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The forces that shaped the Irish Regional Technical College buildings

The paper charts the early development of environmental thinking in Architecture up to the radical paradigm shift of modernism and brutalism. The resulting emphasis on proportional grammar over the technical performance of the interior environment would be common threads in Educational architecture leading up to the design of the Regional Technical Colleges (RTCs) in 1967. Changes in technology, materials and skills shortages led to the development of post war steel frame Hertfordshire Schools which greatly influenced the future direction of Technological School and College design. Financial rationalisation saw a movement away from the steel frame CLASP models to concrete frame Intergrid systems, which would directly influence a key precedent of the RTC design, the M&M building at the University of Birmingham. The intelligence of the building design by ARUP would be compromised by the Modernist emphasis on plastic over glazed facades, which lacked shading suffered from great heat loss. The movement away from quality materiality and exposed grid structure, resulted in a loss of delight and a greater level of brutalism.

The opening of Ireland to international trade in the 1960s saw a projected shortage of 10,000 technicians by 1970 resulting in the creation of Regional Technical Colleges in 1967 (Healy 1988, Browne 2008). The pre-oil crisis design of the RTC and its precedents resulted in poor energy performance. Political interference, a lack of systemized construction experience and materiality cutbacks resulted in cold, ugly buildings (Mills 1974) that were both uninspiring and costly to run.

As RTC's move to become universities, this paper sets out the forces of architecture, education, economics, precedent, politics, philosophy, society and the professional power struggle that shaped their design and their consequential environmental performance.

The forces that shaped the building

The Brutalist Architecture of the 1967/68 designed Regional Technical Colleges in Ireland can trace their stylistic origins back to the turn of the twentieth century with the battle of empiricism over rationalism. Changing priorities and disconnections between architecture and building performance can be traced back to the 1600s.

From Harrison's *"Description of England"* in 1587, principles of building performance was evidenced by the masons preferential location of houses in valleys over hilltops where *"the stormy blasts of winter, should breed them (occupants) greater annoyance"* (Harrison, 1587). Concurrent exemplars like Hardwick Hall (1597) contradict this, with its hill top location and large expanses of glass; Hawke (2012) argued that it had an optimal orientation despite its exposed location and large expanses of glass. As a disciplinary definition of architect began to be distinguished from master mason in the seventieth century, Perrault would see the good architect as having an appreciation and knowledge of aesthetics rather than construction. Leoni's translation of Palladio's 4 books of architecture (1715-20) saw the birth of English Palladianism and explicit guidelines for designing to climate (Hawke 2012). Although based on a Venetian climate there is a clear correlation between size of rooms and sizes of openings, daylight and heat loss. However, eighteenth century rationalist architecture would not fully grasp the environmental impacts of construction. Banham references the 18th Century medical professions view of the architectural discipline and it's apparent indifference *"to the environmental performance of their buildings"* (Banham 1969). Jacob would later refer to the ubiquitous low priority given to ventilation and air quality by architects (Jacob 1894).

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Durand's scientific view would bring the influence of Structural Rationalism to the Ecole des Beaux Arts as the first academically qualified architects graduated in 1819. Architecture from the origins of its professional education would be concerned with both aesthetics and performance.

The paradigm of structural rationalism would transform into scientific determinism as the industrial revolution progressed, continued by Darwin's theory of evolution in 1859. Reacting to the increased mechanisation of the age critics like Ruskin promoted "ornamentation" as a central part of Architecture, championed by Architects like Pugin and designers like Morris would see a platform for its promotion at the great exhibition 1881 (Pesvner, 1991). Empiricism would lead to an interest in traditional architectural forms, craftsmanship and regionalism.

The architecture of Voysey's house at Broadley followed the style of the Arts and Crafts movement embracing optimal orientation, creating double height bay windows for light, cantilevered balcony creating a ground floor verandah to the south for shelter and shade, placing service areas in the east of the house and having environmentally appropriate window sizes to room function and orientation. By 1910, this would demonstrate a steady advancement from the fifteenth century in the understanding of building physics and how a buildings design related to its environment and location.

In this context the later (1967) RTC buildings would be designed without regard to orientation with a common homogenous approach to fenestration and accommodation. Something had radically changed in architecture that led to such a difference in approach.

