirement	1000	3.5	12.5	-	0.36
CLW-SBA bricks (300 X 150 X 100)	1000	3.58	12	No Shrinkage	0.35



### BIM Workflow



Total Reduction in cost per unit  
INR 54755 (~793 USD) (16%)

Feature/Claim	Quantification of Claim	Evidence@
Lightweight	1000 kg/ m <sup>3</sup>	Density = weight/ volume = 4.5 / (0.30 x 0.15 x 0.10)
Thermal Comfort	A 34 % increase in thermal resistance compared to fly ash bricks	TRNSYS Simulation was carried out and it was found that a CLW-SBA brick gives more thermal comfort. This is due to its low thermal conductivity.
Energy Efficient	Consumes approximately 55 % lesser energy than clay bricks also reduces operational energy demand	Reduced no. of bricks per cum of brickwork reduces the energy consumed. Higher thermal resistance than conventional bricks.
Cost Effective	Cost of the project reduced by 15.45 %	Reduced no. of bricks per cum of brickwork and less steel consumption reduces the overall cost.
Sustainable	Uses agro-waste, 100% replacement of Natural sand	Composition of Brick is Cement: SBA:: 1:3 with foaming agent
Durable	Within permissible limits given by IS 456:2000	Chloride and Sulphate resistance test were carried out.

The CLW-SBA bricks were developed from SBA, cement and foaming agent. The test results were conformed to IS 2185:2008 requirements. The CLW-SBA bricks were found to be lighter in weight (43 %) with a lesser thermal conductivity (66 %) than commercially available FA bricks. The bricks, when examined for durability and thermal conductivity, showed encouraging results, indicating that bricks are durable and thermally efficient. Individual product cost of CLW-SBA brick was calculated as Rs. 10. Overall, the developed bricks were found to be an effective and economical option over the commercially available burnt clay and fly ash bricks. The use of waste makes SBA bricks a reliable solution for the environmental pollution and waste management issues associated with traditional bricks; which can also fulfill the demand of large construction products. The test results showed significant potential for the utilization of the SBA in the development of bricks. It has good earthquake resistance properties. Faster construction directly relates to a reduction in labor required. CLW-SBA Bricks offer highest thermal insulation making cool summers and warm winters. Use of CLW-SBA bricks makes highly accurate and smooth walls, which results in reduction in plastering. In addition, Use of Information modeling helps to reduce the cost of rework as it helps in clash detection and also updates the change order and improve the efficacy of project delivery within time and budget. BIM tools can be used to determine the energy demand and cost estimate, which help in decision-making.

## Visual Sound Indicator

**THE NEED:** To develop a more effective way of alerting the workforce when noise reached potentially damaging levels on site.

With 1 in 5 people suffering from noise induced hearing loss, finding new ways of protecting the workforce was vitally important and a high priority for the Interserve Yorkshire team.

Having identified the challenge the Interserve team started to look at possible solutions. They wanted a change from the usual site signage as they felt that, with the amount of signs already on sites, the workforce could easily become 'sign blind'. They knew that an audible alarm wouldn't work, as this would add to the hazardous noise levels and potentially not be noticeable above them. So the team decided that a visual indicator, which illuminated once the sound level had reached dangerous levels, would be the best way forward.

## How it works

The Visual Sound Indicator is a totally new approach to monitoring sound levels on site. It is essentially a sound monitor that triggers an illuminated sign once sound levels reach potentially dangerous levels.

## Development

Once the initial idea had been developed the team worked with a local manufacturer of noise and sound meters to look at ways in which they could provide a visual indication for the workforce when noise levels reached an agreed limit. They produced a prototype device which was trialled and evaluated on site to allow it to be further developed.

## Current and future benefits

What started out as a desire to help reduce hearing loss across the industry has led to an ambitious team creating a simple but effective new piece of equipment that will benefit the whole construction industry and transform the way in which we monitor noise levels. The health benefits alone make this innovation something that will truly benefit the workforce for generations to come, leaving a lasting legacy across the industry and beyond.

As well as being distributed across our business, the benefits of the device have been shared with our supply chain. A case study identifying the benefits has been produced and distributed across the business to allow the best practice to be shared.



## Testing and improvements

The prototype device was put into use at our site at the University of York where its benefits were immediately obvious. The workforce reacted well to the new signage and it appeared to be more effective than the traditional signage.

It became obvious that it would be beneficial to develop the device further to make it easier to move around the workspace and include hearing protection so that the workforce could take immediate action to protect themselves. So the device was mounted onto a trolley that included a dispenser for ear plugs.



An early prototype which was tested on our University of York site



The final design allowed for easier movement around site and included an ear protection dispenser to allow operatives to take immediate action



INNOVATION  
YORKSHIRE

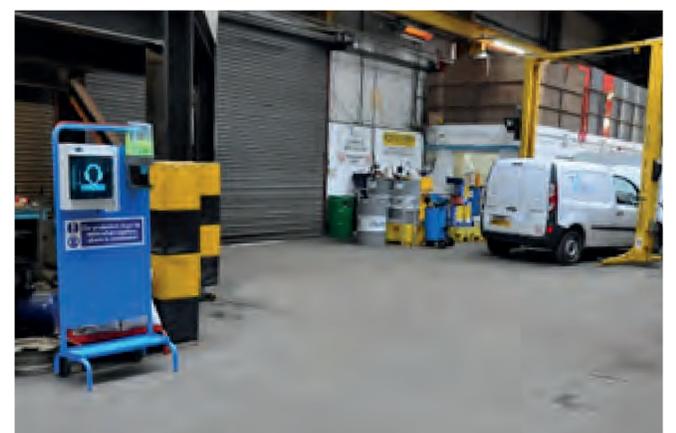


## Other uses

The manufacturer, Pulsar Instruments, has put the device to market, so it is now available across the industry and not just within the company. This means that the innovation of our group is now being shared nationally across all industries, allowing the benefits to be realised beyond just the construction industry.

It has already been adopted by our international division and it could be easily adapted for use across the different sectors such as rail, manufacturing industry, garages and even pubs and nightclubs where noise hazards are present. It is successfully being used in the Interserve fleet garage in Birmingham.

The device was originally designed for use on construction sites however it could easily be developed for use in other industries where noisy environments are a potential health and safety hazard. The device can also be used in quiet locations such as exam rooms, hospitals and libraries to indicate when noise levels must be kept down. By setting the device to trigger at low level ensures that noise levels in quiet environments stay within acceptable levels.



## ALLAM MEDICAL BUILDING

The landmark Allam Medical Building development has transformed the way the University of Hull teaches the next generation of health professionals. The 6,500sqm building provides an innovative and practical environment in which to train doctors, nurses, midwives and healthcare workers including a full mock hospital ward, operating theatre and intensive care nursing facilities.

### Building Information Modelling (BIM) goals

Although BIM wasn't a contractual requirement, Interserve saw the benefit of using Level 2 BIM for clash detection and for coordination of the works.

We also wanted to utilise our 4D BIM capabilities with the external precast concrete cladding panels to allow a visual representation of the construction progress at any given week throughout the project.

### How BIM was used

Early modelling was used to demonstrate to project funders what the final building would look like. One of the key donors made changes to reflect their contribution, which included removing corners, adding balconies, changing the external cladding and adding a feature canopy. The visualisations helped to demonstrate this so funding could be secured.



The IFC model was generated and viewed in client and design team meetings to aid validation, with changes fed back into the model. At the completion of the project the final model was made available for the University, allowing them to use it for their ongoing FM and building management.

The 4D BIM model enabled the team to schedule 'just-in-time' delivery of materials to the site, increasing efficiencies and eliminating the cost of storage. It was also used to coordinate the phasing of the works, making potential obstructions and hazards more obvious.



### BIM vs. reality



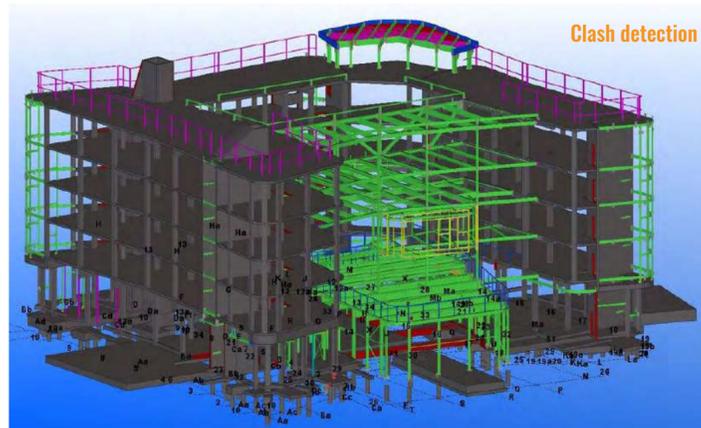
*"Interserve's use of BIM has helped the University in numerous ways. As owner, occupier, user and FM operator BIM is bringing benefits perhaps in ways that weren't immediately obvious. For this project, our experience leads us to feel BIM will continue to deliver benefits throughout the building's life."*

David Reynolds, Client Project Manager, Faithful + Gould

### Technical excellence

**Clash detection:** The BIM model was used for the coordination of the concrete frame, steelwork and precast concrete panels. These interfaces had to be exact as changes would be difficult and extremely costly to rectify afterwards.

Where clashes were highlighted, amendments were made to the design in a staged process. For example, the mechanical ductwork was changed before the electrical containment route.



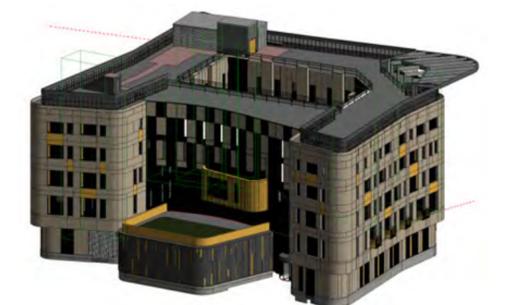
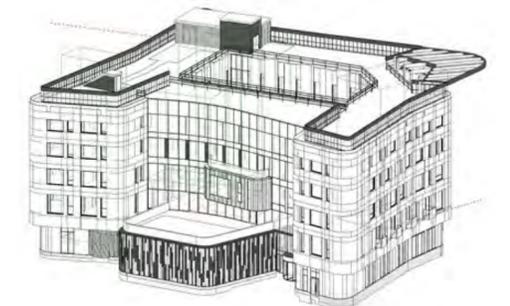
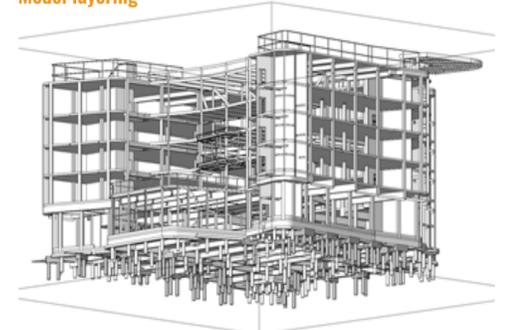
BIM models were used on the site team's tablets and mobile devices. This was invaluable in helping to phase the works safely, as the site team could 'look ahead' in the programme and view the progress of the concrete frame and panels.

### Achievements and benefits of using Level 2 BIM

- Used by the University to demonstrate to project funders what the final building would look like.
- Helped non-technical stakeholders to fully understand the design and maintenance.
- The 3D model helped to reduce the amount of drawings required to be reviewed at any one time.
- Using 4D BIM greatly aided the project and client team by allowing a visual representation of the progress at different phases of the works.
- Early clash detection was invaluable, saving time and cost and reducing the amount of redesign and rework.
- The University had previously not had good experiences using BIM but they now see the advantages and possibilities and will be using it on their projects going forward.
- Practical experience of 4D BIM has upskilled the project team.
- Aided the overall health and safety of the project.



### Model layering



## PIAZZA LEARNING CENTRE

Completed in 2017, the stunning Piazza Learning Centre at the University of York embraced the use of innovative digital technologies.

### Building Information Modelling (BIM) goals

As this design and build scheme involved the reconfiguration of an existing design with complicated interfaces we worked in full 3D BIM to Level 2 from the outset.

With a key structural subcontractor based overseas a fully coordinated model and a common data environment ensured all parties had access to the latest information.

### How BIM was used

This was the first time the University of York had utilised Level 2 BIM. A fully coherent protocol and BIM execution plan was used throughout all stages, with Project Vault used as the common data environment up and down the supply chain. All sub-contractors fed Revit models into the architect's model on a regular basis, who then federated and published a combined structural, civil, architectural, and services model.

Using BIM to demonstrate the M&E, steel and glulam designs to stakeholders



During the early stages of design we used the Revit 360 Degree Client Experience Tool to digitally walk the University and end users through the building.

This provided clarity that would not have been possible solely using standard 2D and 3D drawings, allowing early design decisions to be made. Model walkthroughs continued to be regularly showcased at client/user meetings.

Using the Revit 3D model in envelope workshops generated constructive debate on aspects that may have otherwise not of been raised and using Revit with Enscape helped stakeholders decide on colours and signage.

Lecture theatre in two 3D BIM colour choices and as built



As the University hadn't used Level 2 BIM before we provided asset data in an IFC format allowing them to trial its compatibility with FM software. At handover the final model was made available to the University, allowing them to use it for their ongoing FM and building management.

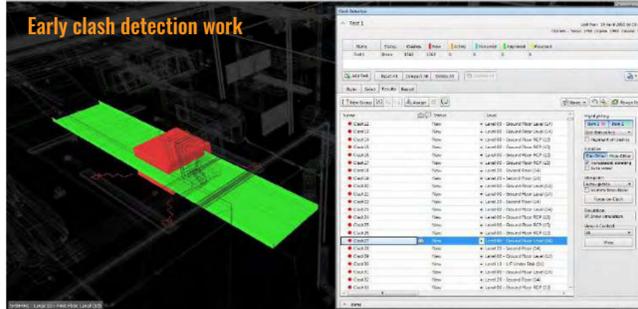
*"The University is very conscious of energy management and due to the use of BIM we had confidence this would be considerably reduced"*

Stuart Davies  
Mechanical Clerk of Works, University of York

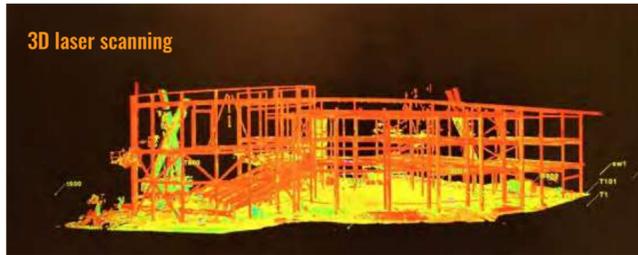


### Technical excellence

150 clashes identified saving circa £45,000. During steelwork design there was significant clash between a perimeter steel beam and the curtain walling frame. **£45k SAVING** Early identification gave us time to reposition a primary steel column and foundation without affecting programme.



On-site 3D laser scanning of the installed structural frame was cross checked against the fabricator's BIM model to ensure it has been installed within tolerance, providing assurance for quality and programme.



Every drawing had its own unique QR code assigned through Revit for effective document control. Using QR readers on smart phones/tablets, any member of the construction team could check the accuracy of the information they were working to at any time.

90% of the entire M&E main service distribution pipework and containment was modularised off-site. Working in full 3D BIM to Level 2 provided certainty of right first time installation of the significant number of modules.

3D BIM Model vs. completed atrium



Gary Ashmore  
@gasheroo

The power of BIM in all it's glory!! What a building, what a result, what a team!!  
#yorkpiazza #perfection

### Achievements and benefits of using Level 2 BIM

- ✓ Accuracy during construction - the built project closely resembles the early architectural visualisations - we delivered what we promised.
- ✓ Client satisfaction - 3D BIM allowed the University and end users to visualise the finished building and services, giving them confidence about the choices they were making
- ✓ Increased quality and accuracy of operating and maintenance instructions.
- ✓ Soft landings by involving operations and maintenance teams from design stage.
- ✓ Enabled collaborative working across countries
- ✓ Early clash detection avoided corrective work
- ✓ Used by the University to demonstrate to project funders what the final building would look like
- ✓ Helped to identify areas where sustainable improvements could be made to achieve the target BREEAM rating
- ✓ The University of York are now looking at their own resource and IT capability, in order to take ownership of the Revit models provided as part of O&M instructions, and further develop them into their maintenance tool.

*"The BIM modelling on Piazza has been extremely useful in engaging a wide range of groups and individuals across the University. The detail of the services and their relationship to the building structures has allowed the maintenance and audio visual teams to engage with the facility at an early stage, which made handover significantly more efficient and effective."*

Helen Stephenson  
Project Manager, University of York

## PIAZZA LEARNING CENTRE

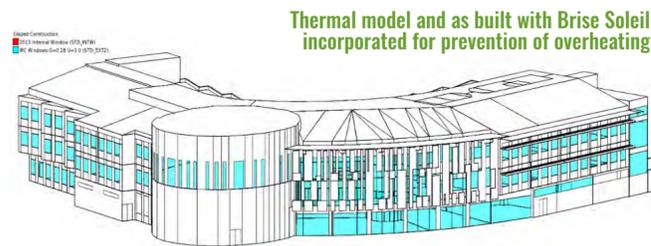
Completed in 2017, the stunning Piazza Learning Centre is a sustainable and highly efficient building situated within a picturesque lakeside setting.

The 6,800m<sup>2</sup> three storey building on the University of York's Heslington East campus is both sympathetic to the natural landscape whilst also being accessible and future proof.

### Sustainable design to reduce the building's impact

Both Interserve and the University of York are committed to being socially responsible organisations with forward thinking sustainability strategies.

Working collaboratively we took a sustainable approach to reconfigure an existing design (c.2011), using fabric first principles, to serve new functional requirements and bring it in line with current building regulations and legislation.



### Energy efficiency and building performance

The building was designed with Level 2 BIM and this model was used to develop the energy efficient specification of the building elements, window and solar shading design to achieve high levels of insulation and low U-/G- values.

- Conditioned/Heated Floor Area 6,651m<sup>2</sup>
- Connected to the University's district heating system powered by a biomass boiler plant
- Main atrium is naturally ventilated using stack ventilation.
- Lighting system is 100% LED
- Air-tightness of 5m<sup>3</sup>/h.m<sup>2</sup>@50Pa
- Heating energy demand:  
Design = 42.64 kWh/m<sup>2</sup>/yr  
Actual = 32.09 kWh/m<sup>2</sup>/yr
- Glazing U-value 1.3 W/m<sup>2</sup>k / G-value 0.28 Uf W/m<sup>2</sup>k

Level 2 3D BIM model



### Sustainable construction, challenges and solutions

- Being at the side of a man-made lake (acting as attenuation via a system of swales), with an extremely high water table one of the initial challenges the team had to overcome was stabilisation of the ground conditions. The sustainable solution, developed in partnership with our supply chain, was vibro-compaction as there was no spoil generated and no fill material required.
- We reviewed the external landscaping to increase the green space and biodiversity. We sourced 1,800m<sup>2</sup> of a unique native enriched turf product developed to attract butterflies and bees that requires little maintenance.

