Project Call for 2022 ERBE Cohort

MaREI Supervisor	Prof. Jamie Goggins
Institution	NUI Galway
Co-Supervisor & Institution (if known – please note this is not a requirement at application stage):	Dr Asit Kumar Mishra (NUI Galway), Co-supervisor from from UCL or Loughborough University with expertise in smart building controls
PhD Proposal Title:	Resilient classrooms for the future – Exploring lean and agile techniques for sustainable and healthy learning environments
Alignment with ERBE Themes: (200 words max – please specify if the project aligns with 1 or more of the ERBE Themes)	The topic aligns with two of the ERBE themes, viz, Flexibility & Resilience and Comfort, Health & Well-being. The research question being posed is, can we select agile and lean engineering solutions so that we can have classrooms that are resilient to future challenges to indoor environment quality (IEQ) while still satisfying needs of energy efficiency and occupant comfort? The focus on classrooms comes from the unprecedented disruptions brought by the Covid-19 pandemic to in-person education. The challenges to IEQ could be due to acute events like the current pandemic or an epidemic, seasonal issues like a flu outbreak, or issues due to climate change like overheating. These challenges would impact occupant health (both communicable and non-communicable diseases) and comfort. While current efforts aim at making buildings energy efficient and running them for healthy indoor environments, these efforts do not take into consideration future challenges. Consideration of future IEQ challenges leads to future resilient buildings, ready for an array of challenges including climate change. The proposal aims to do this by adding an element of flexibility – agile and lean solutions that mean an energy efficient operation during normal use and enhanced operation when faced with a “challenge”.

Project Call for 2022 ERBE Cohort

PhD Proposal Abstract: (500 words max)	Due to the Covid-19 pandemic, classroom-based education has suffered immensely. For classrooms of the future, from a health angle, can we design them to be more resilient to future acute events, like a pandemic, while also operating in an energy efficient and healthy manner during everyday situation? In addition to pandemics, the future events against which a resilience is desired would include any epidemic outbreaks of communicable diseases, seasonal outbreaks such as flu, events triggered by climate change such as overheating or dampness and mould formation, forest fires in the neighbouring area etc. This question requires exploring of engineering controls that can be made part of the building construction. In the **hierarchy of controls** for controlling exposures, engineering controls come above administrative controls and personal protection. They can be implemented without requiring occupants to undergo behavioural changes. This would be especially useful for classrooms with young children. The engineering controls that can meaningfully face the aforementioned challenges would include enhanced ventilation and filtration, germicidal UV treatment of surfaces and air, reduced contact surfaces and self-cleaning high-touch points, automated disinfection of high occupancy spaces like elevators etc. A simple strategy could be to overdesign indoor environmental controls for such a building so that they can stand up to challenges that require extra cooling (overheating) or more fresh air (airborne infections). However, this would mean that the building would not be able to achieve energy efficient and comfortable operation during normal operations. Such a design could be resilient, but the purpose of this thesis would be to come up with designs that not only provide future resilience of the classrooms indoor environment but are also **agile and lean**. The agility of the solutions refers to their flexibility and ability to easily move between normal operation and “challenged” operation. Even during normal operation, the solutions would be able to contribute to a healthier indoor environmental quality of the classrooms. The lean factor would be ensuring that the proposed combination of solutions would not overly expensive in terms of energy usage or upfront costs. The proposed PhD thesis would explore a combination of engineering controls, utilizing a combination of interviews with practitioners and review of literature to compile and evaluate available engineering controls for future resilient classroom design, at the first stage. Controls that are deemed to be suitable in this stage will be evaluated using building performance simulation in the next stage. Building performance simulation allows us to simulate the impact of future events on building operation. At the same time, it also allows to evaluate the

	combined impact of multiple solutions implemented together. This would also help us evaluate the agility and leanness of the solutions, individually and in combinations. The primary deliverable of this work would be matrices of solutions that, in combination, can provide resilience to future classrooms while also ensuring energy efficiency and comfort during normal operation, while being capable of facing any acute challenges to the classroom indoor environment.
PhD Proposal Summary for inclusion in Student Call Document: (300 words max – please note the student will be indicating their order of preference for all submitted proposals; please ensure this summary includes a project overview & introduction to the supervisor & institution)	The Covid-19 pandemic has had a disastrous impact on classroom-based education, something that is considered integral to our educational system as well as children's overall development. This poses a challenge to engineers – can we inculcate engineering controls into classroom construction that would make them resilient to any future similar event? This would mean in-person education would not be hampered during any similar future events. Simultaneously, controls can be put in place to deal with other future challenges for classrooms indoor environment that emerge from climate change as well, like overheating. The goal is to build in resilience into future classrooms while keeping them energy efficient (lean) and able to smoothly transition between "challenged" operation and normal operation (agile). The work will explore combinations of engineering solutions that can achieve such agile and lean resilience for future classrooms. It will involve extensive interactions with construction industry professionals and use building performance simulations to come up relevant solution matrices. Prof. Jamie Goggins will be acting as the supervisor for the thesis. He is a Chartered Engineer and Established Professor in Engineering in NUI Galway, with 20 years' experience in consultancy, construction, and research. He is a Co-PI and member of the Executive Management Committee of the MaREI Centre. He has been principal investigator on over 30 research projects in the past 7 years, with a total worth of €71.5M. NUI Galway focuses on research intended at benefiting the economy, the society, and humanity at large. The University encourages creative thinking and cross-disciplinary collaborations. The Research and Innovation Strategy 2021-26 has been recently launched at NUI Galway, grounded in the values of respect, sustainability, excellence, and openness. The strategy is intended to maximize research impact while nurturing its research community and encourage robust partnerships, both locally and globally, across industry and academia.