

meets

NEIGHBOURHOODS OF THE FUTURE

NatWest

TATA STEEL

PROJECT LIVING BUILDING is multi-faceted and contains various levels of complexity, each addressed by novel innovations and technologies. When treating buildings as biological organisms, one can break down a building into four aspects that nature's most successful organisms have been developing for over three billion years. Firstly there is the organism's physical presence and structure which determines its strength and ability to cope with physical strain - the self. Secondly, organisms that have developed a certain level of intelligence and an advanced nervous system are far more resilient - self-awareness. Thirdly, the less an organism depends on its environment and other organisms for energy (food) and other needs, the more likely it is to survive and cope with ever-changing conditions. Finally, regeneration helps organisms achieve a higher level of resilience and ability to survive - self-assembly.



buildings as organisms

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PROJECT LIVING BUILDING meets NEIGHBOURHOODS OF THE FUTURE





project outcome





The Self is the project area concerned with the building envelope and its physical structure. The focus will be a new approach to construction that reduces the overall environmental impact of a building at every stage of its life and improves occupants' wellbeing needs whilst ensuring that design flexibility and aesthetics are not compromised. In nature nothing is everlasting and every organism is connected to and is part of a larger system – this is the approach that needs to be adopted in construction to meet environmental, human and economic demand.

The main innovation being developed to realise this vision is Biohm's Triagomy, which is a patented (pending) interlocking construction system.





the self

we are currently developing our revolutionary interlocking construction system, Triagomy. it does not require permanent binders or fasteners to create robust high-quality buildings. this allows buildings to be deconstructed at any stage of their life - eliminating demolition and making extensions, downsizing, relocation, recycling and re-use a much easier process.

a beautiful convergence of parametric design and natural structural engineering, the system boasts unrivalled environmental, social and economic benefits.

life cycle assessments comparing 'Triagomy' with traditional construction methods show reductions of up to 120% in a building's environmental impact, up to 70% in costs and around 95% in build-times.



Triagomy | innovation

beneath the external pattern lies a robust web of hexagonal geometry created by the configuration of the different components. this internal structure is distributing the loads in the most efficient way possible, inspired by simple lessons from nature.



this off-site construction system creates carbon-negative buildings that can be deconstructed at any stage of their life; supporting a much-needed transition towards agile infrastructure and offering unprecedented flexibility to architects, property developers and occupants.

Triagomy uses our very own unique bio-based

plant-based concrete.

insulation, orb (organic refuse bio-composite) and

Triagomy | innovation



SELF-AWARENESS The building's intelligence and nervous system

Self-Awareness is the project area concerned with the health and wellbeing of occupants and bringing the building to life with intelligence and an integrated 'nervous system'. With such emphasis on sustainability, economic growth and egocentric design, it seems the human had been left behind. Buildings have been known to receive excellent environmental assessment ratings yet perform poorly when it comes to meeting their occupants' wellbeing needs.

In order for the living building to equally meet the needs of the environment, the human and the economy, a certain level of intelligence is necessary. The focus of this aspect of the project will be on the creation of an intelligent system that gathers data and allows the building to either act accordingly and immediately or create patterns of information that will allow it to predict behaviour and events and, in turn, delight its occupants. The intelligent system will involve integrating a number of sensors and data analysis methods (algorithms) to monitor its occupants and ensure that they are operating at a high level of wellbeing at all times. This would inevitably result in occupants that are more comfortable and productive.

The system will also be able to collect additional types of data from the building's performance and other systems/facilities that operate within it to achieve energy savings and a higher level of self-awareness. The modularity of the system will allow it to develop in stages focusing on key data channels and expanding to include others.





self-awareness

The intelligent system diagram clearly demonstrates the system's full potential:

- Monitoring the occupant's health, behaviour and habits to ensure that they are comfortable and well at all times
- Monitoring and potentially controlling the indoor environment to ensure that it meets occupants' needs
- Understanding the organisation/household's goals, needs and character to suggest improvements in design & layout
- Monitoring the external environment to make accurate assessments of changes in internal environment and to make informed suggestions to the occupants
- Monitoring the building's energy and water flow to predict under-performance and suggest cost-saving methods
- Understanding and monitoring the building's structure to predict any issues and be aware of the building's layout
- Understanding the facilities and technologies available within the building and communicating with the building manager

The system's full potential described above and in the diagram is what Project Living Building will work towards, however, this is unlikely to be the outcome at the end of the three years. A phased and modular approach will be taken with the intelligent system to start with a minimum viable product and as the research and the system's capabilities develop, more features can be integrated along the way. Data collection capabilities will be built-in to the various other systems in the building (e.g. wastewater treatment system) - this will be the responsibility of the organisations and collaborators developing those systems. The integration of the data collected from those other systems in to the intelligent system will depend on the data platforms used and the intelligent system's stage of development.