50+  
WILDFLOWER SPECIES



### Building materials

Every effort was made to ensure materials were specified for their robustness, low environmental impact, longevity, and where possible future recycling.



An early WRAP Designing out Waste workshop identified opportunities to eliminate and reduce project waste at design stage. Outputs from the workshop were captured to inform the site waste management plan for construction. The scheme scored full marks on Credit Mat01 Life Cycle Impacts.

#### Sustainably sourced glulam beams and structural ply



Birch cross laminated glulam beams and a structural ply roof-deck reduce the potential for thermal bridging.

90% of the whole M&E main service distribution pipework and containment was modularised, produced at an off-site factory in Bradford, reducing transport impact and waste.

#### Off-site fabricated mechanical and electrical modules



*"The University is very conscious of energy management and due to the use of BIM we had confidence this would be considerably reduced"*

Stuart Davies  
Mechanical Clerk of Works, University of York

#### Wrap workshop outcomes

Design review workshop – action plan					
Project:	Plazza Building	Date:	19/04/16	Prepared by:	Joe Spavin
This table provides a record of the top opportunities to Design for Resource Efficiency which were identified in the workshop and will be considered further for inclusion in the design.					
This document, or the information it contains, should be used as the basis for reviews in subsequent design team meetings, and should be included within the project Resource Management Plan and/or Site Waste Management Plan.					
Attendance	Joe Spavin (LS) Lianne Lawson (LL) Tim Robinson (TR) Dorsey Greenwood (DG) Kayley Lockhead (KL) Corinne Hall (CH)	ICL			
Retain the excavated soil on site	To engage with UoY	Lianne Lawson	17/05/16	High	Easy
Swale diversion – Retain as piped	Incorporated into the design	N/A	N/A	High	Easy
Reduced ground floor height	Incorporated into the design	N/A	N/A	High	Easy
Material Interface set out	Investigate design	Corinne Hall	Next design meeting	High	Easy
Use of plastic Shuttering for repeat pours	Investigate availability and hire cost of plastic shuttering vs reuse of plywood shuttering	Lianne Lawson	Next design meeting	Low	Easy
Use of non-metallic plumbing	Needs client agreement	Daniel Greenwood	Next design meeting	Low	Difficult
Storage areas for wood, block and site offcuts	Recommend to site manager	Lianne Lawson	Next design meeting	Low	Easy
Offsite prefabrication of building envelope elements	Investigate with Supply chain	Mark Strangeway	Next design meeting	High	Difficult
Offsite manufactured services units	Investigate with Supply chain (NG Balleys)	Kayley Lockhead	Next design meeting	Low	Easy

97%  
WASTE DIVERTED FROM LANDFILL

102 TONNES



102 tonnes of wood was recycled and reused in partnership with the not for profit Community Wood Recycling scheme.

- Adding in a LeafNut control system enables the University to control the external lighting from their central BEMS system, reducing energy use and emissions when campus is not in peak use.



### Achievements

The Piazza project comprehensively captured the principles of sustainability from tender stage and delivered an exemplar project for a delighted client.

- We have committed to achieving the BREEAM Innovation Credit Man 05 Aftercare ensuring monitoring of energy and water consumption for 3-years post construction.
- Our exemplar sustainable construction practices were also of benefit to the University in their own journey to achieve environmental management system certification.

*"Thank you for your involvement in our recent ISO14001 certification review. We have received a positive recommendation for award of ISO14001 and we are grateful for your input to that. The auditor was particularly impressed with what he saw and experienced when he visited you on site and that played a very big part in the positive feedback we got as a whole.."*

Gary Ashmore  
Head of Estates Development University of York

CONSIDERATE  
2018 GOLD  
CONSTRUCTORS  
SCORE  
46/50

SCORE  
10/10

How satisfied are you that we considered the impact of sustainability in the design of the facility and/or during construction?

Customer project review with Gary Ashmore, University of York

### Printhall, Leeds City College

The Printhall 1A project was the final phase of the Leeds City College Printworks Campus redevelopment. The conversion and restoration one of the most recognisable industrial landmarks in Leeds transformed a derelict building into a vibrant and unique facility for students. The historic significance of the Printhall was protected whilst creating a new hair and beauty salon, public bar and restaurant, teaching spaces and a stunning new boardroom for the College.



*“This wonderful Grade II listed building is part of the proud industrial heritage of the area, so we’re delighted to see it brought back in to life as part of Leeds City College’s Printworks Campus. It is fantastic that it will be used to help young people learn and develop their skills as part of the vibrant education quarter of the South Bank to be accessed by 10,000 students every day.”*

Judith Blake  
Leader of Leeds City Council



### Achievements and benefits

The Printworks development rejuvenated an iconic building and helped to preserve the long-term future of a part of the Leeds’ industrial heritage, whilst providing a unique learning experience.

Throughout the project the team worked closely with Re-Making Leeds, a heritage building skills training provider that works to develop the restoration skills of 18 to 24 year olds, helping to ensure these specialist skills are not lost. The team provided workshops, work experience and site visits for the Re-Making Leeds students, allowing them to experience first-hand the intricacies of working on Listed and heritage buildings. Two members of the Interserve team also became mentors for the Re-Making Leeds scheme, providing students with help and guidance during their training.

The team also worked with Leeds College of Building to offer site visits, workshops and work experience placements for their students, allowing them an insight into working on a listed heritage building, and the challenges that brings to the construction process.



### A unique scheme

The iconic industrial building was formally the Alf Cooke Printworks but had been empty since the works closed in 2006. Significant historic aspects from the original building were preserved and enhanced during the restoration and became features of the new campus building.

Original attributes including a wrought iron spiral staircase, industrial sliding doors and original balustrade were repaired and retained, becoming features of the new space. Replacement balustrade panels were carefully replicated using original moulds and the existing sash windows were repaired and restored to their original glory, with careful work from skilled traditional trades. The concrete staircase was retained as part of the listed building consent

and we worked closely with building control to agree a consistent riser and steps. In the café and atrium exposed brickwork that showed the history of the building was turned into a feature, contrasting against the newer, more modern aspects of the build.

One of the striking features of the development is ‘The Object’ a new-build structure in the heart of the building, providing two levels of teaching space as well

as a lecture theatre. Interserve worked closely with the architect to develop a design that maintained the budget and adhered to planning and conservation restrictions. The design team worked closely with the planning and conservation officers to agree sign-off on the various aspects of the refurbishment. It was importance to maintain the existing fabric of the building whilst ensuring all new materials were sympathetic to the existing structure.



BIM was used to aid the design, bringing the following benefits:

- 3D images to allow the end users to visualise and agree the design of the ‘object’
- How the ‘object’ would fit inside the listed building
- Agreeing steel connections with the Conservation Officer, ensuring the fabric of the building was protected



### Piazza Learning Centre

The stunning University of York Piazza Learning Centre is the new home to the International Pathways College. The quality and design of the building are world-class; rich in technology, sustainable and highly efficient to operate, providing an inspirational environment for students and academic staff, with 36 classrooms, 350-seat auditorium, 100-seat lecture theatre, staff areas, offices and a 350-seat restaurant.



*"The standards on site are probably the best I have seen within the industry... Health and safety is of paramount importance and the team has developed a number of really innovative ways to engage the wider team and deliver the project safely"*

Gary Ashmore

Head of Estates Development, University of York

The Piazza project was delivered with zero reportable accidents despite being on a live campus surrounded by 16,000 students, having over 1,000 tradespeople on site throughout the scheme and welcoming nearly 500 visitors onto site.



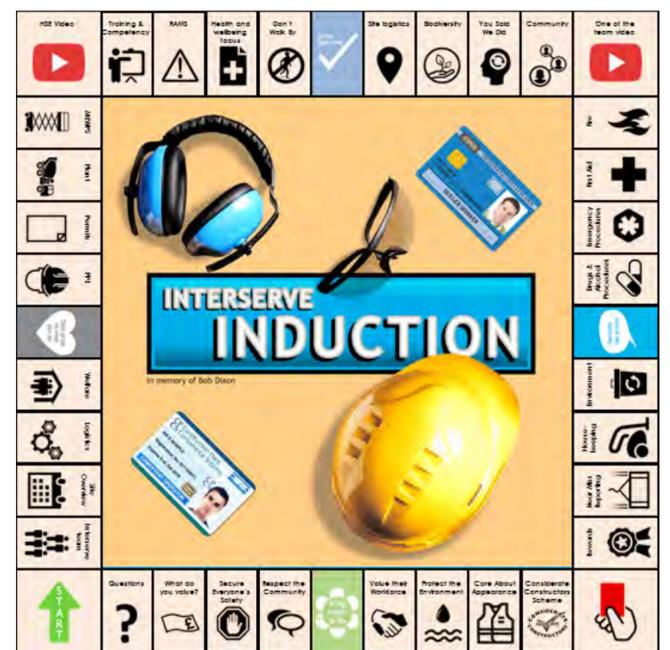
The team worked to change the culture of health and safety on the site, adopting new ways of interacting with the workforce and using new technologies to help raise standards. They set new standards for health, safety and wellbeing. The initiatives that were implemented across the project went beyond the norm and really put the workforce first. The team's commitment to excellence started at the tender stage, with a determination to go above and beyond.

From designing a new induction video to engage with the workforce from the outset, to having a dedicated safety awareness pod in the compound, the team thought through every aspect to improve the safety experience for all operatives working on the site. The team's commitment didn't end at H&S improvements; they also worked hard to improve employee wellbeing having a resident trained counsellor on site, running regular health and wellbeing initiatives and arranging discounts for staff at a local gym. The team at Piazza proved that when health, safety and wellbeing is embedded in the culture, and not just a 'tick in the box', that changes can be made that benefit everyone on the site and true provide a positive working environment, helping to remove the negative stigma that can sometimes be attached to H&S.



The Piazza project was a stand-out project with regards to health, safety and wellbeing for Interserve and the University of York. The site team's commitment and innovation led to the implementation of several initiatives including:

- A board-game style video induction to mental health
- QR code campaign linking to vital safety procedures and information
- Health screening on site
- The creation of a 'Safety Awareness Pod' that was used on a daily basis to brief operatives about the hazards on site that day.
- Reduced rate at a local gym
- Advertising style information boards by the turnstiles, which displayed up to the minute safety messages.
- Trained counsellor on site
- A text line to allow operatives and employees to report observations
- The development of the Visual Sound Indicator - a device that monitors noise levels and provides a visual alert when they reach dangerous levels
- Health and wellbeing campaigns covering topics from healthy eating to mental health
- Innovation days and toolbox talks delivering training to all operatives covering topics including working at height and dust, tailored to each group of operatives



# Building Information Modelling BIM

## and the effect on the traditional design team in the UK



### Abstract

Building Information Modelling (BIM) started as a software solution race between players from the United States, Western Europe and the Soviet Block. The aim was to disrupt 2-Dimensional CAD workflows with a complex information model that would improve the efficiency of construction design. Early stages of BIM software moved through constructive solid geometry (CSG) and boundary representation (BREP) in the 1970's to Gábor Bojár's Radar CH in the 1980's. Radar CH (also known as ArchiCAD) later went on to be the first available BIM software for personal computers.

In the present day, BIM gives a digital description of the built property, this is achieved through interdisciplinary contribution from architects, engineers and other construction professionals alike. In-depth information can be extracted from the models such as time schedules, clash detection and cost projections, this real time information is beneficial across many construction professions. However, it can reduce the traditional responsibilities of others.

There are fears that the automatic BIM calculations will threaten the practicality of the traditional design team. It is therefore thought that the key roles and responsibilities of the professionals will move into a new BIM based direction where management is key. This research paper will look directly into the current and future state of BIM with its potential to eradicate, combine or create the roles of a design team. Research was carried out using published research papers, books and anonymous questionnaires

### Literature Review

**Defining Job Titles and Career Paths in BIM - Malachy Mathews**

Mathews key concepts, theories and ideas in this paper focus around BIM implementation at education level; whether it's through a BIM specific course at an undergraduate level or with an add-on course at postgraduate.

He believes there should be four job titles available within BIM, these should be BIM Technician, BIM Coordinator, BIM Project Manager and BIM Manager. He believes that if BIM was taught at post graduate level then each job title would be discipline specific. For example, someone who studied Civil Engineering at undergraduate level and BIM at post graduate could go on to be a BIM Coordinator (Civil). However, he also strongly agrees that BIM education will need to be implemented at an earlier stage if it is going to fully revolutionise the construction industry.

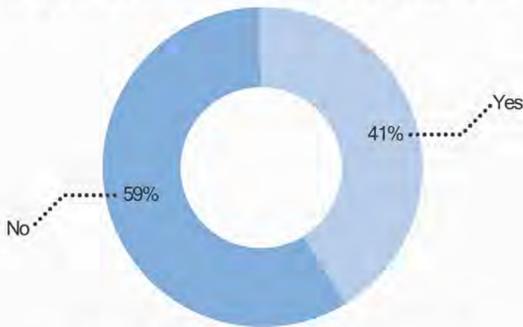
He pushes upon the notion of "boundary crossing"; having a skillset that is applicable to more than one discipline which is feasible by the level of collaboration promoted by the BIM process. He suggests that Architectural Technologists are the most equipped for this as they are often found working within the engineering, construction and surveying disciplines.

### Research Methodology

This research paper was undertaken to further understand the future effects of BIM on the traditional design team. For this, careful consideration had to be made for the research methodology used in collecting data which is why both quantitative and qualitative research methods were used.

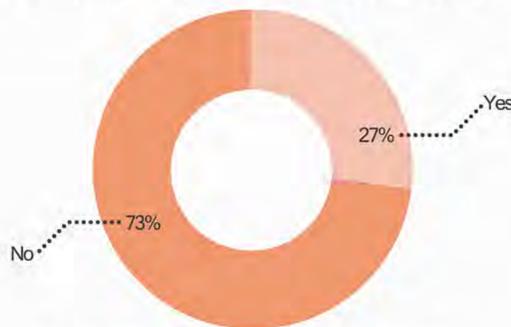
A questionnaire aimed at working professionals was utilised as it allowed for the collection of open ended and closed loop questions; was cheap to produce and easy to distribute to the relevant recipients. This was capped at 30 respondents due to the short amount of time available for conducting research. The questions proposed to the participants were aimed to withdraw their own opinions of BIM and its affect on their own careers and those they may interact with in a work environment. This was important as it helped to correlate, compare and validate data collected via the questionnaires with the findings from the pre-established literature review to provide a greater depth of understanding and input. The most important data that the questionnaire tried to verify from the literature review is whether the roles and responsibilities associated with job titles will change, and if so, will it have a large enough impact to combine or eradicate job roles.

Do you use BIM in your place of employment?



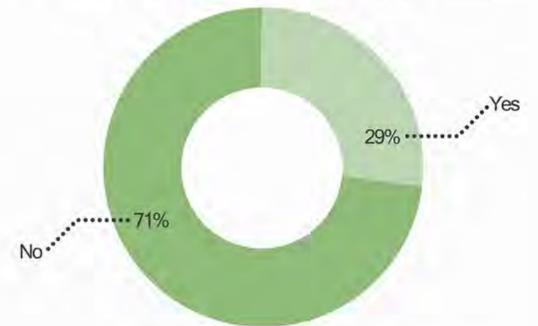
This question was asked to determine how many of the participants utilised BIM in their working environments. This would allow for the research to be interoperated in a certain way.

Does BIM complete any tasks you cannot?



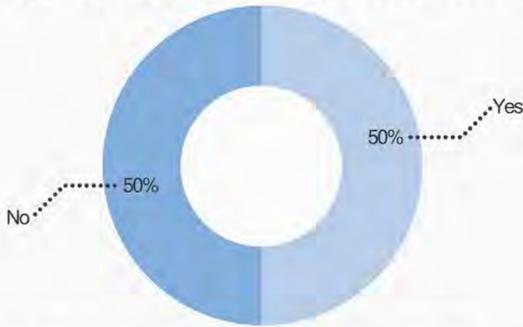
This questions aimed to see how people reacted when asked if the BIM process was more competent than them in certain areas of work. This was to find out how comfortable people are within the BIM role they work.

Do you believe that certain professions are at risk of eradication because of BIM?



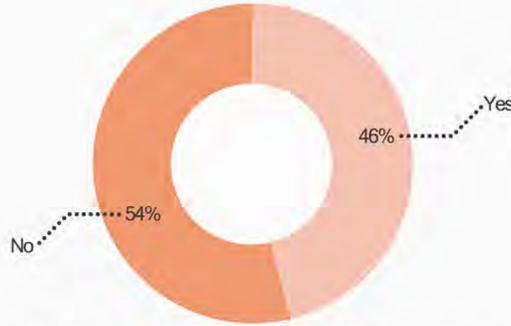
This was the penultimate question asked in the questionnaire. It was to see if people were of the opinion that a traditional role in the design team could be eradicated due to the BIM process.

Do you believe that certain professions key responsibilities will change because of BIM?



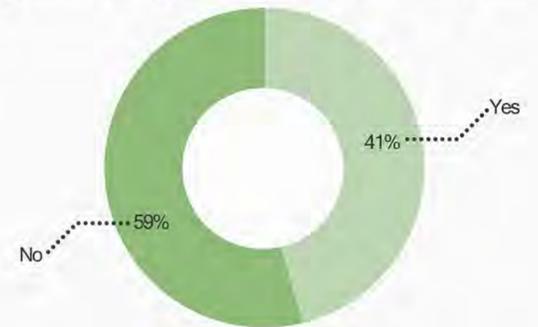
The purpose of this question was to gather an opinion within the profession as to whether key responsibilities of traditional members of the design team will change due to the BIM process.

Do you believe that certain professions will merge into one because of BIM?



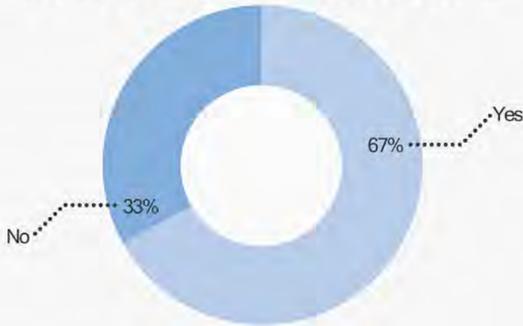
This was asked to see if professionals believed that certain responsibilities of job titles had become less crucial and could be merged into one because of the BIM process.

Can you complete other professionals personal responsibilities using BIM?



This question aimed to see how people responded when asked if they could complete other professional's responsibilities using a BIM process. This was to determine if people felt their skillsets would extend beyond that of their traditional roles.

Do you believe that new job professions will be created because of BIM?