In 1904, having studied the contemporary styles of British housing, German Architect, Hermann Muthesius proposed that German architecture should take a more rational and utilitarian approach; which he called Sachlichkeit. This was a reaction to the ornamentation and decoration of the Art Nouveau movement (Millais, 2009). Loos writing in 1908 dictated that the natural progression of cultural evolution would see the elimination of ornament in the everyday item. Sant Elia clearly defined an ideology for the International style (Sachlickeit) in 1914 by defining a concept of brutalism in architecture... *"with the use of concrete, steel and glass...to be ugly in its mechanical simplicity"* (Sant Elia, 1914). On the day the last RTC opened, Mills (1974) reported that the RTCs were *"ugly to the eye"*.

Behrens who had been prominent in the Art Nouveau movement joined Muthesius' Deutscher Werkbund in 1907, where he designed the AEG Turbine Factory, Berlin (1909) in the style of industrial classicism. AEG predated Sant Elia's concept of brutalism. Behrens language would influence his assistants Adolf Meyer and Walter Gropius who designed the Fagus Werks building (1911-13), which would be christened the first Modernist building. Its glass envelope, flat roof, concealed structure and expressed grid was flat and without relief. You can see the grid relationship between the 2 buildings in the large expansive modulated glazing. Mallias (2009) argued that the retrofitted first floor shop awnings over the Fagus Werks glazing evidences overheating and a poor consideration of heat gain by Gropius and Meyer, perhaps suggesting a lack of awareness of building physics in the design. The adherence to a plastic aesthetic of flat façades would be mimicked in the later (1967) RTC buildings leading to similar problems.

Dessau Bauhaus (1926), which was designed by Gropius, was constructed of a reinforced concrete frame in a grid structure with non-load bearing walls. Feuerstein (2002) infers that Gropius seemed to learn little from the functional issues arising from the Fagus Factory... *"Realities derived from the design created their own problems, within the building; undersized and inefficient heating, huge heat gain and heat loss from the expansive, unprotected and non-insulated glass facades; poorly maintained roofs, which led to leakage"* (Feuerstein et al, 2004). Whilst Feuerstein is reflecting back on Dessau Bauhaus from a different context in time, the physical issues are broadly similar to the 1967 RTCs.

City of Refuge by Le Corbusier for the Salvation Army in 1931-33 would be an initial failure but experiments with active double skin facades (murs neutralisants), mechanical ventilation heat recovery (respiration exacte) and an air tightness would be almost 60 years