Intelligent System | innovation

Building standards have undoubtedly served a crucial role in the formalisation of soft issues and transformed perceptions when it comes to sustainability and wellbeing. However, they can also be a hindrance to innovation and progression due to their static nature and inability to please a range of cultures and needs. Wellbeing is a complex and multi-faceted subject that needs to be addressed in a more dynamic way; especially when it comes to psychological wellbeing. A spectrum approach, much like that adopted by modern psychology alleviates the rigidity and static nature of standards and can only be achieved with the help of intelligence and data collection. The complexity of standards is necessary and central to correct implementation and good practice. However, such complexity does not need to be in the public eye. It can constitute the inner workings of a seemingly simple and accessible system.

Systems in nature, for example, may appear to be simple, yet the complexity under the surface can be beyond comprehension. A rigorous and holistic approach needs to be adopted to reach the highest levels of complexity within a system. Only then can a system become beautifully simple. This is what the intelligent system will aim to achieve to meet the wellbeing needs of occupants.

With the aid of technology and wearables, relevant data can be collated, along with existing big data, and fed into a system that amalgamates the required information regarding people and spaces to create a customised solution that is tailored for its user. The data can continuously feed into the system and an iterative optimisation process can initiate. No two humans are the same and the same can be said for workplaces and organisations. A spectrum approach has allowed us to better understand human psychology. Perhaps the same approach can allow us to effectively implement a flourishing life in the workplace, at home and other indoor environments.



Intelligent System | innovation



SELF–SUFFICIENCY The building's ability to sustain its needs

Self-Sufficiency is the project area concerned with the living building managing and treating its wastewater and generating and storing its own energy. A concept of self-sufficiency will be developed and proven, where the building can generate the energy that is required to power itself.

Solar panels integrated in the construction system will be the primary energy source for the building. The energy will be stored using a recycled battery energy storage system by Project Aceleron for use in the evenings. A wastewater treatment system by WASE will allow the building's water to be treated on site so that it can be circulated, with additional rain water harvesting.

The project's outcome will be a complete integration of the wastewater treatment system, solar power and energy storage system. The technologies will be integrated into a showcase building at Brunel University as a technological feasibility showcase. This will demonstrate the environmental, economic and social capabilities of the innovations as an alternative to existing technologies.

Both the integrated solar panels and energy storage system will be modelled on the use of a standard home in the UK. The wastewater treatment system will be modelled on the single household to prove the concept and show how the various technologies can work together.



self-sufficiency

We are developing modular Upflow Electromethanogenic ReactoR (UEMR) to treat wastewater, food and organic waste. The system uses a combination of biological and electrochemical processes to treat the waste and generate methane-rich biogas (70+ percent). The bioelectrochemical process allows the waste to be treated up to 10 times quicker than conventional anaerobic digestion systems reducing the system size.

WASE is currently planning two pilots for the UK. The first is to upgrade an operational micro anaerobic digestion system in London which will be operational by September 2018. The second is currently in the feasibility stage to assess installing an onsite system for a microbrewery in London to treat a portion of their wastewater onsite and produce electricity and heat through a combined heat and power system.





Wastewater Treatment System | innovation



Aceleron Ltd. has developed an energy storage solution that can manage the energy needs for homes. The system uses end-of-life lithium batteries to create new storage systems that can be used for various applications. The battery pack comes at a highly competitive price with the ability to replace its modules to extend its lifespan. Integrated sensors will monitor the performance of the battery pack(s) and alert the service provider when modules need to be replaced.

ACELERON

Energy Storage System | innovation

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PROJECT LIVING BUILDING meets NEIGHBOURHOODS OF THE FUTURE

Self-sufficiency has the benefits of not requiring large infrastructure networks and can be combined to create a collection of micro-grids that share resources between one another and reduce losses. The water collection and recirculation can help reduce the effect of water shortages in some regions, combined with sustainable energy generation. The system can significantly reduce the environmental impact when compared to centralised systems. The building that these systems will be integrated in will remain connected to the grid to offer the opportunity to feed back into the grid and eliminate energy cuts.

A building's ability to generate all of its own energy and potentially more can have a significant impact on the economy. This will boost the economy's ability to generate clean energy from renewable sources which would significantly reduce carbon footprint and improve air quality. Coupled with a construction system that offers superior insulation and an intelligent system that helps monitor and manage energy consumption, the 2050 target of improving energy efficiency by 90% may not be too difficult to achieve. Especially when considering that buildings currently account for around 50% of Europe's overall energy consumption.

self-sufficiency | innovation



SELF-ASSEMBLY The building's ability to assemble and heal itself Self-Assembly is the project area concerned with the development of a new material that would allow the building's structural elements to self-assemble and self-heal. Building on the knowledge and research carried out on existing materials that possess such qualities, a new bio-based material will be developed. The material will be used as a concrete alternative providing structural strength as well as other properties necessary to ensure that the building performs at its optimal level.