This question was asked to see if people believed that the BIM process could bring enough change to the construction industry that it would force the creation of new job roles.

### Discussion

59% of people who took part in the questionnaire do not or have not used BIM in their place of employment, it can therefore be presumed that the rest of the results will be biased in favour of traditional methods. This result agrees with both Joseph's and Mathews' literature reviews. Joseph's stated that organisations within the AEC industry did not have or will not apply the economic or managerial resources to implement BIM effectively so don't adopt it at all. Mathews suggested that AEC businesses didn't want to adopt innovative new processes after the 2008 global crash due to fear over economic stability and 'being comfortable in the process they know'.

27% of participants believed that the BIM process could complete tasks they could not compared with 41% who believed they could complete other professions tasks using the BIM process. This shows people feel they are both more willing and have the capability due to BIM to complete others responsibilities but fail to see that the BIM process threatens their own roles. Mathews pushes upon the concept of "boundary crossing". By this he means having a skillset that is pertinent to more than one discipline by the level of collaboration encouraged by the BIM process.

There was a 50/50 division between partakers when asked if they believe that certain key responsibilities will change due to BIM. This shows that there is still uncertainty and confusion to the functionality and processing power of BIM when it

comes to job responsibilities. Joseph suggest that a lack of understanding surrounds the ability of dealing with transformation and how to react in-order to retool and support a BIM based environment. This is also suggested by Mathews who discusses the vagueness of PAS 1192 02 and its inability to efficiently dictate or direct a BIM role.

54% of the results favoured the answer no when asked if they think professions will merge because of BIM. However, of the 46% percent who said yes, 46% said that the Project Management and Quantity Surveying professions were the most likely to merge. This contradicts what was said by Mathews who believed that BIM roles were discipline specific and addition to a discipline, not replacing it.

Landslide of participants (71%) believed that traditional roles would not be eradicated due to the BIM process, but, 69% did believe that new BIM specific professions will be created due to the BIM process. 47% of the participants who believed new BIM specific roles were needed named BIM Managers and BIM Technicians as the main role to be created. This shows there is an understanding that BIM requires a different skillset which isn't yet being fulfilled. This was in alignment of what was said by both Mathews and Joseph who believed the roles of BIM manager, BIM Coordinator and BIM Technician needed to be clearly defined for BIM to be fully utilised in its process.

### Conclusion

Currently, BIM is still a new technology in the UK and has not been adopted into the majority of practices. It is therefore difficult to draw results on how BIM will affect the traditional design team as a large amount of professionals don't fully understand or utilise it yet. For those who do, 41% felt confident enough in their own skillsets to be able to complete other professions tasks when using the BIM process. This was an unexpectedly large amount when you take into consideration that 59% of the participants don't utilise BIM in their place of employment. It is also an important indicator that people are willing to expand and cross boundaries between skillsets. From the research, participants don't generally think that traditional roles will be lost. However, there is clearly a gap in skillsets between traditional roles and BIM led roles with 71% of people agreeing that new job titles will be created from the back of BIM. This is in line with what both Michaels and Joseph said in their papers. They both believed that new job roles will have to be created as there is a large amount of boundary crossing when it comes to the roles and responsibilities of BIM workers.

In the future, as BIM progresses and workers within the construction industry become better trained with higher skillsets in the subject area; the need for traditional design team members will most likely decrease. Further research will need to be undertaken at the time to fully encompass the effect BIM has had.

# FLOODING AND WATER DAMAGE



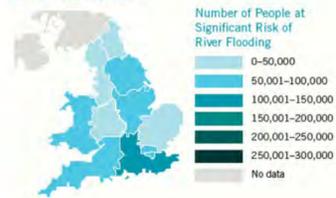
LindenTero

## THE RISING RISK OF FLOODING IN THE UK

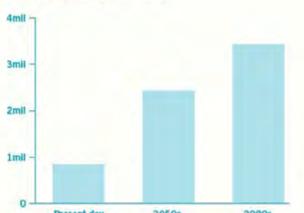
Currently, roughly one in six properties in the UK is exposed to risk of tidal or river flooding, leaving millions of people and critical infrastructure at risk. What's more, the risk of flooding is expected to increase due to rising sea levels, deteriorating flood defences, and increasing frequency of flooding. The Department for Environment, Food and Rural Affairs predicts that the number of people and properties at risk of flooding in England and Wales could grow significantly over the next few decades.

### RISING RISK TO RESIDENTS

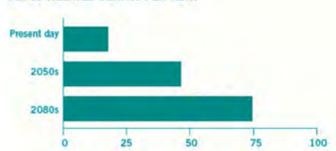
BASELINE AREAS WITH RESIDENTS AT RISK OF RIVER FLOODING



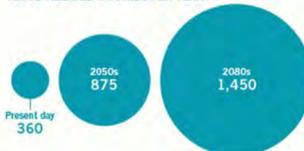
PEOPLE AT RISK OF FLOODING



FLOOD-RELATED DEATHS PER YEAR



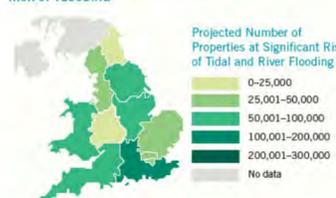
FLOOD-RELATED INJURIES PER YEAR



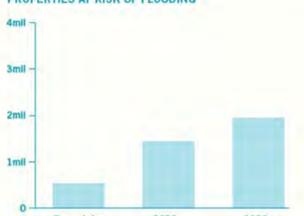
Projected values show average estimate accounting for factors like climate change and population growth.

### RISING RISK TO PROPERTY AND ROADWAYS

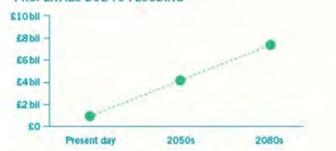
BASELINE AREAS WITH PROPERTY AT RISK OF FLOODING



PROPERTIES AT RISK OF FLOODING



EXPECTED ANNUAL DAMAGE TO PROPERTIES DUE TO FLOODING

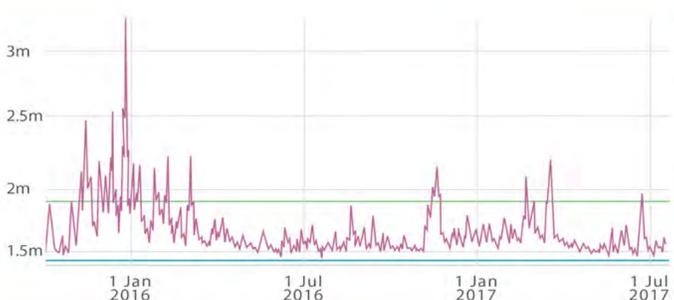


LENGTH OF ROADS AT RISK OF FLOODING



Projected values show average estimate accounting for factors like climate change and population growth.

### River Levels at St Anns Mill Site



The foremost aim of the research is to identify whether the site is appropriate for redevelopment and if so identify the most sufficient flood defence scheme/resilience schemes to prevent the site from catastrophically drowning in river waters as it did in December 2015.

The Climate Change Risk Assessment 2017 contains the following analysis of present causes of flooding in the UK, the following shows a clear indication that more investments need to be put into fluvial/river defences:

- Fluvial (river) – contributing £560m (40%) of total UK economic annual damage
- Coastal flooding – contributing £320m (24%)
- Surface Water – contributing £260m (20%)
- Groundwater – contributing £210m (16%)

The research was carried out with use of secondary research through journals and documents found online, and through emails from professional in areas such as the EA and Leeds City Council. Qualitative research methods were used to review opinions from other people working on similar topics, this method was done by interviewing the individuals through emails. Prior to the emails an ethics form was completed and approved also consent and assent to participate in research forms were constructed for the participants to understand the research and risks and benefits included in their participation and what is expected of them as subjects. The selection of the subjects were chosen due to their knowledge in the topic as well as their accessibility of data.

Leeds was one of the cities that had suffered a major impact during the 2015/2016-winter flood event. In previous year the city had close encounters to extreme flooding, these were; 1946, 1947, 2000, 2004, 2007, 2008 but nothing as big as the 2015/2016 event. Looking further into previous events, flooding in the city is becoming more often, this is due to climate change and the expansion of infrastructure within the city. During the latest unpredicted flood event, the increased amount of rainfall led to the River Aire being at its highest level ever recorded reaching 2.96m at Leeds Crown Point as opposed to 0.40m – 0.74m (River Levels, 2017). An estimated 3000 residential properties were effected and a further 700 commercial properties, resulting in £10million worth of infrastructure damage.

The Leeds Flood Alleviation Scheme (FAS) is the largest river flood defence scheme in England, the scheme is set out on 2 phases [Phase 1 & Phase 2], the first phase was complete in June 2017 (Leeds City Council, 2015). The FAS will protect 3000 residential and 500 commercial from future impacts, safeguarding 22000 jobs over the next 10 years according to the Leeds City Council. The phase 1 development stretches 4.5km through the city, it comprises two new moveable weirs which are the first to be used in the UK. One places at Crown Point and the other at Knostrop, the scheme has the ability to reduce flood levels within the area by over a meter. The Phase two also aims to further protect areas further away from the city with new flood defence systems as show on the map.

### SOLUTION

This intricate design sits in close proximity to the mountains flowing rivers, which previous to 2012 flooded the Trollstigen area. The whole of the structure acts as one large flood defence system, limited water can enter the area and is controlled with the use of small weirs and flow in a series of regulated cascades and pools. The materials used within the construction have been carefully selected to ensure the design does not look out of place and visually flows with the appearance of the landscaping. A balustrade runs around the complex structure for people to walk around the mountain and move from view point to view point, these balustrades also act as flood barriers, made with corten steel which will oxidize and gain its own natural coating over time another main used material is in-situ concrete which has been treated with several different techniques and is used for its durability and also matches the mountains grey landscaping.

Forrest Flood



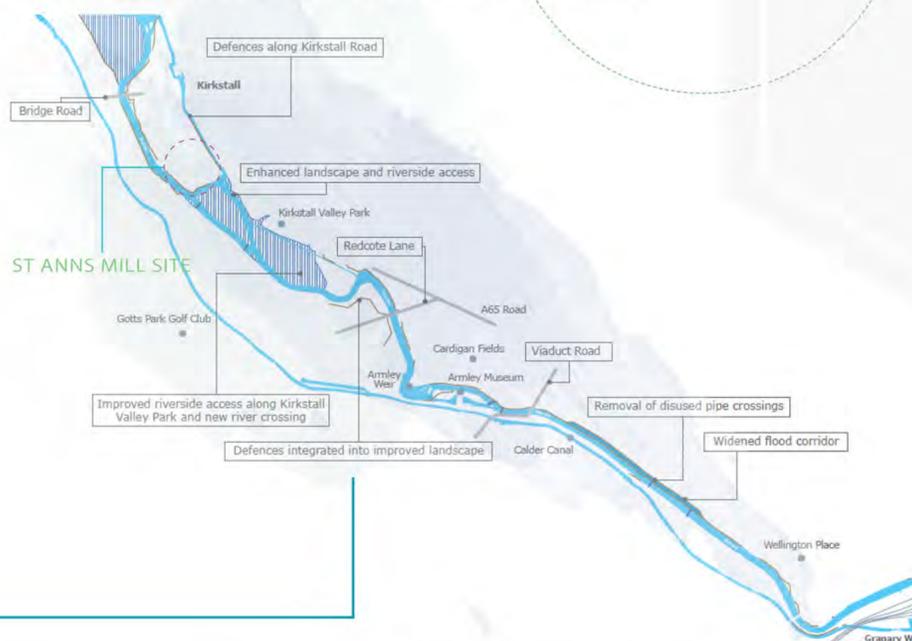
Trollstigen Visitors Centre



Infrastructure Damage



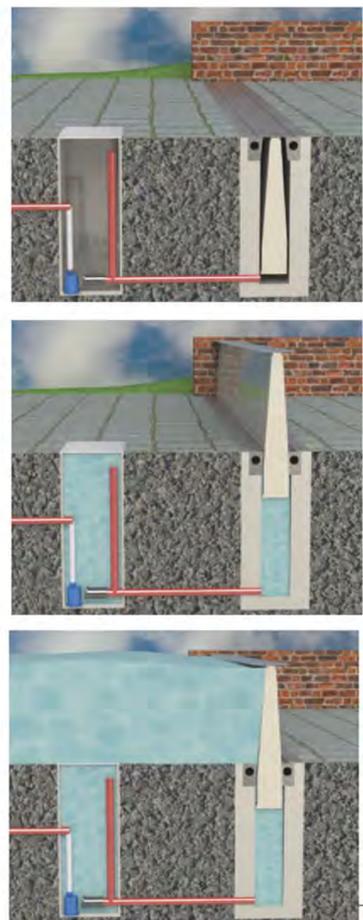
### PHASE 2 LEEDS FLOOD ALLEVIATION SCHEME



### DEFENCE SOLUTION

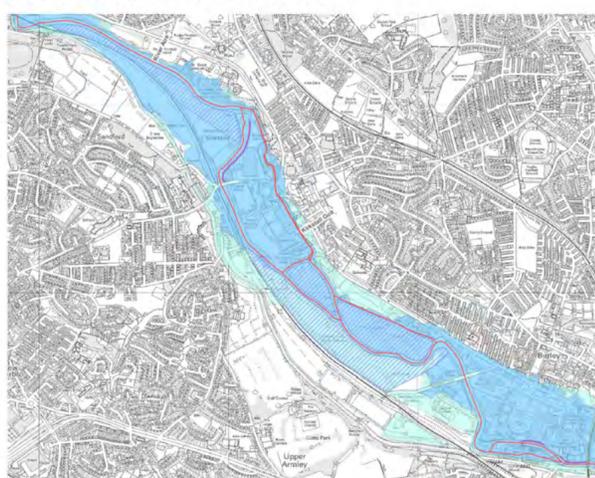
An appropriate system to use on the St Anns Mill site would be the Automatic Sectional Barriers, these are self-lifting flood barriers that rise with water levels, they are invisibly concealed within the ground ready to deploy so there is no need for offsite storage, due to the barriers being lifted with the power of the rising water, they require no energy or manual intervention, these barriers can span any length and can reach heights of up to 2.5 meters and they return under-ground when the water subsides. Automatic Flood Gates may also be good in some areas, they usually close the gap within a flood defence and are controlled by sensors. They do not require any offsite storage but due to them being automatic, the mechanical parts of the system may can fail.

- Resting Position
- Deploying
- Fully Deployed

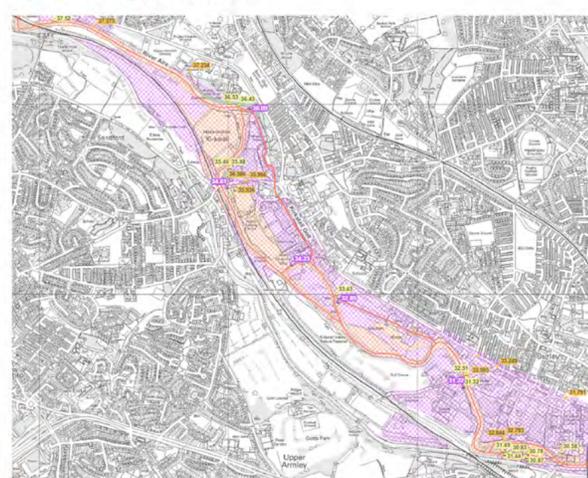


### SOLUTION

#### FLOOD MAP FOR PLANNING



#### FLOOD HISTORY MAP



- LEGEND
- Main River
  - Flood Map Flood Defences
  - ▨ Areas Benefitting From Defences
  - ▨ Flood Storage Areas
  - Flood Zone 3 (FZ3)
  - Flood Zone 2 (FZ2)
  - ▲ DEC 2015 Flood Levels (M)
  - ▲ FEB 2002 Flood Levels (M)
  - ▲ Autumn 2000 Flood Levels (M)
  - FEB 2002 Flood Extent
  - ▨ AUTUMN 2000 Flood Extent
  - ▨ NEW\_2015 Foutlines

# RISEAWARDS 2018

## NORTH EAST FUTURES UTC HERITAGE AWARD FOR RESTORATION/RETROFIT



# THE SCHOOL OF THE FUTURE WITH AN INDUSTRIAL PAST

North East Futures UTC is perfectly situated in Newcastle's Stephenson Quarter development. Stephenson Quarter offers a spacious land mass but more importantly is based in the centre of the city with easy access to both The Metro and Newcastle Central Station, along with great bus and road links making the UTC attractive to young people across a wide area.

A UTC is a University Technical College and is different from others because it has unique support from local, high-profile industry partners and employers. This means young people can take advantage of the UTC's specialist subjects; Health Sciences and Digital Technologies while still taking GCSEs, A Levels and Technical Awards.

The North East has huge skills shortages in the Health Sciences and Digital Technology industries; two of the fastest growing sectors in the region. The UTC aims to help young people gain the correct skills and qualifications, to thrive in these industries and help to grow the North East economy.

The new build teaching space at the UTC is entwined with the existing Hawthorn Engineering Works building, which in its heyday was at the forefront of pioneering new technologies in the railway industry. This space provides inspiration from the past, present and future to ensure the region keeps its industrial roots, as well as advancing in the ever-changing technological world.

Stephenson Quarter is steeped in history, including the pre-existing Hawthorn Engineering Works building which was part of the 19th Century Hawthorn Engineering Works that turned out marine and locomotive work.

In 1831, brothers Robert and William Hawthorn produced their first steam locomotive and rapidly expanded; second only to that of Robert Stephenson.

In 1937, Robert Stephenson of Darlington amalgamated with the locomotive works at Forth Banks to form Robert Stephenson and Hawthorn.



PAST

The new block provides teaching space, whilst the Hawthorn Engineering Works building provides a large proportion of the non-teaching space for assembly, dining and a fitness studio.

North East Futures UTC has been established to change the education, skills and employment paradigm in the North East Digital and Health Science sectors. It will provide the opportunity for young people, from all communities in the region, to benefit from its specialist provision and by creating a more effective model to 'grow our own' skilled, committed and 'work-ready' young people.



PRESENT

The UTC project is part of a wider vision for turning Stephenson Quarter into a dynamic working, learning and relaxing environment. Creating up to 4,000 jobs when finally completed.

The overall master plan could win Newcastle 'World Heritage' status; the scheme will open up the public listed buildings which have previously been hidden gems. It will be a very exciting, major piece of regeneration, creating a 21st Century development which would be firmly embedded in its historic setting.



FUTURE



SES Engineering Services, Moorside, Monks Cross Drive, Huntington, York YO32 9LB Tel: 01904 437340

### UNIQUE FEATURES

Constructed over five-storeys, the UTC will be attached to the Hawthorn Engineering Works, a historic Georgian building, which played a key role in the North East's contribution to the development of the railways and also home to the world-famous Robert Stephenson and Company.