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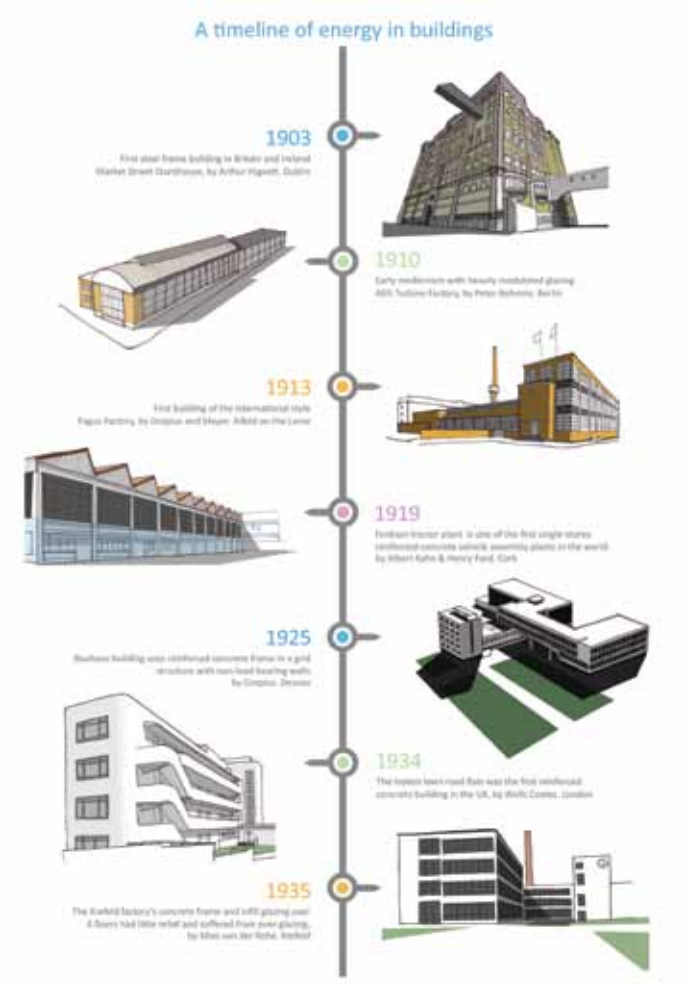
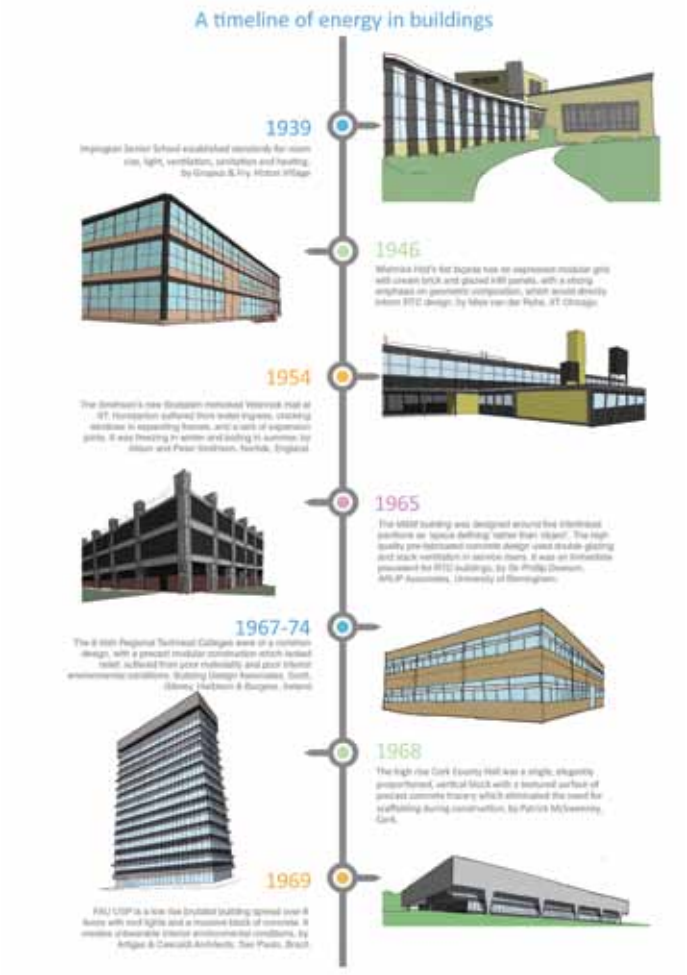