A set of criteria and specifications have been identified for the material used in 'Triagomy', the construction system, and this will form the basis for the development. Many of the material specifications and properties identified are contradictory and are not usually found in the same material. However, in order to ensure that Triagomy's components are homogeneous, the developed biobased material would need to multi-task and serve more than one purpose.



self-assembly

PROJECT LIVING BUILDING meets NEIGHBOURHOODS OF THE FUTURE

SYNERGIES

BETWEEN PROJECT LIVING BUILDING AND NEIGHBOURHOODS OF THE FUTURE

There are three avenues through which Project Living Building could be aligned with Neighbourhoods of the Future



BUILDING MATERIALS



INTELLIGENT SYSTEM



TECHNOLOGIES

alignment

PROJECT LIVING BUILDING meets NEIGHBOURHOODS OF THE FUTURE



As Biohm's construction system, Triagomy, is still under development and would not fit in with steel-frame construction in its current state, there are aspects within the system that could be adapted to be integrated within TATA STEEL's steel-frame construction system immediately.

This involves the use of Biohm's mycelium insulation combined with UK Hempcrete's plant-based concrete alternative

TATA STEEL



BIOHM.

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mycelium

the vegetative part of a fungus | a network of fine white filaments

Fungi are truly wondrous organisms with significant untapped potential. We are experimenting with different species of mycelium to create sustainable alternatives to some of the construction industry's most damaging materials.

Mycelium consumes organic and synthetic waste to grow into desired shapes and different types of waste alter its properties. This could have highly significant implications for ridding our planet from the mountains and islands of synthetic waste. It can be grown into any shape or size in a controlled and economically beneficial manner.

We have developed a 100% natural and carbon-negative foamed mycelium material that is an excellent substitute to synthetic insulation. It is capable of achieving higher insulation values than current alternatives and could be developed to have structural integrity. We are currently undergoing a scale-up operation where we are opening a facility in Wales in order to significantly increase our capacity and production capabilities. BSI, the Manufacturing Technology Centre (MTC) and Imperial College London are supporting our testing and accreditation process.







hempcrete

a bio-composite material | a mixture of hemp hurds and lime

Hempcrete is a net carbon sequestering material. Approximately 50kg of atmospheric CO_2 is locked up in every m2 of hempcrete wall we build. Its thermal performance means that very little or no energy is required to run a well-designed hempcrete building.

It is a mixture of insulation and thermal mass, which means it has long phase shift times (approx. 12 hours for 200mm of hempcrete) and so buffers external temperature changes, maintaining a near-constant internal temperature with little or no demand on heating or cooling systems.

As a completely vapour open system, and because of specific properties of the hemp plant, hempcrete passively regulates internal humidity by a constant process of absorption/release of moisture in and out of the wall in response to relative humidity inside the building. This keeps internal humidity to a safe level (between 40-60% RH), preventing the growth of damp spores, viruses and bacteria, and ensuring a healthy indoor environment.

In addition, because of the lime binder, hempcrete needs no chemical treatment for fire, pest or rot resistance, and therefore is a completely natural product and as part of a wider design can help to provide a completely natural, chemicalfree, zero-carbon and low-energy home.





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How would it work?

This is a simple illustration of how Biohm's mycelium, UK Hempcrete's hempcrete and TATA STEEL's frame could be combined to form a carbon-negative/neutral and low-energy healthy home. However, there are various options that could be explored.

The mycelium can be encased in TATA Steel's breathable steel sheet material to help attach the mycelium to the steel frame whilst allowing the building to be deconstructed at end-of-life. To prevent cold-bridging and maintain the building's breathability, a bespoke hempcrete system developed by UK Hempcrete would encase the entire structure. As the mycelium can be grown into any shape or size, there are various options that can be explored when it comes to construction and configuration. Other forms of cladding could be used, however, hempcrete would be an ideal option as it offers additional insulation and is fully aligned with mycelium's health and wellbeing benefits - natural, breathable, carbon-negative, etc.

Due to the unpredictable (temperature dependent) drying time on-site, especially when building at scale, wet-cast hempcrete would not be advisable. UK Hempcrete have developed a "Better-thanzero-carbon" walling system for steel framed buildings. The system combines hempcrete with wood fibre external board insulation, which can be rendered or clad, according to the clients requirements. The system has a BBA certificate covering the external wood fibre board and lime render system. Once mycelium's structural, thermal, moisture and fire performance has been thoroughly tested and certified, it could easily be used as a healthier and more sustainable substitute for wood fibre board within this system.

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breathable steel sheet



INTELLIGENT SYSTEM

As the creation of Neighbourhoods of the Future will require the use of various technologies, this intelligent system is a potential option for managing the separate technologies and combining data points in a unified platform. A year-long investigation into the impact of the built environment on one's health and wellbeing resulted in the development of an integrated intelligent system that would provide seamless communication between sensors, databases and platforms.

NQuiring Minds and Know-Now Information have worked on significantly simplified versions of this system in the past and are willing to develop it with the support of other tech partners (Microsoft, IBM, etc.). This could also be integrated into a larger platform that would combine its data with digitalised standards, Building Information Modelling (BIM) data and government databases to create an ecosystem that encourages innovation and best practice in construction.



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TECHNOLOGIES

Wase and Aceleron's technologies can be used and integrated into developments of various sizes. They could also be used in isolation for a single house-hold.





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