Catering for up to 600 pupils, the UTC will have a specialist focus on teaching health sciences, robotics and IT. As such, the building requires state-of-the-art building services, which led to SES' appointment.

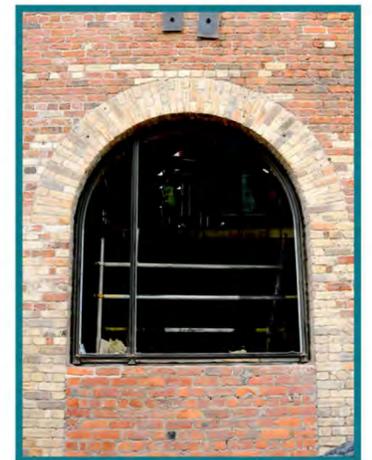
### CHALLENGES

While on site, SES will face challenges such as connecting a historic building with the new build element. A lecture theatre will be created within the Hawthorn Engineering Works building, whilst in an unusual move stemming from land constraints, a rooftop multi-use games area will feature on the new build element.

SES overcame the challenge of ensuring the existing building was preserved, by utilising the building structure to hide the cabling, so as not to detract from the existing features. The installation techniques are not only aesthetically pleasing, but also boast new technologies; such as motorised high-level blinds, powered window actuators and an evocative lighting design.

A major renovation and restoration piece included retaining the existing cast iron support beams between the new and old building as a feature. To carry this out, a specialised contractor was brought in to restore the cast iron archway. This involved removing one of the original arches, which had very limited damage, making it into a mould and recasting two new archways. This meant the damaged arches could be replaced with replicas, that are in keeping with the original build methods, as well as the look and feel of the space.

From an M&E perspective all containment is surface-mounted galvanised conduit or at a high level. Within the beams all containment solutions are traditional or invisible to the end user, this ensures the finished area will have the industrial elements from the past, combined with the modern heating, cooling, power and lighting requirements for a building of this stature.



### BENEFITS

This is an exciting project, not only for Stephenson Quarter's £200m development; but also for education in the city. The UTC has received wholehearted support from the business community and Newcastle City Council as well as the region's universities.

The school will also benefit from direct links and access to some of the high-growth businesses choosing Stephenson Quarter as their preferred location.

On earlier visits to site, SES was responsible for installing a full range of building services on The Rocket, a multi-storey office block, the four-star Crowne Plaza Hotel and Spa – a jewel in Newcastle's burgeoning leisure sector – and a multi-storey car park. Work on Stephenson Quarter has led to the significant regeneration of a key site in the city.

This is one of the many exciting projects that SES is currently working on in the region, and is one which clearly demonstrates our ethos of providing local knowledge and resources to all projects that are undertaken.



### ARCHAEOLOGICAL FINDINGS

Pre-Construct Archaeology Ltd was commissioned by Galliford Try PLC on behalf of the Clouston Group Ltd to undertake a series of archaeological investigations within Stephenson Quarter.

The site is located in the area between the Crowne Plaza Hotel and the Stephenson Works Boiler Shop on South Street and is bounded to the north by Forth Street and to the south by a retaining wall, beyond which the land drops steeply.

The majority of the archaeological work was undertaken in conjunction with the construction of a walkway to be created between the hotel and the Boiler Shop as part of the proposed development of a new public square (Stephenson Square).

One element of the archaeological work was associated with the construction of the new North East Futures UTC on land to the south of the site; a foundation trench for the north wall of this building extended into the south-western corner of Stephenson Square.

A foundry was also located within the western side of the development area and is first observed on a map in 1849. An inscribed stone for Wright & Brown Foundry dating back to 1839 was found in building rubble on the site prior to archaeological work commencing. By 1881, Wright & Brown's Foundry had been incorporated into the Stephenson Works.

The first phase of archaeological work, in January 2017, comprised of structural remains, situated in the south-eastern part of the site, being cleaned by hand, and records were formed of all the remnants within the eastern half of the proposed walkway route.

The structural remains were exposed following the removal of concrete hardstanding and some initial ground reduction which occurred in December 2016. This was followed in June-July 2017 by the investigation of four evaluation trenches to better understand the scale and depth of the surviving archaeological remains at the site.



## Introduction to 3D Printing:

3D printing was developed in the years 1995-2000 also known as contour crafting, which initially began as a ceramic extrusion and shaping method. These techniques have been adapted to help revolutionise the construction industry. Companies since then have been creating components of buildings using this process. This presentation aims to address how the use of 3D printing has been introduced into the construction, and provide an insight to how efficient the latest technology can effect the construction process. This presentation also analyses the impact 3D printing has on Architects and it's design team. This contemporary technology is an exciting prospect for all Architects and Contractors as it has the potential to become one of the leading technologies in the future due to its efficiency in producing innovative buildings and materials.

### Advantages of 3DP in Construction:

- Shorter construction periods - meaning the efficiency of the technology allows components or buildings themselves to be erected in a much smaller time frame.
- Incredibly less labour costs - 3DP allows a contractor to reduce the cost to employ people to build and print buildings.
- The ability to remove human error from the construction process - this allows for more precise engineering and designing.
- An increased complexity when designing buildings - this allows for an architect and architectural technologist to almost produce designs that are too complex for the traditional construction methods used today.

### Drawbacks of 3DP in Construction:

- Companies are "wary" of the advancement in technology as it can be seen to have a detrimental effect on the labour markets.
- 3DP is growing at a faster rate than the construction industry due to the availability of materials.



# 3D Printing in Construction

*"This is just the beginning" - Joris Laarman*

*"We are looking into the future" - Marinus Schimmer*

*"Brick and mortar buildings will be a thing of the past" - Clare Scott*



## Research and Methods:

This research paper into 3D printing used case studies and cross examination comparison techniques to identify results into the efficiency of 3D printing in construction and the impact this has on Architects and Architectural Technologists. Case studies have often been viewed as a useful tool for the preliminary, exploratory stage of a research project as such with this papers research into the contemporary technology of 3D printing.

### Case Studies:

This paper analyses 5 different projects all of which have used an aspect of 3D printing. These projects have been cross examined to identify how efficient 3D printing is in the construction process and the impact this has on Architects and Architectural Technologists as part of the design team. The case studies used are as followed:

- 1) Office of the Future, Dubai, United Arab Emirates
- 2) 3D printed apartments, China
- 3) Vulcan Pavilion, Beijing, China
- 4) 3D printed bridge, Amsterdam, Netherlands
- 5) MX3D Steel Bridge, Amsterdam, Netherlands

Construction waste reeduced by 40-60%

## Case Studies:

### Office of the Future:

Dubai is currently at the forefront of the construction industry and a haven for modern architects and contractors. In May 2016 the office of the future was inaugurated, and is the very first of its kind. A 3D printer measuring 20x120x40 feet long fabricated the offices. The building was constructed off site using the 3DP and then transported on site and erected in just 2 days. The printing only took 17 days. The labour involved in the process included 1 technician, 7 people to install the components on site and 10 electricians and specialists to complete the building services. This is a significant decrease as labour costs were cut by more than 50% when compared to traditional construction methods.

### MX3D Steel Bridge:

Architect Joris Laarman and startup company MX3D are in the process of developing a 3D printed steel bridge, used for pedestrians over the Amsterdam Canal. This project uses 3D printing robots of which are able to print in metal. The robots are able to print more complex and larger structures as the robots print a structure for themselves as they move across the project. The steel bridge spans 8m in length, and will be printed in one piece - this has never been done before. The bridge may be small in size but the structural integrity and design complexity is what makes this one of a kind. The bridge is being printed in steel.

### Vulcan Pavilion:

China are also leading the way forward with the complexity of design, not just through efficiency of construction. This was shown through LCD's Vulcan Pavilion.

The pavilion was designed to represent a mushroom cloud that would form during an eruption. The detailed elements of this pavilion were inspired by the silken webbed filaments shown from the research of cocoons. The structure itself is comprised of 1,086 different 3D printed parts all of which were printed off site. The structure is 3m in height. The pavilion took 30 days to complete and 12 days to assemble. Where labour costs were cut by 50% as the project involved 20 large scale 3D printers. The pavilion is a statement to all architects and designers as architect Yu Lei states that other "modern architects" are able to achieve their ideal design quality from concept through to construction.



## Aims And Objectives

- Ascertain current levels of spatial skills abilities across primary and secondary levels with a particular focus on the gender differences;
- Determine the impact these skills have on students' perceptions of, and success in, STEM subjects;
- Develop and evaluate educational interventions specifically aimed at improving these skills;
- Analyse data in the context of demographic data, year, subject choice and level, CAO choices and perceptions of STEM education, focusing on gender differences.

## Methodology

Spatial skills are measured using validated and standardised tests such as:

- PSVT:R (mental rotation)
- MCT (mental transformation)
- DAT-SR (spatial relations)
- To test at primary level, new tools will be developed and validated
- Questionnaires and interviews will ascertain students' perceptions of STEM subjects and disciplines
- Spatial skills intervention courses will be implemented and evaluated in both second and primary level

## What is Spatial Ability?



How do we test spatial reasoning? Figure 1 below shows an example question of the DAT-SR test

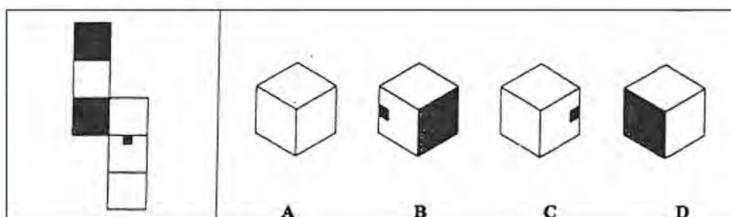


Figure 1: Example question from the DAT-SR test [1]

## Results and Discussion

Figure 2 below shows preliminary findings from a previous study. The graph indicates that the students' spatial skills are increasing with age but the gap between girls and boys is increasing [2]

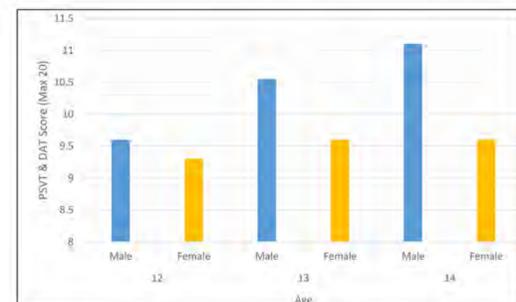


Figure 2: Preliminary data showing spatial skills levels by age and gender (measured by PSVT:R, DAT-SR)



Currently second level schools across Ireland are being contacted, with over 30 already agreeing to take part in the study



These schools are currently being sent links to the spatial skills test, where we are assisting with the organizing of the testing



The data is being collected and stored to be analysed at a future date

Figure 3 from a well known study shows spatial abilities measured across 53 countries with a significant gender gap [3]

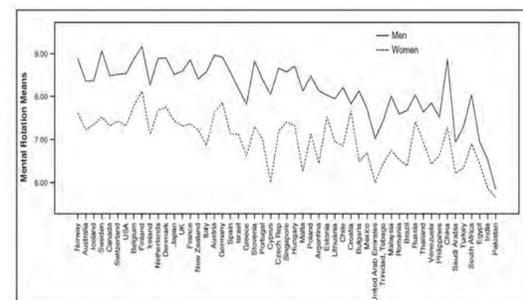


Figure 3: Spatial Skills Level across 53 countries showing gender gap (measured by MCT)

A landmark study in the US tracked 400,000 students over a 30 year period. The study found that "A child's spatial skills level is a better predictor of STEM attainment than their math skill level in 7<sup>th</sup> grade" [4]

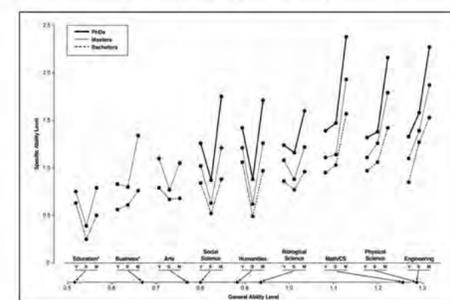


Figure 4: Highest level of education acquired grouped by discipline, showing verbal, spatial and math levels as measured in 7<sup>th</sup> grade (12-13 year-old students)

## Acknowledgements

I would like to sincerely thank Prof. Brian Bowe, and Dr. Robert Howard for their continued support and guidance as my supervisors for this project. I would like to thank Intel Ireland for their generous support in funding this project, and the PDST for their support in selecting and testing in second level schools.

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- [1] Differential Aptitude Tests. Fifth Edition (1990). The Psychological Corporation (USA)
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## Conclusions

As this project is in its early stages, the research is currently being designed. Future work will include:

- Measure the spatial skills of 50,000 second level students (first to sixth year);
- Collect perception and approaches to learning data through surveys and interviews;
- Identifying relationships between spatial skills and data pertaining to demographics, profile, subject choice, subject level, higher education discipline choice and assessment results;
- Introduce spatial skills courses into transition year and evaluate the impact on the students' spatial skills, perceptions, approaches to learning and attitudes;
- Development of tests and learning resources for primary school.

## Overview

The innovative Radwraps system is a special formulated magnetic sheet which applies on the front of your radiator. It is an alternative to traditional radiator MDF wooden covers which improve thermal emissions to a room while retaining the benefits of concealing the radiator from full view and reducing the risk of burning. This work shows the finding of an experimental testing for these two radiator covers and the effect on heat transfer under the same conditions. The Radwraps Ltd company approached Liverpool John Moores University (LJMU) to test the product in LJMU lab and the test was repeated in LJMU Exemplar house (modern) as a real world environment. Radwraps are now being utilised in nurseries, schools, nursing homes as well houses in general, across the UK.

## Why Radwraps is Different

- Unique material with less heat loss compared with traditional MDF wooden cover.
- Green product with low CO2 emissions compared to MDF wooden cover.
- Cost effective.
- Have different designs to match wall paper, or other backgrounds as preferred.



## Challenges

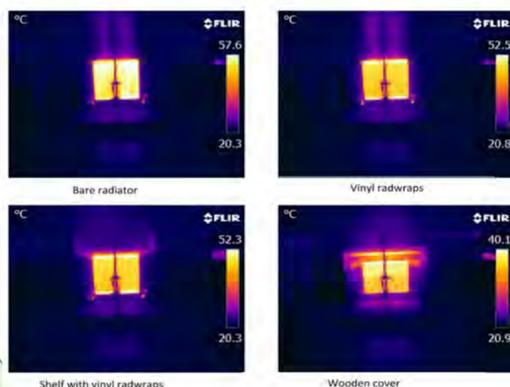
- Finding an innovating material: by trial and error and testing different materials to see how they reacted with the heat and print. Prototypes of a roller blind system has been produced with a sheet of steel, and eventually, after many years of testing, the right material was found.
- Testing from a recognised world renowned organisation was a huge challenge: the company approached LJMU Low Carbon project (ERDF) for free support.
- Brand awareness: This is a new product in a totally new market. In order to help customers realise what it is, who we are and what we can do when looking to promote and maximise brand exposure, we looked towards local news forums, competitors, bloggers and we collaborated with different organisations to promote and market.
- Raising awareness of the low carbon benefits in comparison to wooden covers: this has been overcome by using media, events and LJMU test report.

## Methodology & Test Setup

Experimental tests were carried out by constructing a radiator system in a closed room space. The system comprised of a double panel radiator in which hot water is circulated with a certain flow rate.

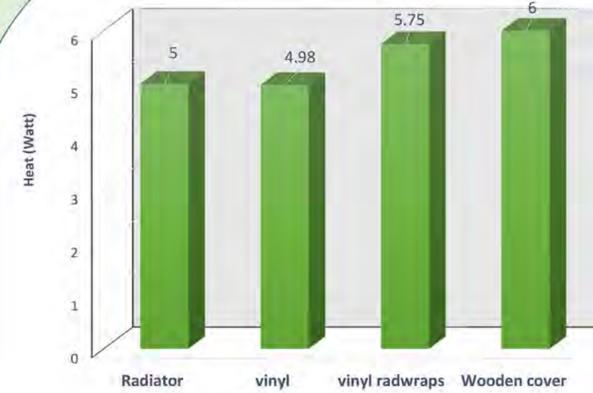


Ambient conditions were controlled by using insulated panels. Before the tests were carried out the system was operated for several hours to reach steady state conditions. Surrounding conditions were the same for each of the scenarios that have been tested with external ambient air temperature of 20°C. Four scenarios have been tested. A radiator under the magnetic only and magnetic with a shelf, traditional wooden covers radiator, and a bare radiator. Temperature recordings were obtained by thermocouple data logger and thermal imaging camera tests for the purpose of comparisons.

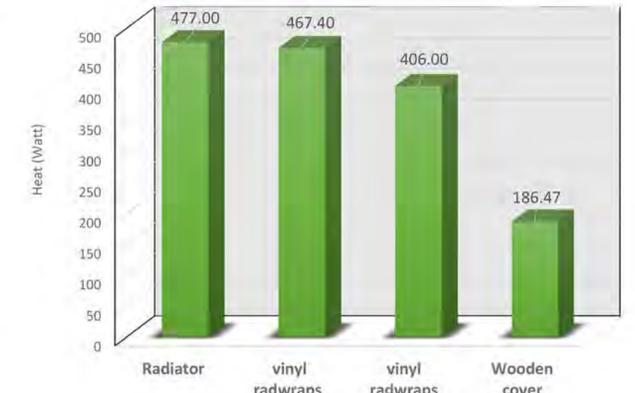


Thermal imaging for different scenarios show the temperature on different surfaces

## Results



Total heat loss by conduction through the wall during steady state condition



Total heat transfer to the air from the radiator system (convection and radiation)

Scenario	Actual Efficiency based on input/output heat%	Efficiency compared to radiator power rating%	Efficiency compared to bare radiator %
Bare radiator	80	57	-
vinyl Radwraps/ Shelf	78	56	98
vinyl Radwraps	68	48	85
Wooden cover	31	22	39

This table explains the efficiency for each scenario under same surrounding condition

## Product Achievement & Current and Future Benefits

- Reduction in heat output up to 40% using the timber casing, however when replaced with the magnetic cover this amount is only 11%.
- Magnetically applied radiator covers efficiency increased by 13–20% relative to traditional radiator wooden cover.
- Radwraps or radwraps/shelf could result in an extra heat saving, compared to a wooden cover of 1.85 kWh and 3 kWh a day respectively.
- For one home one radiator Radwrap saves 6.24 kWh of energy per day and 187.2 kWh Per month 561.6 kWh Per year £30 Per year avg.
- The product yielded significant profit for the company and is now very well known.
- Radwraps cover supports future reduction of energy and greenhouse emissions and mitigates the impact of global warming on the environment.
- The findings of this test have been published in a high impact factor periodical Journal "Energy and Buildings" under the title: "An investigation into the effect of decorative covers on the heat output from LPHW radiators".