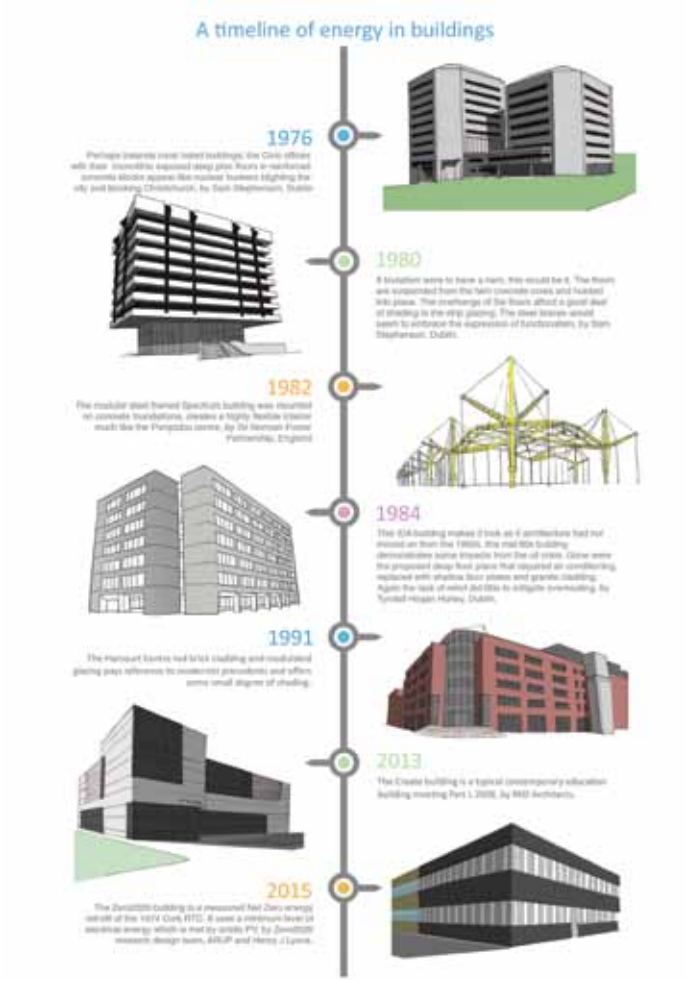


ahead of Passive House. The building suffered from summer overheating due to solar gain and mechanical failures. This project perhaps displays how a lack of knowledge in building physics can compromise building function leading to harsh environmental conditions for the occupants. City of Refuge caused similar levels of overheating and heat loss to the RTC buildings.

Impington Senior School development (1936) saw Gropius and Fry apply *"modern architectural possibilities in structure, design, materials, decoration and hygiene"* (Morris 1936). Their design *"established standards for room size, light, ventilation, sanitation, heating and access to water, as well as proximity to the workplace, grocery stores and childcare"* (Anker 2010). Of course limitations in 1940s glazing technology would greatly contribute to heat loss. The Impington school design would inform 'finger planning' for schools and RTC buildings. This design featured classroom units, usually prefabricated, along long, spoke-like corridors, which would become the template for British school design after the war.

In Berlin, frustrated by dwindling work Mies van der Rohe emigrated to Chicago in 1938 to become Director of Architecture at IIT (MiesSociety, 2014). His first building, the Armour Research Foundation (ARF) Metals Building followed the precedent of the 1935 Verseidag Factory in Krefeld, Germany. Verseidag was similar in style to Gropius' Fagus Werks building 20 years earlier, with heavily modulated glazing, flat geometric facades and expressed concrete structure. However it would be the lesser-known IIT Wishnick Hall 1946 which would greatly influence l Scott & Burgess' façade of the 1967 RTC buildings in Ireland. Wishnick's flat façade has an expressed modular grid with textured cream brick and glazed infill panels. This refined expression of grid and geometric composition would be the high point of the international style, however its lack of relief and large glazed sections did little to avoid heat gain and heat loss.

Post-war London saw the development of New Towns outside London. G.C.Stilman, county architect of West Sussex, developed a modular concept of construction based on Gropius and Fry's pre-war Impington College. He pioneered non-traditional lightweight steel grid structures for primary and secondary education. *"These were based on a three*



bay module to give a 24'x24' (7.3m square) classroom" (Bullock, 2010). The Hertfordshire models optimised prefabrication with steel frame structures and external cladding or infill panels. Given that it only took 2 years to build 9 schools after the initial pilot project in 1946 (Jackson, 1970) the speed of construction would become very successful and become both admired and widely adopted by the London City Council (Bullock 2010). This is a critical precedent to the later development of concrete frame, modular grid optimised education constructions such as the Irish RTCs.

Many of the Hertfordshire designs featured a steel structure with horizontal precast concrete infill panels instead of brick. The aesthetic was particularly brutal and ugly but effective, modular and fast; Steel was still in better supply than brick due to post-war resource and skills shortages. Mies van der Rohe's IIT Chicago inspired the 1949-54 Smithson's Huntstanton Comprehensive School in Norfolk. The Smithson's interpreted the two dimensional photographs that appeared in the Architectural review 1946 of the Metals & Minerals Research building, IIT, to inform the design of Huntstanton. (Zimmerman 2010) *"Where Mies' work at ITT was refined and taught, the Smithson's work on Hunstanton was raw and brutal, the construction was expressed with each exposed weld, bolt and pipe. Hunstanton is more honest than Mies' work – what you see is the true structural frame, welded on-site to make a continuous plastic structure to save steel. The standard sections, though large and in short supply, were relatively cheap. The brick end walls brace the structure, and inside all the finishes and pipes are exposed"* (Harwood 2010). Phillip Johnson recognised the departure in grammar from Mies' work *"the rigid formality of the plan, based on a strongly symmetrical layout"*; Sterli agrees that the symmetrical layout was not very Miesian and owed perhaps more to a traditional Palladianism (Stierli, 2010).