# AN INTEGRATIVE MACHINE LEARNING METHODOLOGY

## FOR OCCUPANTS' BEHAVIOR PREDICTION

AN ATTEMPT TO MINIMIZE ENERGY PERFORMANCE GAP

Rima Alaaeddine, Professor Song Wu  
The University of Huddersfield

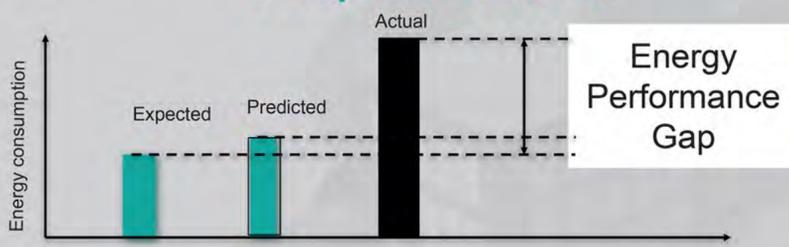
### • BACKGROUND

Buildings account for **40%** of total energy consumption.

The energy use of the residential and commercial buildings alone reach a staggering **60%** of the total consumption.

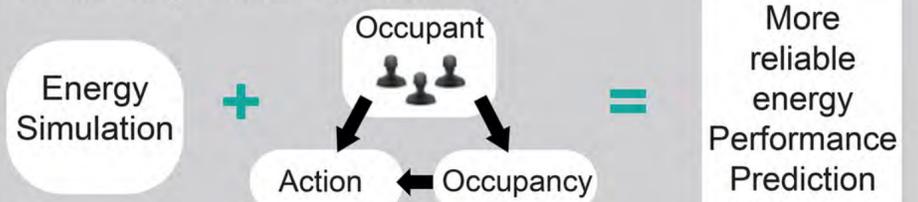


Buildings are consuming more than **160%** of predicted energy. One of the main contributors to the energy performance gap is **Occupants Behaviour**



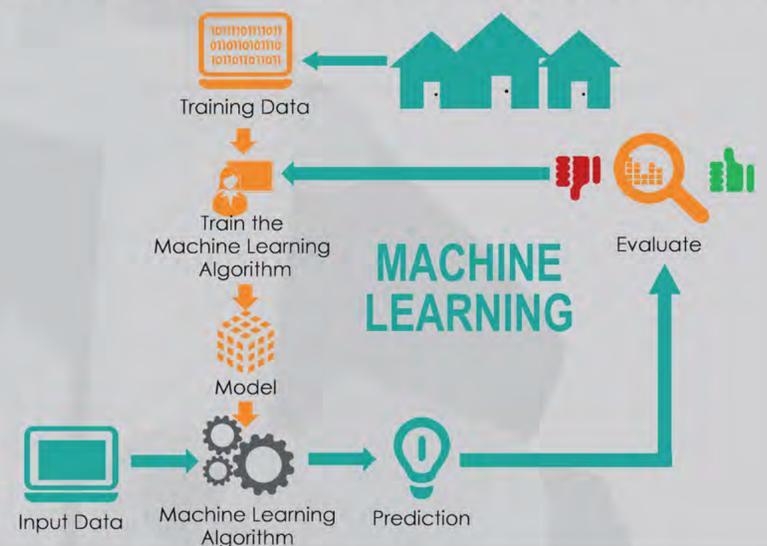
### • RESEARCH AIM

The research aims to improve the reliability of building energy predictions by integrating occupants behavior analysis through machine learning techniques, in which occupants behavior impact on building performance is realized, quantified and foreseen.

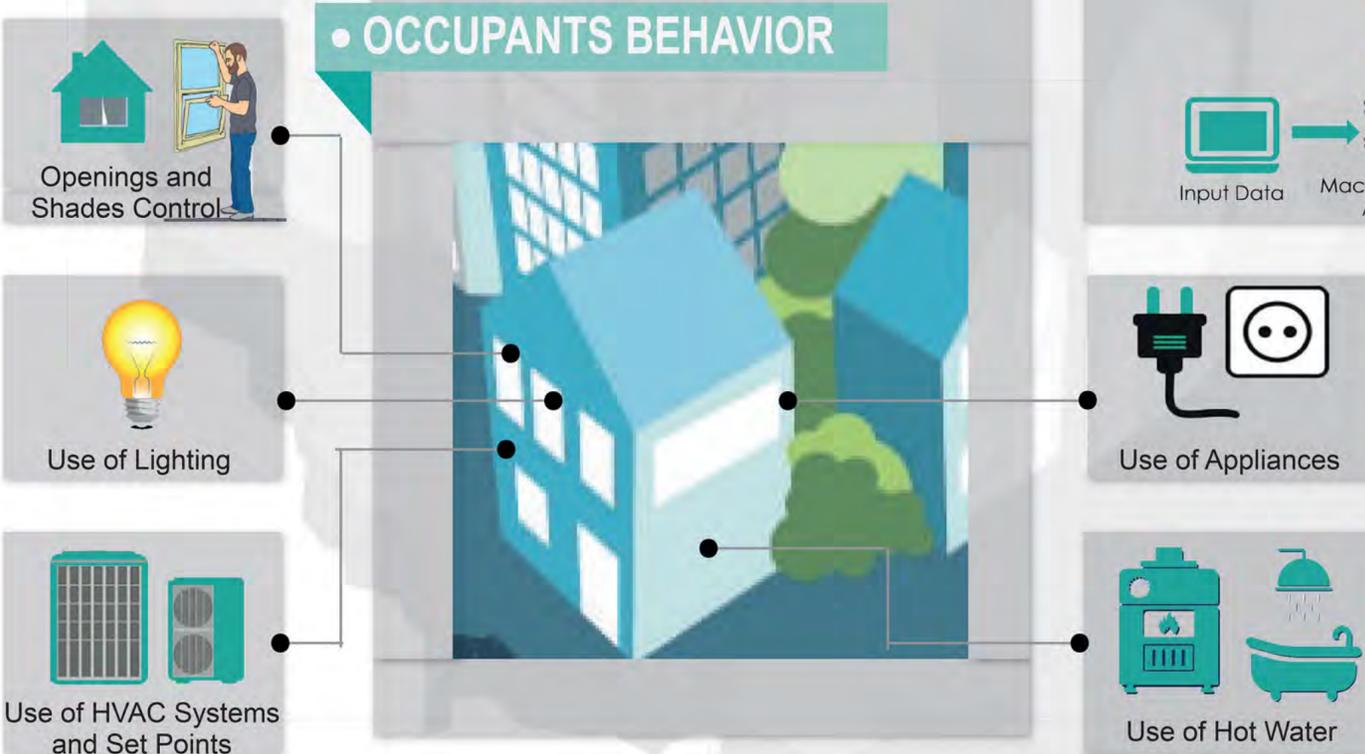


### • WHY MACHINE LEARNING ?

Machine Learning is computational learning using algorithms to learn from data and provide predictions.



### • OCCUPANTS BEHAVIOR

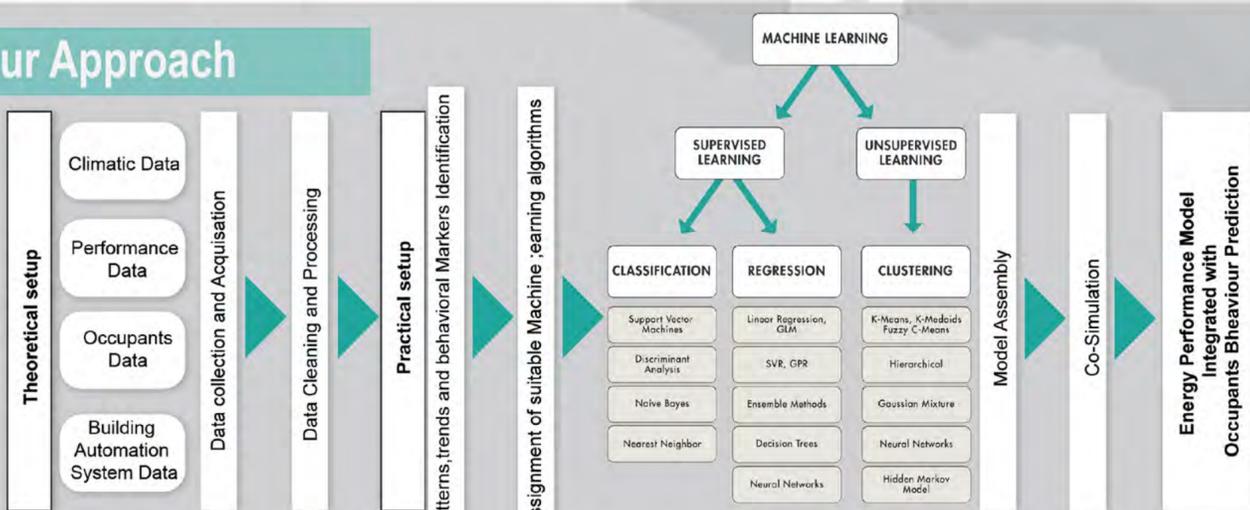


### • CONCLUSION

Impact of occupants behaviour when included in Energy simulations, can reduce the Energy performance gap.

Machine Learning approaches, could provide more accurate predictions and eventually support the simulation phase.

### • Our Approach



- Identify the various parameters and constraints that affects occupants behavior.
- By means of Machine Learning techniques, provide weighting factors of each of the identified factors.
- Develop probabilistic model for predicting occupant behavior
- Integrate the model with Building Energy Model (such as energy plus) to add up the prediction of behavior impacts on building energy use



## DHS-HomeManager Open Smart-Home Platform

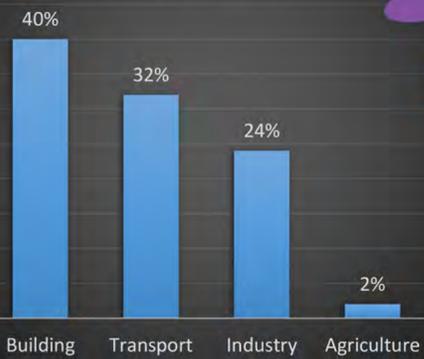


Limit global warming

to a maximum of 2°C

Kyoto protocol and Paris agreement

### Share of Energy Consumption



CONCERTED ACTION  
ENERGY EFFICIENCY  
DIRECTIVE



EPBD

Energy Performance  
of Building Directive

### EU states have adopted 3 strategies

- Building Retrofitting
- Renewable Energy Sources
- Building Automation



### The technology jungle:

- Germany is the largest Smart-Home market in Europe
- A multitude of technologies, standardized as well as proprietary are available here
- Different systems can't be integrated



### The solution is a platform

The DHS-HomeManager is not a single product, it's an open configurable platform, based on the O<sup>4</sup>-approach:

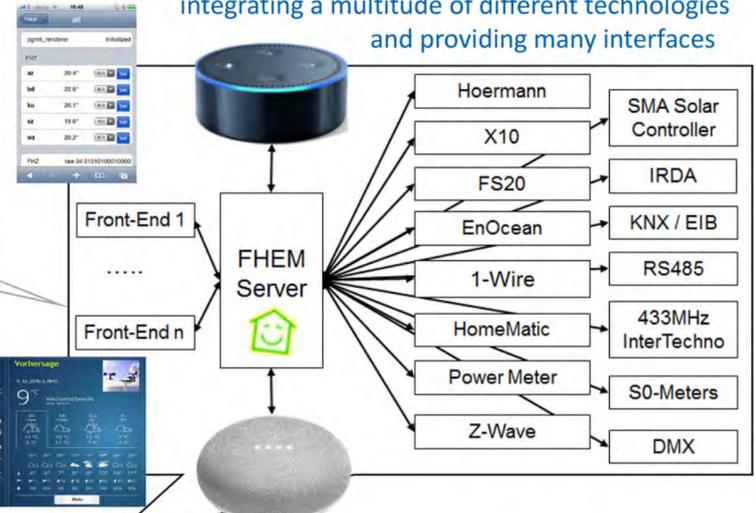
- Open-Source Smart-Home Software
- Open-Source Operating System
- Open Hardware Platform
- Open-Source Firmware Modules



FHEM is an Open-Source Smart-Home Server, integrating a multitude of different technologies and providing many interfaces



ARMBIAN is an Open-Source Linux-based Operating System



The Hardware is based on an NanoPi NEO Core2-LTS, built by FriendlyArm. It is equipped with 1GB Ram, 8GB eMMC Flash, an Allwinner H5 Quad-Core 1.5Ghz Processor, USB & Ethernet Ports.

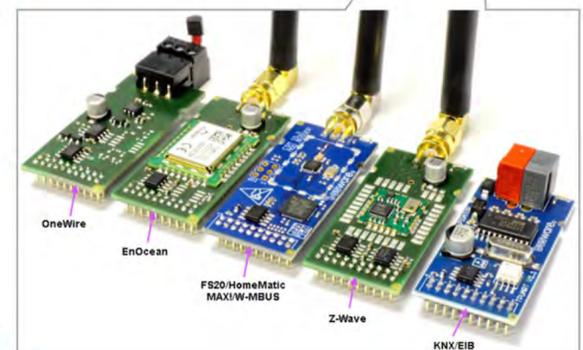
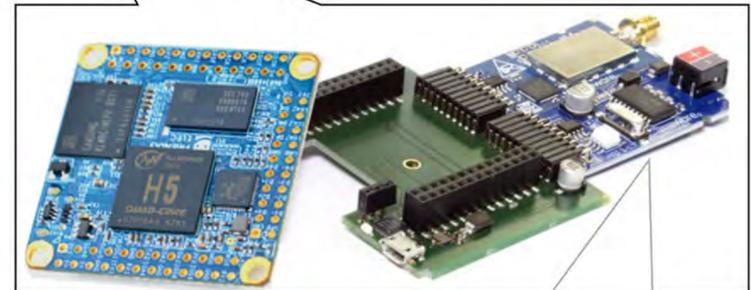
The NEO Core2 resides on a baseboard incorporating two module carriers for TEMs (Technology Extension Modules), an USB & Ethernet Socket.

The board supports a resistive touch display for direct interaction. The module carriers can connect up to two TEMs, which can be chosen freely from a variety of different modules.

Each TEM (Technology Extension Module) supports a specific bus-technology, standardized as well as proprietary ones. Most TEMs using a local microprocessor for implementing a specific bus logic. The firmware in these microprocessors are also Open-Source based and can be adapted freely.

The TEMs do support protocols like: FS20, HomeMatic, MAX!, EnOcean, Velux, EM100, HMS, FHT, HomeEasy, Philipps Hue, Intertechno, Oregon, LIRC/IRDA, W-Mbus, 1-Wire, KNX/EIB, RS485, Z-Wave, Allnet, Jeelink, etc.

New TEMs are created as needed for new protocols.



### Extending the platform

If more than two bus modules are needed, extension interfaces can be connected to the DHS-HomeManager, either via USB, Wifi or Ethernet, carrying one up to four new TEMs.



Different extension carriers can be attached to the DHS-HomeManager to cover any bus system on the different levels of a building. By this it is possible to attach a Buderus heating system in the cellar, running Z-Wave devices in the ground floor and a KNX/EIB bus in upper floors. The extension carriers seamlessly connect the TEMs into the platform.

# RISEAWARDS 2018

RESEARCH | INNOVATION | SUSTAINABILITY | ENTERPRISE

## Automated Generation of Digital Twins of Existing Reinforced Concrete (RC) Bridges

click to see [Project Video](#) (3'35'') and [Demo](#) (53'')



**Open-source**  
Free to download  
<https://github.com/ph463/Gygax>

• Gygax is a research coding platform based on the .NET framework.  
• Gygax can access to IFC models/images/videos/point clouds, visualize and process them simultaneously.  
• Gygax provides a native access to powerful processing libraries that contain a good encapsulation quality.

### Gygax + VR = Future Bridge Inspection

## FUTURE

**VR technologies will make it possible to bring such on-site inspection work into the office.**





We have the world's largest collection of real-world RC bridge point clouds!

### Nature of Innovation

This innovation provides a step-change in a way we inspect existing RC bridges in a virtual 3D space by using the point cloud data to automatically generate their geometric digital twins and then, by using high-resolution images to detect defects and map them into the digital twins to help solving today's global bridge management challenges.

### Likelihood of Success

The likelihood of this project to succeed is quite high. We have tested this system on 10 real-world RC bridges and the overall average detection F1-score reached 98% with the defect detection rate 92%. The outcomes have been published in top scientific journals. This proves that we are among the first researchers in the world to achieve high performance on digital twins generation for RC bridges. We will collaborate with industry partners to extend the current solution to other bridge types.

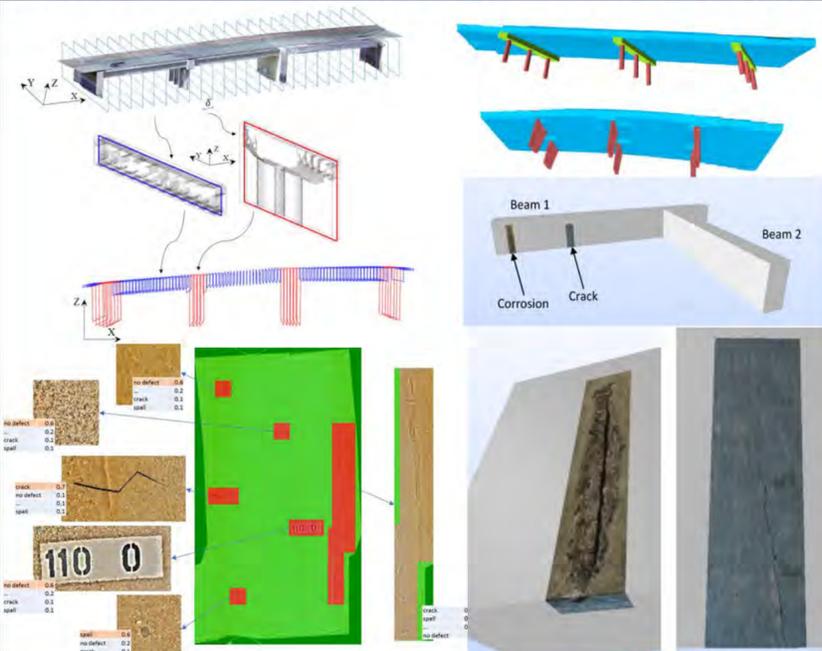
### Honors received

- 2018 - 11th ICCM (Innovation Competition) (China) --- 1st prize
- 2018 - Young Innovator and Entrepreneur (France) --- 1st prize
- 2017 - Fiatch CETI award (United States) --- Outstanding Student Research Project
- 2017 - LC3 Construction Innovation Competition (Greece) --- 1st prize

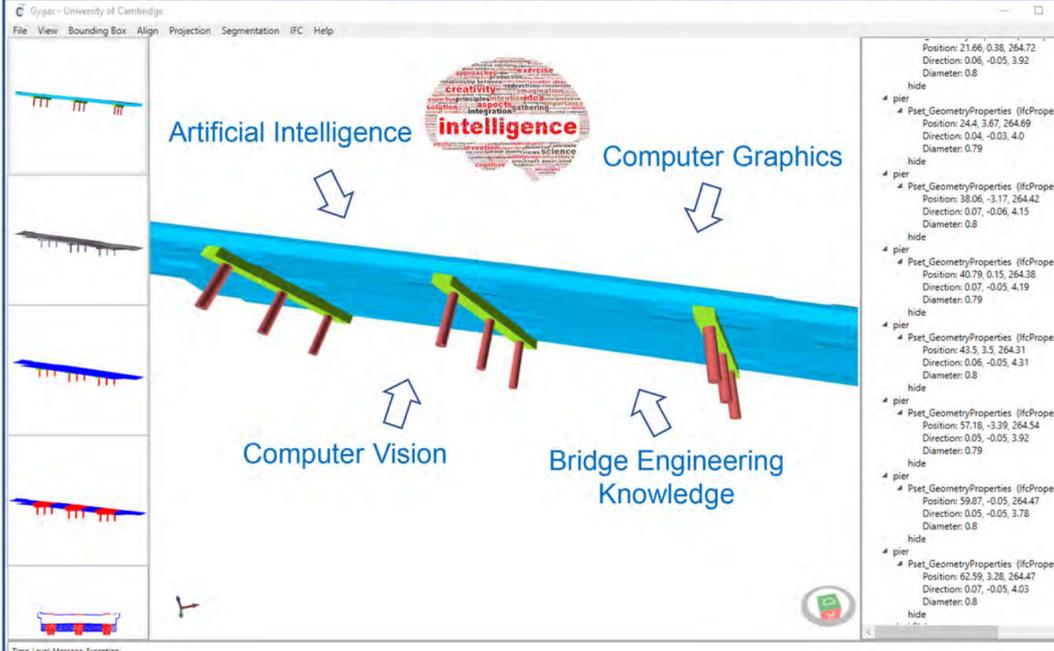
Ms. Ruodan Lu, Ph.D. Candidate,  
Engineering Department, University of Cambridge  
Mr. Philipp Hühwohl, Ph.D. Candidate,  
Engineering Department, University of Cambridge  
Dr. Ioannis Brilakis, Laing O'Rourke Reader,  
Engineering Department, University of Cambridge



### Geometric Digital Twin generation & Damage Mapping



### Gygax – Software targeting near market-ready outcomes



# Energy Efficiency Assessment of Buildings Using Sustainable Walling Material

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## 1. Introduction

### 1.1. Global concerns

Rapid industrialisation has also raised the concern regarding solid waste generation and greenhouse gas (GHG) emission. Hence, to check and address the social and industrial practices which have an impact on the environment, it is expected from the industries to exercise Corporate Social Responsibility (CSR). Sustainability in business is managing the environmental and social aspects apart from the financial profits. CSR is a business approach which confirms that the industries are liable for their activities which impact the environment in which they function.

### 1.2. Concerns in construction sector

Essential resources for construction sector:

- Energy (oil, coal, gas, biomass, electricity etc.)
- Raw materials (Stones, soil, sand, minerals, timber/tree products, chemicals, etc.)

The total per annum energy consumption of these materials in India is  $3155 \times 10^6$  GJ<sup>1</sup>.

## 3. Methodology



Figure 1. CFBA (Malu Paper Mills Ltd, Saoner, Nagpur District., Maharashtra, India)

1. Survey: Identification of locally available industrial waste (CFBA obtained from co-combustion of coal and saw dust in the proportion of 1:1.

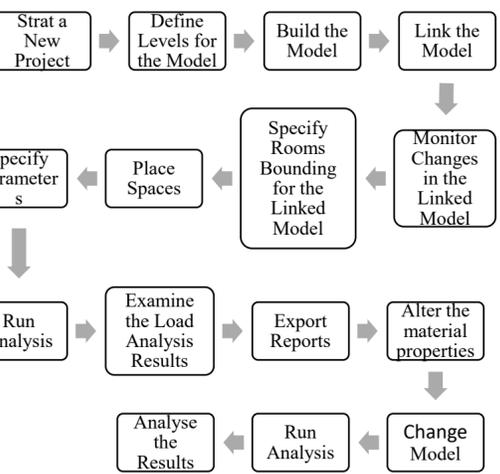


Figure 8. Revit Architecture flow diagram for peak cooling demand estimation

## 4. Results

### 4.1. CFBA characterisation

#### a) Chemical characterisation

Table 2. Chemical Composition of CFBA ash

Elements	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MgO	K <sub>2</sub> O	Na <sub>2</sub> O	SO <sub>3</sub>
Share (in %)	57.5	26.12	4.3	0.71	0.81	0.39	0.42

➤ Table 2 suggests, CFBA represent a higher silicon dioxide content than the limiting value (>25%), indicating the potential pozzolanic property of CFBA as per IS 3812 (BIS, 2003).

#### b) Mineralogy

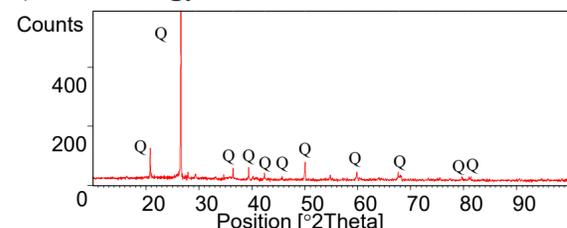


Figure 9. XRD spectrum

- The presence of silica in crystalline phase affects the pozzolanic property of ash.
- XRD monograph implied that CFBA possesses crystalline silica content mostly available in the form of the quartz (SiO<sub>2</sub>) and mullite (2SiO<sub>2</sub>.3Al<sub>2</sub>O<sub>3</sub>) (Figure 9).
- Hence, CFBA was unable to contribute much to the strength development and acts as a micro-filler in the matrix.

#### c) Morphology

- CFBA particles were irregular in shape.
- The SEM micrograph implies that a CFBA particle partially consists of fine pores (indicated as (1) in Figure 10), which makes it lighter in weight.

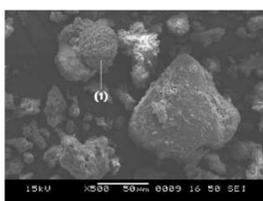


Figure 10. Scanning Electron Microscopy (SEM) image

#### d) Physical characterisation

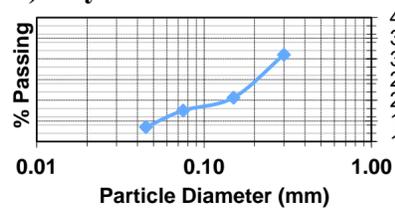


Figure 11. Sieve analysis

Table 3. Particle size distribution

Distribution	Specification size (mm)	CFBA (%)
Gravel	>2	0
Sand	0.075-2	82.5
Silt	0.002-0.075	4
Clay	<0.002	13.5

- From the particle size distribution (Table 3), it was inferred that the major portion of CFBA falls under the category of sand (82.5%), which suggested the suitability of CFBA as a fine aggregate substitute.
- Specific gravity of CFBA was obtained as 2.34 g/cm<sup>3</sup>.

### 4.2. Physico-mechanical properties

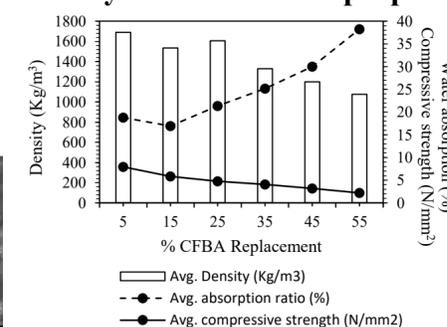


Figure 12. Physico-mechanical test results

## 2. Aim and objective

### 2.1. Aim:

The study aimed at the determination of the feasibility of the novel industrial waste (co-fired blended ash (CFBA)) as an alternate raw material in the production of sustainable walling material (bricks).

### 2.2. Objectives:

- Identification of co-fired blended ash (CFBA) in the local region for the feasibility check as an alternate raw material for construction sector.
- Development of composite materials using identified CFBA i.e. bricks.
- Physico-mechanical properties and thermal conductivity of the developed product were investigated as per the specification of Indian Standards.
- Development of walling treatment for the developed bricks reduction in heat gain in the building.
- Performance evaluation of the developed products through software simulation analysis using Building Information and Modelling (BIM).

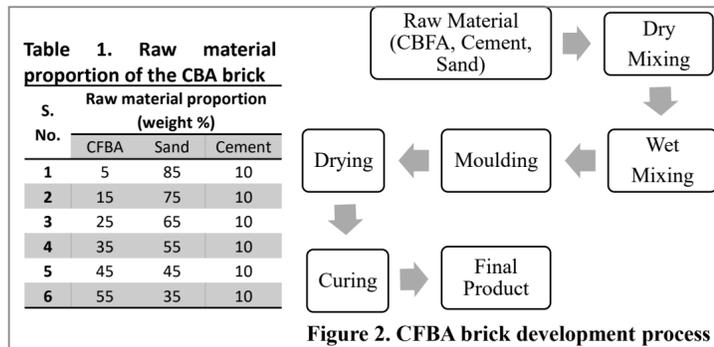


Figure 2. CFBA brick development process

Table 1. Raw material proportion of the CBA brick

S. No.	Raw material proportion (weight %)		
	CFBA	Sand	Cement
1	5	85	10
2	15	75	10
3	25	65	10
4	35	55	10
5	45	45	10
6	55	35	10

- Compressive strength (IS 3495-1 (BIS, 1992)).
- Water absorption (IS 3495-2 (BIS, 1992))
- Efflorescence (IS 3495-3 (BIS, 1992))



Figure 3. Developed CFBA brick

### 3. Development of sustainable product

### 6. Surface treatment of the developed product by autoclaved aerated concrete block (AAC) waste for enhancing thermal performance of the CFBA brick.

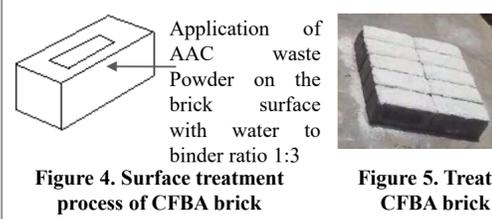


Figure 4. Surface treatment process of CFBA brick



Figure 5. Treated CFBA brick

### 5. Thermal Conductivity Test of the developed brick (Using Lee's disc apparatus)



Figure 4. Lee's disc apparatus

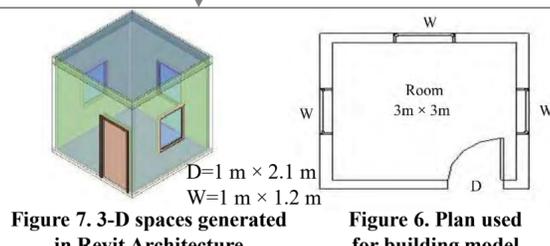


Figure 6. Plan used for building model

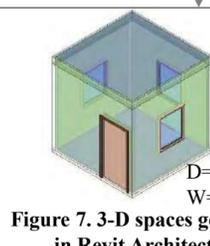


Figure 7. 3-D spaces generated in Revit Architecture

- Bricks developed using CFBA (15% by weight) as a sand substitute were able to fulfill the required physico-mechanical properties laid down by Indian standard (IS 1077 (BIS, 1992)) for bricks of class designation 3.5 (i.e. with a minimum compressive strength of 3.5N/mm<sup>2</sup>).
- The developed bricks are suggested to be used for non-load-bearing walls.

### 4.3. Comparative analysis

Table 4 provides the comparative property assessment between commercially available FA bricks and the developed CFBA bricks. With respect to FA bricks, CFBA brick possessed:

- 11% lesser density
- 10% lower in compressive strength.
- 4% higher water absorption.
- 10% less equivalent energy estimated.
- 61% lesser thermal conductivity.

Table 4. Comparison of CFBA and FA brick properties

S.No.	Brick Type	Fly ash bricks	CFBA bricks
1	Raw Material Proportion		
	a. Ash	40	15
	b. Sand	50	75
	c. Cement	10	10
2	Size (in mm)	230×100×80	230×100×90
3	Density (Kg/m <sup>3</sup> )	1800	1600
4	Water Absorption (weight %)	12	17
5	Compressive Strength (Mpa)	6.5	6
6	Thermal conductivity (W/mK)	1.05	0.4
7	Cost (INR per brick)	5	5
8	Embodied Energy (MJ/brick)	2.734	2.468

### 4.4. Surface treatment

- Thermal conductivity decreased from 0.4 W/mK to 0.37 W/mK for CFBA bricks when surface was treated with AAC waste powder.

### 4.5. Software Simulation Analysis

- First, in the primary case model (H-1), the peak cooling load was estimated for the model with walling material as FA bricks and the walls were plastered standard mortar (density-1762 Kg/m<sup>3</sup> and thermal conductivity-0.721 W/(mK) (SP 41:1987, 1987).
- In the secondary case (H-2), the primary case model was modified by replacing the FA bricks by CFBA bricks with AAC waste surface coating and the procedure of cooling load estimation was repeated.
- In comparison with the primary case, the peak cooling load in secondary case reduced by 30%.

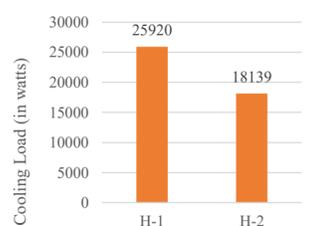


Figure 13. Peak cooling load demand of model houses

## 5. Conclusion

- Appropriate sustainable material helps in designing the energy efficient buildings. The presented study briefed the development of novel CFBA bricks as a walling material and its assessment for evaluating the energy efficiency of building model.
- Bricks developed using CFBA (up to 15%) were in accordance with the Indian standards and found suitable to be used in non-load bearing walls.
- The thermal conductivity of CFBA bricks (with AAC waste surface coating) was 64% lesser than the commercially available FA bricks, which
- The lower thermal conductivity of the developed product (bricks with AAC waste coating) was helpful in reducing peak cooling load by 30% in comparison with the FA bricks.

## 6. References

1. CIOB, 2014. Environmental Legislation and Incentives in the UK. See <http://www.carbonaction2050.com/basics-sustainability> (accessed 10/09/2017)

# Stephen Elsey

# Insulated Concrete Formwork

Research Paper into potential use in dwellings against Traditional Masonry

Insulated Concrete Formwork is an uncommon method of construction which is rapidly gaining popularity in other European nations, offering multiple long-term benefits in regards to energy efficiency and speed of erection. The method was developed in the 1970's and patented by 'Isorast' who have progressively improved on the system to satisfy the best worldwide standards. The more common method of constructing a dwelling is to use traditional masonry which has been widely used since the 1700's with a mason laying bricks/blocks bonded with a mortar to construct the external walls. Within the UK there are over 23 million homes (Office for National Statistics, 2017), over half of which will have been constructed using traditional masonry, considering the vast improvements in technology in and around the construction industry over the past decade it is an ideal time to scrutinize the traditional method and conclude whether insulated concrete formwork would be a valid improvement.

The primary aim of this study is to research how well dwellings constructed with insulating concrete formwork actually perform in practice and the reasons as to why the approach is currently avoided on larger scale developments with some UK housing associations neglecting the method entirely. The research shall be conducted via a combination of questionnaires, desktop studies and simulation tools to ensure a sufficient amount of results.

The objectives of this study are based around answering the core question, whether insulated concrete formwork is a viable alternative to established masonry construction methods in mainstream British housing?

The methodology of this research paper was developed on the basis of gaining feedback and experiences of industry professionals during their careers. Individuals will be requested to provide information regarding the residential sector, ICF construction and traditional masonry. The questionnaire survey will establish an idea of what the respondents prioritise within construction and their opinions on various methods. This approach has been selected as it is the most efficient data collection technique.

There are multiple occupations within construction, each of which play a pivotal role in the success of the development. From approaching a variety of professionals it can be discovered whether the general opinion on the subjects is consistent or relative to their occupation.

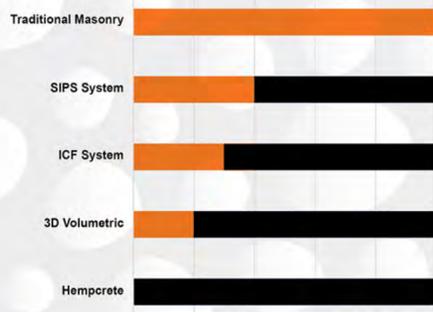


Figure 1: Methods of construction encountered by respondents



Figure 2: Respondents level of knowledge within following fields

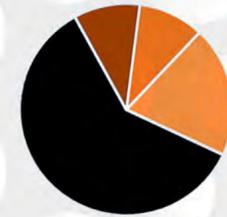


Figure 3: Greatest problem with traditional masonry



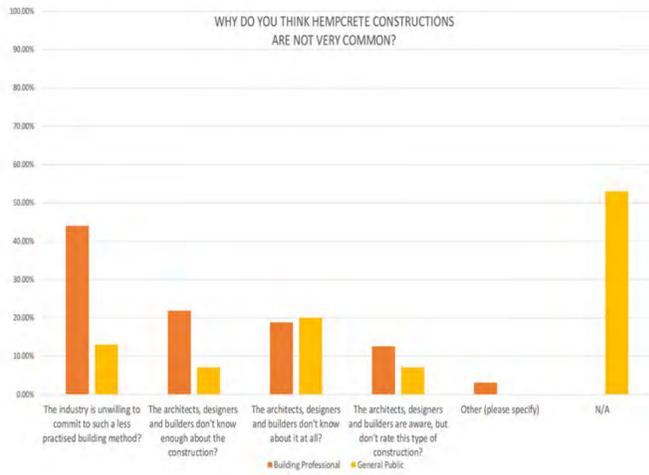
# Building With Hemp and Why it is Neglected in Industry

The purpose of the study was to learn about the natural plant hemp when used as a building material. Part of the hemp plant called hemp shiv (the stalk) is harvested and dried out. When mixed with water and a lime binder it produces a building material known as hempcrete. Research on hempcrete was the initial part of the study. It revealed the advantages and disadvantages of using the material as well as learning about hempcretes characteristics. The second part of the research was to identify what the peoples current knowledge is on the material or if they know of it at all. Furthermore the study would question poeple's thoughts opinions on hempcrete and if they have ever come across it in a real life situation. To extract this information there were two surveys used, one aimed at the general public and the other at professionals who work in the building industry. Once the results were in and analysed, it was then compared to the original research about the qualities and suitability of hempcrete which meant that various conclusions could be made, most important of them been whether or not hempcrete is getting neglected by the industry.