These buildings are critical to the development of a Brutalist language as is their environmental performance. After Smithson died in 2003, a former geography teacher, JTA Shorten, declared to The Times that Hunstanton was *"a tragedy"*. He complained about water ingress, the lack of expansion joints, cracking windows in expanding metal frames. *"This building's principal problem: that it is freezing in winter and too hot in summer."* This indicated perhaps a lack of architectural competence in material and environmental performances in different climactic conditions. These examples demonstrate a continued emphasis on the proportional grammar over the technical performance of the interior environment. It could be argued that this over-emphasis continued to inform architects approaches to modern education buildings like the subsequent 1967 RTCs in Ireland.

Emphasising the theoretical disconnection with environmental performance Corbusier (1929) would aspire to *"one house for all countries"* and Gropius (1943) would see modern architecture as *"not a few branches of an old tree-it is a new growth coming right from its roots"*. The dogmatic rationalism of the Internationalist and Brutalist ideologies rejected the environmental learning outcomes of their predecessors resulting in poor post occupancy conditions. Buckminster Fuller claimed that the international style was superficial, ignoring fundamentals of technical performance and concerned only with *"formalised novelties of quasi simplicity"* (Fuller, 1999). Banham identified the lack of technical training at the Bauhaus and the failure to understand the fundamental problems of building technology (Banham, 1960). Perhaps there are other reasons for the apparent poor performance of the education building precedents that would inform the design of the RTCs in 1967.

The British government cut educational funding by a third in 1951. This prompted an analysis of materials and construction techniques. The Architecture and Buildings Branch of the Department of Education (UK) instituted research into the cost of separate elements of *"a building, the foundations, steelwork, cladding and roofing were priced independently"* (Stanford 1962). The light steel frame system which has been used for the design of the HCC schools will be used for approximately £3.5 million construction; the concrete frame designed for heavy, multi storey urban buildings will be used for approximately £1 million construction; and the traditional load bearing methods will be used for small buildings and renovations at an approximate cost of £0.5million. The clear advantages of the industrialised system in speed of construction, over traditional methods, came at 7 times its cost (Stanford 1962).

Thus, we can see that the transition from the lightweight architecture of Hunstanton and IIT buildings of brick, steel and glass to the more cost effective concrete frame and over clad prefabricated panel buildings, were heavily influenced by the forces of government

policy, in the early 1950s. This led to a general rationalisation of the system build, away from steel frame and brick infill panels leading to the concealment of the expressed grid, for which the proportional grammar depended so heavily on in the precedents of AEG, Fagus, Verseidag, Wishnick and Hunstantion. The concealment of the grid at the RTC buildings results in a poor geometric composition resulting in an emphasis on material where quality is lacking. Therefore, this move, which was influenced by cost rationalisation, would result in less delight.

A new more impressive low-rise construction started to emerge as the unit costs were assessed. Closed Prefabricated Systems arose to replace more open systems such as the Large Panel Systems of Ronan Point (which partially collapsed in 1968), Ballymun Towers (1966) and external panel hung frame systems, such as the 1967 RTC buildings. The early 1960s became a key fulcrum point in the Industrial system building typology. The switch from steel to concrete would provide a cheaper construction typology, which meant if used properly; the exposed thermal mass could be harnessed for passive thermal control. The BRE also found that its steel (CLASP) predecessor suffered *"serious corrosion to parts of the steel",* making it ill suited to retrofit (Ross 2002).

The RTC Template

By 1963 Arup Associates was formed in Britain with architects working collaboratively with structural and service engineers under one roof developing the principles of Gropius' Total Architecture. Their first project was the Mining and Metallurgy Building at the University of Birmingham in 1963-65. Philip Dowson developed ideas for Science buildings over a few years, paying particular attention to adaptability and servicing. The project was designed around five interlinked pavilions as *'space defining'* rather than *'object'*. Each pavilion was based structurally on a tartan grid with extensive prefabrication of concrete elements. *"Concrete was the ideal material with which to achieve this integration, since it can easily serve both load bearing functions and interpenetrating voids that are necessary to pass services horizontally through the floor structure and vertically through risers that can usually serve as sheer walls for the building"* (Addis, B., & Bussell, M.,2008). The vertical service risers, which occupy the over-check in the grid, have vent grilles at every floor level; terminating in a weathered chimney at roof level acting as early stack ventilation. A very narrow (100mm) tinted and unsealed double skin glazed façade vents warm air from the cavity to mitigate solar gain.

The project was completed in 1965 and went on to win plaudits for their clarity, logic and elegance winning the 1966 RIBA Architecture Award for the West midlands (Royal Academy of Arts 2014). Much like City of Refuge (1933) it begins to address environmental concepts that would not be fully developed untill the 1980s.

The M&M building is the key precedent that would influence the RTCs in Ireland. ARUP were common to both projects and the fast track nature of the RTC project forced the design team to look for well-developed precedents. A research team from Dublin travelled to Birmingham and Loughborough in February 1967 led by the UK Department of Education (Education, D.O., 1967) to examine the ARUP buildings. The concrete tartan grid of the RTCs can be directly compared to the M&M building with modifications to the over-check of the columns. The servicing strategy is broadly similar but the external façade is very different. The UK government were very experienced at delivering large multi-site modular constructions since the post war CLASP buildings, however the Irish were not.

Ireland 1960

By the mid 1960s Ireland was on an economic upswing and the new Minister for Education, Donogh O'Malley, set about an ambitious building program establishing the Regional Technical Colleges in 1966. The program set out to address a massive social inequity whereby a child was 68 times more likely to go to college if they had upper class parents (than those of the manual classes). There were 10 times more professional graduates coming out of University than technicians coming out of further education. The government, industry and the World Bank all recognised that this was becoming a serious threat to the potential for continued national economic growth; a change had to be made.

Embracing the systemised construction ethos, O'Malley structured education like an assembly line delivering the children of the working classes to second and then third level education on a scale never seen before in Ireland. He grasped power away from local church dominated vocational groups, under whose oversight school design had been allowed to develop in haphazard and often obscure ways. Making an executive parliamentary decision, he announced his intention to set up the RTCs in 1966, quickly establishing a steering committee to inform a design brief. This move emasculated an existing Commission on Higher Education, established by his predecessor, whose recommendations on a new third level structure remained unpublished.

Political Maverick

Ignoring the existing regional appointments, he handpicked the team he wanted for the largest multi-site construction project in the history of the state, under the guidance of Desmond McGreevy, a close friend of O'Malley's and political party chief fundraiser. The new design team formed a consortium called Building Design Associates (BDA) and included Michael Scott, Arthur Gibney, J.Coleman Healy, Eoin Kenny & Arthur Mayne with Arup's leading engineer, Jock Harbinson.

The Minister required a 3-year design and construction period starting in late 1966 and completing the first phase of 5 buildings in September 1969 with a 20% cost and time savings over traditional methods. The design team were refused a research trip to ITT Chicago in an uncouth manner from the Minister who reportedly responded to their request with: *"I'm not going to pay you fuckers for investigating colleges and universities and whorin' round the world"* (Healy 1988). Scott and Gibney had clearly looked toward IIT for precedent but political forces pointed the design team towards a more local precedent.

Faced with such an unwavering client and imminent deadline, research trips and thus precedent studies were limited to the LCC in London and the University of Birmingham where at the same time Dowson (ARUP Associates) had just completed the Mining and Minerals (M&M) Building. BDA decided to adopt the pre-cast reinforced concrete frame, column structure, tartan grid and 24-foot module (which was a direct descendant of the Hertfordshire models) for the RTCs combined with an external prefabricated concrete cladding system.
The resulting initial design proposed by BDA

in March 1967, which had less than 5 months for design and research was budgeted and presented to Parliament at a cost of £8.4m for 9 college campuses, for which further savings of 16.4% were demanded (Oireactas, 1968). The design, which already suffered from a lack of detailing, was now stripped of much of its quality surface finishes. Precedent brick internal walls were replaced with fair faced concrete block, internal parquet floors were replaced with linoleum coverings, equipping budgets were all cut back, and the independent structures would now be cast together abandoning the architectural ethos of unity and flexibility (Department of Education, 1968).