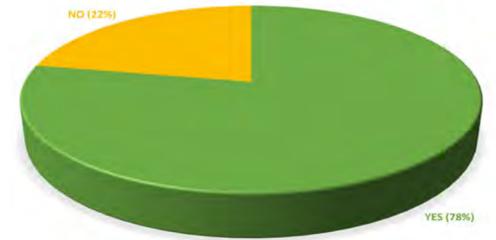
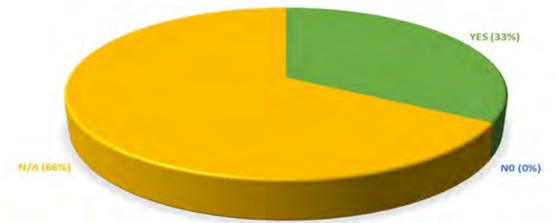
## Research Results

The results were obtained and some conclusions could be drawn from the data that was recieved:

- There were mixed results concerning the reasons people thought that hempcrete was not very common. Generally it revealed that people that a hempcrete is uncommon due to a combination of it not been well known and the risk involved with using an alternative building material (left graph).
- The pie charts on the right illustrate the results that each set of respondents answered the question "do you think the industry is neglecting hemp constructions?". Generally the answer was yes. The public mostly answered "N/A" presumably not knowing what hempcrete is. While 78% of the industry professionals chose "yes" that hemp construction was been neglected in industry.



DO YOU THINK THE INDUSTRY IS NEGLECTING HEMP CONSTRUCTIONS?



## Hempcrete



### THERMAL PERFORMANCE

The thermal performance of hempcrete gives it a good reputation. With impressive U - Value results, tests reveal that the material produces an even lower U - Value in a real building situation than in theoretical laboratory tests. This is because hempcrete has dynamic thermal qualities, meaning that reacts differently depending on the outside conditions.

Hempcrete wall Thickness (mm)	250	350
U - value (W/m2K)	0.23	0.17

### FIRE RESISTANCE

Due to the density of hempcrete and the hemp shiv's encasement of the lime binder, it is very difficult for hempcrete to be set on fire. A fire test by Bevan and Woolley (2008) resulted in a 250mm - thick wall of hempcrete blocks binded by a lime mortar last 1 hour and 40 minutes

### SUSTAINABILITY

Hempcrete construction is in fact a carbon negative building style. We can grow hemp in the UKs climate and it has a growing cycle of 12-14 weeks. As trees are crucial for breathing in carbon dioxide, hemp also contributes in the same way, however it breathes in at four times the rate that trees do. Therefore during the buildings life cycle, the carbon is locked in the hempcrete and is then fully recyclable when demolished.

By Struan James

*"It is no accident that in the comedies of Shakespeare, people go into the greenwood to grow, learn and change. It is where you travel to find yourself..."*

Roger Deakin: Wildwood, A Journey through Trees

## Living Lab Partnership

An Articulated Attempt to Address the Sustainable Development Goals (SDG's) in an Urban Woodland with Charity Occupation on the University Estate



Justine Oakes : University of Suffolk and Grateful Acknowledgements to Joanna Brooks: Eden Rose Coppice Trust

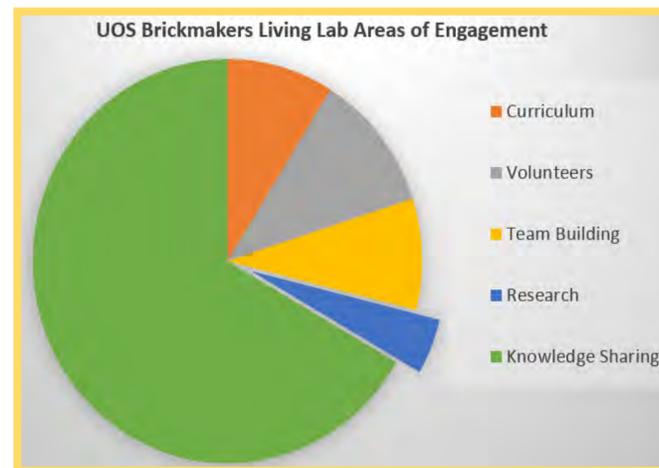
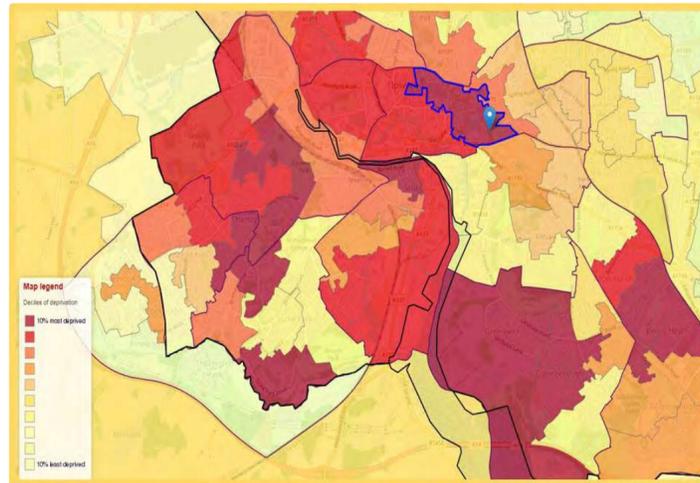


**Figure 1: North Campus 1921 and Present**

Britain from Above; © Crown copy and database right 2018. Historic England

**Figure 2:**

**UOS North Campus Brickmakers Wood**  
 Indices of Multiple Deprivation 2015 Explorer: OpenData Communities.org 2015



### Introduction

The University of Suffolk and Eden Rose Coppice Trust (ERCT), Brickmakers Wood Living Lab Project explores the societal, ecological and educational benefits of third sector partnerships on the University Estate. The importance of green spaces within our estate portfolio is often overlooked in decision-making and under utilised as a resource.

Typically, because the full range of their benefits and value, or the costs of their decline remains invisible.

### Brickmakers Wood

Within our portfolio we have a 3.5 acre brown field urban woodland abutting Alexandra Park (Figure 1). Following an audit in 2015 the site was found to be in deleterious condition, with evidence of substance misuse and anti-social behaviour.

The English Indices of Deprivation (Figure 2) published in the same year, measures relative levels of deprivation in 32,844 neighbourhoods, with Alexandra Ward scoring amongst the 10% most deprived neighbourhoods in the Country. Employment, Income, Health and Disability, Crime and Living Environment indices for this

community are described as experiencing significantly high levels of deprivation for those living in and around the University Estate.

As part of our Estates commitment to sustainability a long term peppercorn lease was extended to ERCT; a regional cancer care and well being charity whose exemplary work in social sustainability and biodiversity align with the Universities strategic vision to seek to address the SDG's within it's own activities and research.

The dynamics of Sustainable Development are complex and intertwined. However, establishing a Woodland Living Lab within the context of the work ERCT undertake and set against the connected framework of the SDG's, has enabled the creation of a transdisciplinary, multi-stakeholder resource where innovations and learning possibilities can take place.

The close partnership between University and ERCT activities are mutually beneficial; with a shared investment in deepening knowledge, widening research application and enhancing the well being and skills acquisition of the communities both organisations serve.

**Brickmakers Wood Positive Impact on SDG's**

SDG	Sustainable Development Target	SDG	Sustainable Development Target
	1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance.		9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
	1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate related extreme events and other economic, social and environmental shocks and disasters		10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status
	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.		11.3 By 2030, enhance inclusive and sustainable urbanization and capacity or participatory, integrated and sustainable human settlement planning and management in all countries, strengthen efforts to protect and safeguard the world's cultural and natural heritage  11.4 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.		11.6 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities  11.2 By 2030, achieve the sustainable management and efficient use of natural resources
	4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.		11.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature
	4.7a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all		13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
	6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes		15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world  15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
	8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value		15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species
	8.6 By 2020, substantially reduce the proportion of youth not in employment, education or training		

## Living Lab Partnership

### An Articulated Ambition to Address Natural Capital in the Context of the United Nations Sustainable Development Goals within the University Estate

Justine Oakes : University of Suffolk - Grateful Acknowledgements to Joanna Brooks: Eden Rose Coppice Trust

#### Curriculum Engagement

Radiotherapy, Oncology and Teacher Training students, have all had designated curriculum time to work within the woodland on team building conservation activities along with clinical representatives from all four partner NHS Trusts and academic SEN specialists. Given ERCT's work with palliative care visitors and behaviourally supported children on site; the knowledge exchange on a scholarly basis is invaluable.

This resource forms the basis of a longitudinal study, working with the new Wildlife, Ecology and Conservation undergraduates, targeting indicator species and evaluating improvements to local air quality and the broader Ipswich habitat.

#### SDG Impact

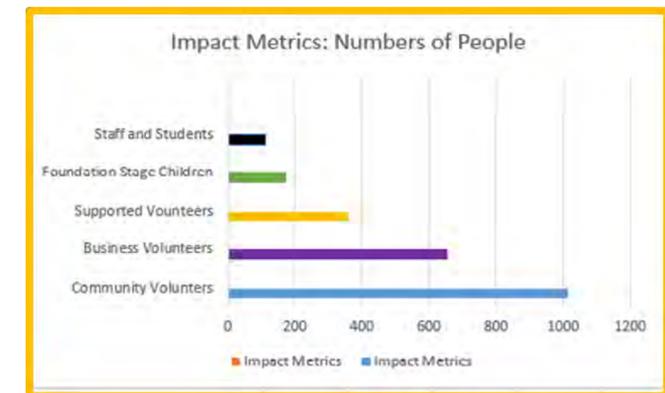
Additional research, supported through the Suffolk Sustainability Institute will evaluate the ongoing impact of the Woodland in it's entirety against the SDG's identified in the table opposite. With evidential data considered within the context of the Multiple Deprivation Indices and the potential positivity that ERCT activities within Brickmakers Wood have on the wider community.

#### Research Engagement

With assistance from a Postcode Lottery grant a new wildlife pond and heritage orchard has been created to support user groups and act as a research site for evaluating localised improvements to Urban Biodiversity in the Alexandra Ward.



Figure 3: Woodland Engagement User Numbers 2015 to 2018



RISEAWARDS 2018

# VITA STUDENT VILLAGE YORK HERITAGE AWARD FOR RESTORATION/RETROFIT

A landmark monument in the UK's £200 billion student property market. Vita Student Village York brings 18 modern student residences to an extensively landscaped, 25,000 sqm listed site in the historic city of York.

## PROJECT OVERVIEW

The Vita Student Accommodation project at Lawrence Street, is located within sight of the York city walls and is within easy walking distance of the city centre and its amenities. The site is well positioned to take full advantage of public transport links and is ideally located for student accommodation use; being central to and within easy walking and cycling distance from a number of the city's higher education institutions.

Designed for Select Property Group, the project was completed in September 2017 – on time and on budget and boasts a remarkable 99% occupancy. The overall project value was £48m.

Located within the grounds of the former Grade-II listed St. Joseph's Convent, the new 'Student Village' provides 644 bedrooms across 15 new and 3 listed buildings. This project combines new building excellence, highly sensitive restoration work and exceptional dedication taken to protect the local flora and fauna during the build process. The delighted client has been able to offer its tenants a range of well-finished, extremely attractive apartments and communal areas, which are second to none. The original convent building's historic fabric has been preserved for future generations, as have the grounds.

## SITE HISTORY

In 1870, Lady Herries obtained and gifted land on Lawrence Street to the nuns from the Order of the Poor Clares in Bruges for the site of a new, purpose-built convent. The main cloister building was completed, up to the Chapter Room on the east range in 1873. In 1875 Chapel, Priest's House and Extern House were built. By 1884, an orchard had been added and the extension of the infirmary wing had taken place. The east range of the workshops and glasshouses were constructed by 1885. In the early 1900's surrounding land was purchased to prevent urban development from threatening enclosure and to increase self-sufficiency.

In 1930, the convent was at its most self-reliant, with 70 nuns living there. However, the population steadily fell, the upkeep of the buildings and land was unsustainable and a new use was required. In 2013, the property and land was marketed for sale, Select was appointed as the preferred developer. After an extensive planning period, works began on site in 2015 to incorporate the listed buildings with the modern accommodation blocks and the renovation was complete by 2017.



## CHALLENGES

Enclosed by a tall listed brick wall and containing a nationally registered orchard with numerous tree preservation orders, additional listed buildings/structures sloping approximately 7 metres from north to south, across its 200 metre length, the site presented an array of unusual and unique challenges. Working collaboratively with the City of York's planning officers throughout the design period, the project design team was able to secure planning approval and listed building consent in February 2015. Exceptional care was taken when restoring the Grade-II listed St Joseph's Convent, working with CYC Planning to meet the demanding heritage requirements. Original walls and other features were maintained, so future generations would be able to appreciate the building and the grounds' historical use. The client was delighted with the project, which completed safely, on time and on budget, and in their words is "a truly excellent scheme". This was largely due to the excellent workmanship and robust quality assurance processes.





The build techniques used have retained the site's antiquity. The completed project really has the 'wow' factor. The blending of heritage, new build, historic gardens, different materials and textures, slate roofs, green spaces and meandering footpaths make the final project outcome, a true celebration of what UK Construction can offer. The historic nature of the site, where roman roads were discovered, meant further strict requirements had to be upheld to maintain and log ancient works for the benefit of future generations.



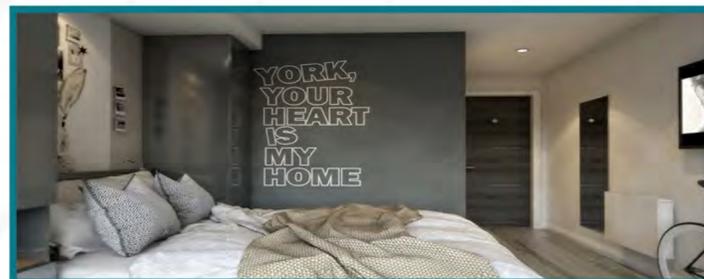
"I walked in and thought WOW! It's more like a hotel, this is not your average student accommodation!"

**ANANYA, STUDENT**



"There's a legacy being left for the future of education in the city, it will be handed down through the generations."

**SISTER MARY PAUL**



"At the outset, part of the brief given to the design team called for the main existing convent building to be placed at the heart of the development, and refurbishing it to provide student living accommodation and importantly, house The Hub, the main communal and social space within a Vita Student development."

**FUSE STUDIOS,  
ARCHITECTURE AND INTERIOR DESIGN**



## COLLABORATION

More than ten parties worked in partnership to develop a co-ordinated design approach across the site. The master plan design evolved through a series of design workshops and importantly, through direct and constructive dialogue with planning officers and other stakeholders, such as Historic England. This co-operative process included a public consultation event, where parties from the CYC, the Diocese of Middlesbrough, York Civic Trust and the surrounding neighbourhood were invited to view the design proposal and raise any questions with members of the design team.

Comments from attendees, which included reducing the height of some of the new buildings in certain locations, were collected and the master plan design evolved as a consequence.



## HERITAGE AND RESTORATION

'The Hub' is located within the ground floor of the existing main convent and chapel building. It provides a range of amenities including group and individual study rooms, movie rooms and gaming rooms as well as private dining rooms, arranged around the original cloistered courtyard. The building also contains a small number of studios which enhance the mix and variety of accommodation offered.

An existing utility building to the south of the convent, which was in poor condition, has been replaced by Goldie House, a new building, housing student studios. Students living in these studios enjoy a marvellous landscaped setting with views over the retained formal gardens.

Mature trees and other significant landscape features have been retained and enhanced with new planting in a restored formal garden to the south of the main convent building. This area provides students with a more reflective and contemplative external space.

To maintain the site's character, all timber sources were tracked through the supply chain and all ancient bricks were cleaned and re-used to construct new buttresses. Thorough watching briefs for bats and birds were carried out and praise was given for exceptional, innovative tree/root protection zones (cited by CIRIA Environmental as "best practice" exemplars in updated manuals). Segregation and monitoring waste saw all targets exceeded, scoring 45/50 on both Considerate Contractors Scheme visits in 2017 and receiving a CCS Gold award.

Great care was taken to allow the Poor Clares nuns access to the existing graveyard at all times (they were even able to hold a funeral there during construction). The nuns were regularly invited to witness progress and were quoted as saying "the new development is a wonderful thing to see."



# we can make...

## CITIZEN-LED HOUSING

The housing system in the UK is in crisis. Our conventional strategies to access housing are reductively competitive. They either require people to divert ever more of their wages and savings to getting on a property ladder where the bottom rungs are missing, or compel people to prove how weak and incapable they are in order to win eligibility for austerity rationed social housing.

**We Can Make** is a housing platform that brings together communities, architects, artists, policy-makers, academics and industry professionals to develop practical and scalable ways in which the citizen sector can have a greater role in making new homes.

### DOWN SHIFTERS

Individuals or couples whose house is now too big for them and are looking for a smaller home. This could be because children have grown up and flown the nest, or they have changing mobility needs, or want to reduce costs in retirement.



### NEW SHOOTS

Families where there is an urgent need for more space, because children are growing up and seeking independence, are having offspring of their own, or caring responsibilities are expanding to include additional elderly or disabled family members.



### BETTER FITS

Families where one member or more is experiencing changing mobility needs and the family home needs to be adapted.



### MAKING ENDS MEET

Individuals and families that need extra income and willing to swap space for rental income and/or reduced bills.



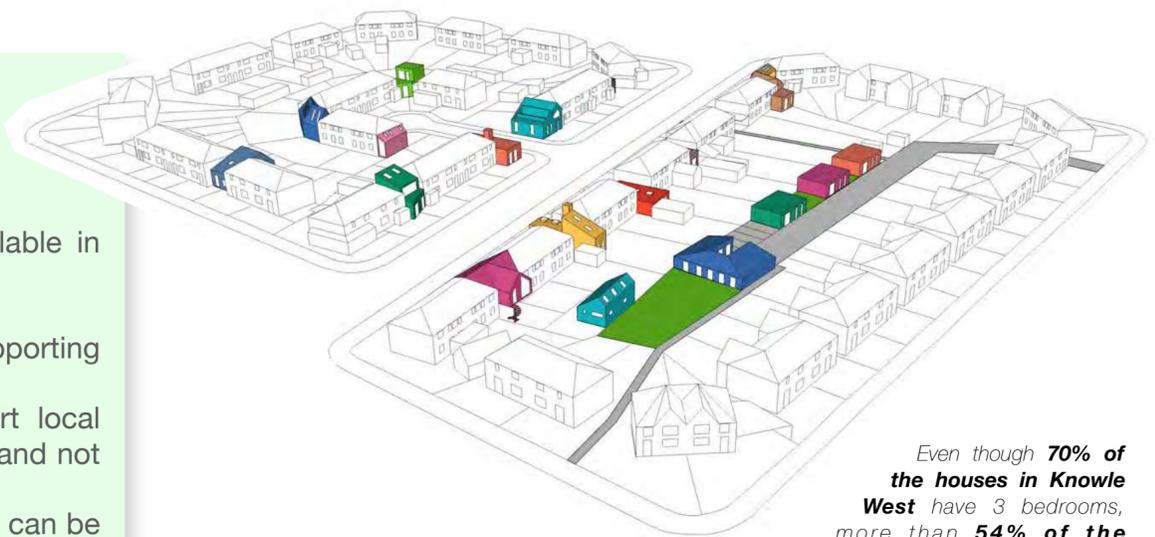
Our research identified four clear primary needs: **Down Shifters, New Shoots, Better Fits, and Making Ends Meet**. Many of these people, however, bring with them significant knowhow and assets, including land. If development can meet their needs on their terms, citizens will want to opt-in - "YIMBY" (Yes In My Back Yard) development - literally.

Knowle West - its needs, assets and knowhow - are the foundation of **We Can Make**. However, the aim is to create a citizen-led system and set of tools for delivering affordable housing at point of need which can be replicated in other neighbourhoods and cities.



### We Can Make offers:

- A non-speculative housing model at the point of need;
- Community assets and know-how to create a collaborative approach to housing;
- The means by which the large volume of microsites available in urban and suburban areas can be unlocked;
- Designs for local manufacture and assembly
- Sustainability and wider social and economic value by supporting innovation, local skills and jobs;
- Investment of profit back into the community to support local facilities and services and the development of shared places and not just housing units;
- Replicable design, finance, legal and enabling platforms that can be exported to, and work in, different neighbourhoods in Bristol and elsewhere in the UK.



Even though **70% of the houses in Knowle West** have 3 bedrooms, more than **54% of the community live alone** or only with one other person. Knowle West needs a wider variety of housing on offer

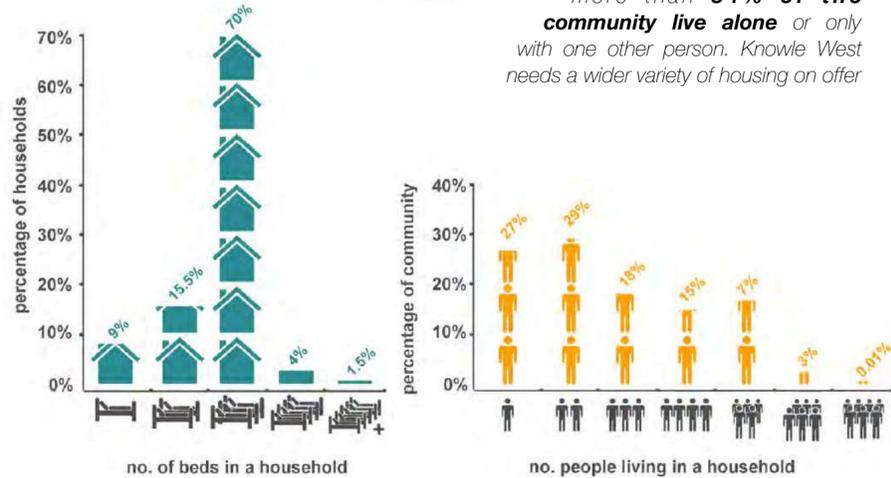
### HOMES ARE THE MOST UNAFFORDABLE THEY HAVE EVER BEEN

The average home in Bristol now costs 8.2 times average annual earning, compared to 3.6 times earning in 1997.



### Collective finance

By acting collectively, a community can have greater financial strength through spanning the gap between the earning power of any one individual and the aggregate lending risk across a group. This means, for example, that through a collective approach We Can Make would be better able to secure lower-rate investment and debt finance than many individuals seeking finance alone.



**Gap micro-sites:** The minimum space required to build a 1-2 bedroom home is 3.5meters wide. Due to the low density of (25 dwellings per hectare) in Knowle West, We Can Make has calculated that there are nearly 1500 gap sites at least 3.5 metres wide, and around 1000 of these are at least 4 metres wide.

# 1495

**Garden micro-sites:** Many of the homes in Knowle West have 20+metre long back gardens. After mapping the total area of back gardens and setting a series of contours from the back of each home to retain some land for use as a private garden, the following developable garden space could be released:

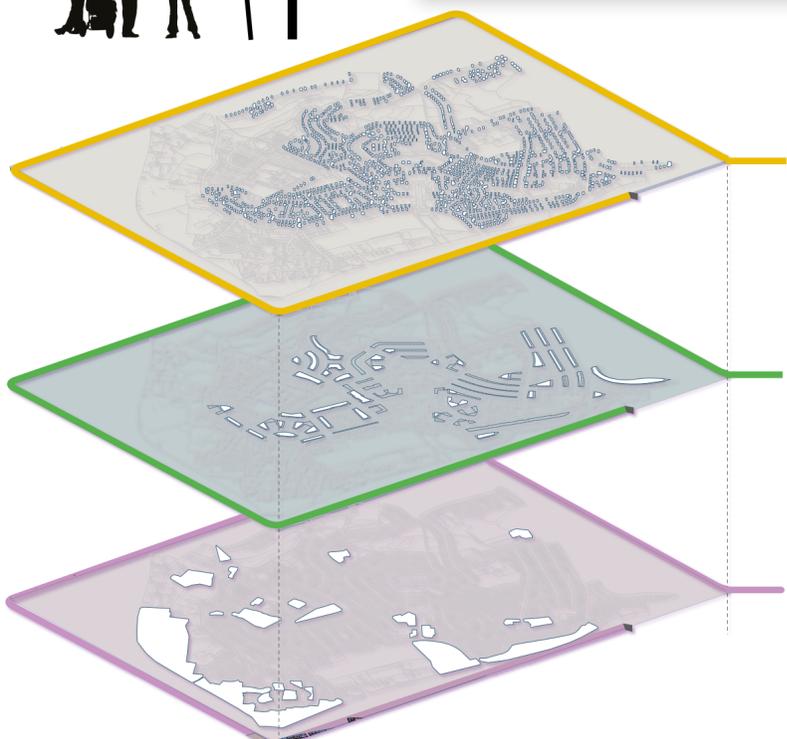
# 31.3ha

**Each home retains:** 6m of private garden.....31.3 Hectares of land is released  
12m of private garden.....18.4 Hectares of land is released  
18m of private garden.....10.2 Hectares of land is released

Even at the lowest level of garden release, 10.2 hectares of land could accommodate up to 500 one-bedroom homes.

**Macro-sites:** Bristol City Council has identified around 40 hectares for housing, primarily around the edges of Knowle West. These are larger plots (for 10+ homes) packaged for the conventional development industry. We Can Make does not seek to compete for these macro-sites. They are shown here for context.

# 40ha



If just 10% of the potential gap and garden micro-sites were developed that would be more affordable housing than was delivered in Bristol in 2015/16.



Following our research analysis, We Can Make suggests **350 citizen-led homes could be built in Knowle West.** This would represent using just **10% of the potential micro-sites available** and represents a **7% densification of the neighbourhood from 25 hours per hectare to 26.75 house**

**per hectare.** This could **help up to 700 households,** through the supply of new homes and releasing capacity in the existing stock. With **522 households in the area registered on HomeChoice,** Bristol City Council's housing waiting list, this represents a substantial new way of meeting housing need.



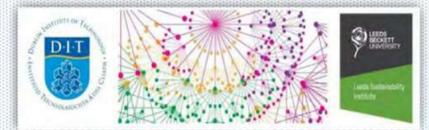
The Jones family live in a 3-bed house. Their eldest son Fred and his new family can't afford a deposit for their own place and aren't a priority on HomeChoice. We Can Make can give them an empty 'Shell' which they can decorate and fit their own kitchen in. This is much more affordable and Fred can learn carpentry and plumbing skills along the way!

Amy is a council tenant in a 3-bed house. She has decreasing mobility and is in need of care support. We Can Make can help to provide her with a smaller wheelchair friendly home, close to her family.

# EXAMINING THE USE OF CROSS LAMINATED TIMBER (CLT) AS A SUSTAINABLE MATERIAL IN IRISH CONSTRUCTION.

4TH INTERNATIONAL SEEDS CONFERENCE 2018  
SUSTAINABLE ECOLOGICAL ENGINEERING  
DESIGN FOR SOCIETY – 6<sup>TH</sup> TO 7<sup>TH</sup> SEPT, 18

Williams J. Gadimoh: PhD Research Student  
Research Supervisors: Professor Lloyd Scott: & Dr Mark Mulville



## AIM OF THE RESEARCH

### Environmental

To shed more light on the importance and benefit of using Cross Laminated Timber (CLT) as an alternative sustainable building material, and beneficial for the environment in Ireland.

### Economic

The need to build sustainable housing that keep pace with the high demand and in return minimise cost and waste in the Irish Architectural Engineering and construction (AEC) industry.

### Social

How can CLT be improved and optimised to ensure sustained and improved energy efficiency in housing construction in response to the United Nations agenda on climate change Agenda.

## RESEARCH QUESTIONS

What is the different experiences, challenges and prospects of adopting Cross Laminated Timber as a sustainable building material?

How will the use of CLT for the construction of residential and commercial building Impact on the three pillars of sustainability (socially, environmentally and economically)?

## RESEARCH DESIGN/METHODOLOGY

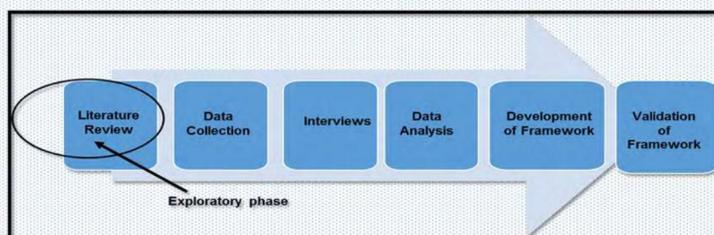


Figure 1: Research Design/ Methodology

Figure 1 represents the research design / methodology, The research adopts a mixed method approach, starts with a literature review.

These involves gathering of initial secondary information on the use of (CLT) from relevant books, conference papers, electronic journals and internet. Once the review literature is completed, it will subsequently lead to data collection based on the literature review.

Findings will be used to compare with existing knowledge in Ireland.. Subsequently will be followed by interviews, data analysis, development and validation of framework.

## RESEARCH POTENTIAL IMPACT / INFLUENCE

This research provides an opportunity for further exploration of environmental, social and economic viability of the use of Cross Laminated Timber for the construction of residential building in Ireland. Using the European Union (E.U) and the North America experience.

### Three Pillars of Sustainability



Figure: 2 Three Pillars of Sustainability

Table 2 Illustrates the make-up of the three pillars of sustainability which represents environmental societal & economic dimension of the use of (CLT).

The economic dimension which represent the cost reduction through out the life cycle of home built with CLT, the environmental dimension which means reduction of emission to our environment and the social dimension representing the positive impact of CLT on communities.

## BEST PRACTICES

### The T3 Building in Minneapolis Excellent Example of the Benefit of Cross Laminated Timber (CLT)

Largest Modern Mass Timber Building in North America  
The 7 Storey, 180,000 sqft timber super structure, built within 9.5 weeks  
Modular Sections delivery, Lower Cost, Faster Procurement times and Environmentally advantageous.



Figure 3: Source: Structure-Craft, T3 Minneapolis Office Building, MN. 20017

## RESEARCH PRELIMINARY FINDINGS

Initiative Ireland, which aims to give a view of housing supply & demand in Ireland forecast 480,000 new homes are needed across Ireland by 2031 and 34000 Units needed on average per annum.

Overall Population in Ireland: 4.5 Million.



Figure 4: Map of Ireland

(Source: Making Landscapes & Memory, Modern Ireland, 2016)

- Greater Dublin Region – Population of 2.5 million people
- Half of the 480,000 new home needed is in the Greater Dublin Area.
- Cross Laminated Timber (CLT) is re-emerging as a promising building material.
- Ireland maximising the use of CLT for the construction of the new homes will mean decreased cost for construction, environmentally friendly and socially acceptable homes.

The early phase of the research identifies that CLT is emerging as a promising building material in the built environment. In response to the United Nations Agenda on Climate Change, there is need to consider the use of Cross Laminated Timber (CLT) for the construction of residential and commercial buildings.

Cross Laminated Timber (CLT) has an excellent Thermal comfort impact, it has better structural, energy saving and insulation properties, as well as fast and easy prefabrication.

CLT is relatively new to Ireland; apart from one-off private developments, there are two more buildings recently completed for Dun Laoghaire Rathdown County Council that used CLT, the building include a crèche, public gym, and offices. Both buildings in Ballygowan, in Ireland.

CLT high load bearing capabilities, high dimensional stability, acoustic, airtightness, low cost and the impressive thermal performance over more traditional material.

## FUTURE WORK

To examine in more detail why CLT has not gained importance in Irish Architectural Engineering and Construction (AEC) industry, research the drivers and barriers to the use of CLT In Ireland.

The bulk of the research will be carried out through an online questionnaire. LinkedIn, the professional networking site, the response to the questionnaire will be analysed and findings will be use as a benchmark for recommendation and possible adoption within the Irish AEC industry.

## CONTACT INFORMATION

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Phone: 353 899837573 / 353 899837573

# SUSTAINABLE DEVELOPMENT IN COUNCIL HOUSING

## Introduction

Studies commissioned by Homes for the North indicate that housing demands in Leeds are increasing, with an estimated 13,000 homes to be constructed every year. It is indicated that Leeds City population has grown by approximately 3.1% over the past 5 years, with a further growth of 2.4% over the next 5 years (Savills, Leeds City region, 2017). With Leeds City Council looking to meet that demand, the cost of construction is also on the rise.

However, with demand wanting to be met, how does the Leeds City Council look to provide a low cost, low maintenance for the occupants? How far has Leeds City Council come over many decades to implement sustainable development in their schemes?

## Research

Looking at the different construction methods found in the research, they will be ideal methods to use in the construction of housing today and will achieve a great deal of reliability and sustainability.

Quarry Hill was deemed to be the big turning point for social housing in Leeds. The complex was constructed using a prefabricated method using a steel frame and pre-cast concrete, which at the time was thought to bring savings during construction. Construction began in 1934 and in 1938 tenants began to move in. Some 40 years later the building was demolished entirely due to the mass structural defects.

The LILAC housing scheme in Leeds was constructed using locally sourced straw and timber. Wall panels for the housing were super insulated and prefabricated. During the construction stage of a house built using conventional methods they can produce approximately 50 tonnes of CO<sub>2</sub>. In comparison to a straw built house which can in fact store up to 12.5 tonnes of CO<sub>2</sub>.

With technology vastly improving for a greener future, this paper will present findings on how housing can be made more sustainable through the use of either building techniques and/or technology. This will investigate further into the energy usage of housing, quality of build, materials and workmanship. This paper will look at how far housing has come from when they were first being constructed and how they compare to now. The paper will explore sustainable development case studies around Leeds and how they have been designed with sustainability at its core.

### Brick & Block

U-value: 0.3W/m<sup>2</sup>  
Cost/ m<sup>2</sup>: £70

### Timber

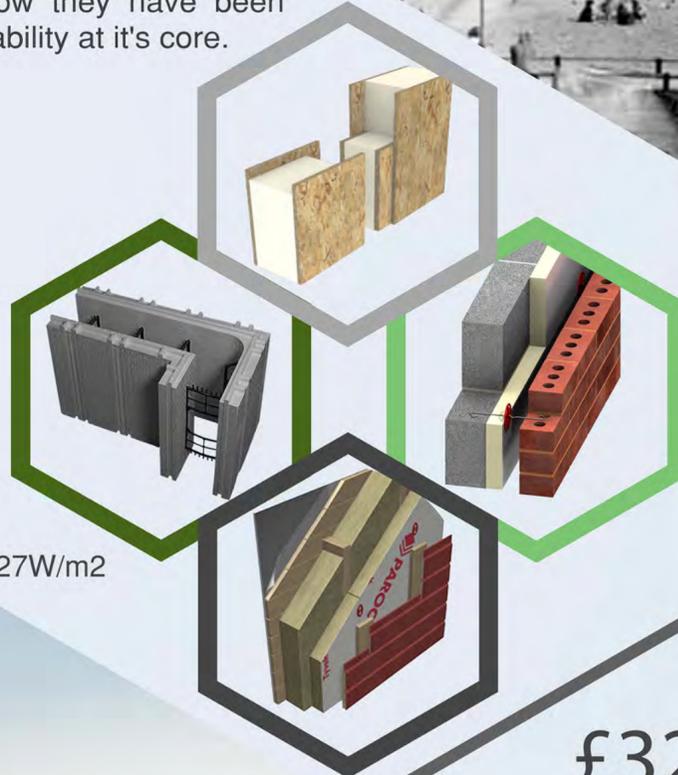
U-value: 0.24W/m<sup>2</sup>  
Cost/ m<sup>2</sup>: £65

### ICF

U-value: 0.22W/m<sup>2</sup>  
Cost/ m<sup>2</sup>: £65/66

### SIP's

U-value: 0.12W/m<sup>2</sup> - 0.27W/m<sup>2</sup>  
Cost/ m<sup>2</sup>: £70



## Conclusion

Using the data gathered it would be fair to say that the social housing in Leeds has improved quite significantly from the construction of Quarry Hill. A building that was seen as turning point for housing in Leeds. Though progress has been made, there is still massive room for improvement. Perhaps working with developers such as CITU and Modcell, which do work to a high level of sustainability, new technologies can be incorporated into future developments.



*"to design a functional, modern and economical 'Eco style' home, that is neither effected by being shoe horned into an inappropriate skin or pre formulated house style, that restricts internal design capabilities and hinders their wish of a green lifestyle."*



This housing development (of eight dwellings and four shops), is located in Huddersfield, West Yorkshire and was an architectural response to the geological and characteristic situation of the area.

Being perched on the side of an unstable slope, facing a green belt woodland setting within a flood zone necessitated very carefully considered design. This had to ensure the dwellings would provide quality family accommodation, whilst being ecologically sensitive and inspirational.

The design uses a combination of measures to reduce its impact on the environment such as high thermal mass, district bio-mass heating, solar energy and deep set glazing. With a very small footprint it can be seen that the building has minimal intervention on the hillside and still serves to stabilise it.



Rise Awards

**2018** YEME ARCHITECTS



enterprise  
award category

"collaborative & entrepreneurial in culture – coworking operators create a strong sense of community among like-minded people. It's infectious!"



This aspirational multi-use, co-working facility forms part of the Roomzzz Hotel in Stratford London. As a stylish, contemporary hotel it aims to offer guests a memorable, attentive experience. However its merged co-working space seeks promote entrepreneurial activity and stimulate aspiration in the community.

It is designed to draw the widest possible user types into the space to increase interaction, improve social mobility and raise aspiration. This is designed to enhance the guest experience in a meaningful and insightful way through community participation, accredited training and apprenticeships. This helps to ensure private developments do not serve to exclude the very community that live there. It also helps to raise aspiration through interaction and mutual understanding.



"these spaces can work really well for individuals, project teams, or elements of the business that want to work autonomously, away from the shackles of 'the mothership'"

YEME ARCHITECTS



Roomzzz Stratford