The resulting design, which differed from its UK predecessors in both detail and finish, progressed apace to site with different project teams. Again political interference had resulted in a concept design team and a different project design team. In general, the engineers, ARUP were the only common members to both panels (Dail Eireann, 1967) at various sites. This further removed the project teams from the design ethos and precedent template. Where in the UK, builders had become very familiar with casting and prefabrication in the post war building frenzy; Irish trades, outside Dublin, had little experience in the same. Thus workmanship and finish suffered particularly in the concrete casting and block walls. Fair faced blocks did not have the fine finish of their Birmingham or London counterparts. On site, stair castings were rough and hewn, the long horizontal and slim aggregate panels were often warped and hard to install requiring remedial site fixing solutions which have been failing since (Kelly, 2010).

On the day the final college opened in December 1974 and in the midst of the first Oil Crisis, a local Cork newspaper reported that the *"structure and design of the building had created many problems, such as the heating. As the building is not insulated the heat disappears quickly. The expanse of glass and bare block add to the coldness of the structure which is ugly to the eye"*. Part project funder the World Bank, conceded in the wake of the second oil crisis (based on an internal report recently declassified), that the design had serious faults particularly with regard to the high-energy consumption. *"Basically there has been inadequate cost provision to meet environmental (heating and ventilation) engineering needs. ....."*, *a design with a high percentage of single glazed windows, inadequate roof insulation and no thermal control have caused high "costs-in-use"* exacerbated by the international energy crisis. The 1967 budget for Cork RTC of £1.45m more than doubled, with the eventual cost coming in at £3.2m (World Bank, 1980).

Physical Findings

The concrete industrial closed system builds, like the Regional Technical Colleges, with precast panels suffer from deteriorating sealant/baffles to the joints between panels with implications for weather, air tightness, surface condensation, a lack of thermal insulation and expensive uncontrolled heating systems all contribute to significant problems for some buildings. However, the spalling steel braces and ties holding the panels onto the building structure are causing panel delamination impacting retrofit strategies. The concrete frame has a longer lifespan than precedent CLASP steel frame predecessors and therefore more suited to retrofit. There exists a high potential for greenhouse gas abatement though energetic retrofit. The external envelopes of 105,000m2 have a high heat loss with a fabric failure resulting in high air permeability and water penetration. It has been shown that there exists a commonality and scale to the RTC typology both here in Ireland and in the UK dating from the 1960s and 1970s with most or all of them being pre regulation. Buildings account for 40% of the EU energy consumption (EU Commission, 2010), and *"new buildings account for only 1% to the total European stock each year"* (Paulou, J. et al., 2014), making energetic retrofit one of the most cost efficient measures for GHG (Green House Gas) abatement (Naucler, T. & Enkvist, P.A., 2009). RTC retrofit actions have demonstrated that full external envelope retrofit can extend the lifespan of the building by a further 40 years (O'Sullivan et al, 2013), whilst delivering energy performances far in excess of building regulations (TGD, Part L 2008). Cost optimisation analysis has also demonstrated that Nearly Zero Energy Building performance can be achieved through retrofit at 25% less cost than new build.

Conclusions

The utility of Internationalist and Brutalist Architecture, from the Gropius' Fagus Factory through to BDA's Regional Technical Colleges, is compromised by a focus on geometric form over technical function. Despite the Internationalists claims to technical rigour, the environmental performances of these buildings are very poor. The flat geometric grid composition did little to relieve the interior environments from overheating and overcooling. It is hard to justify Gropius' claims of perfect harmony in architecture when the emphasis on proportion so outweighed technical function. If that is the measurement criteria then the typologies lack beauty. Buildings like Mies' ITT campus, the Smithson's Hunstanton and Dowson's M&M building all have beauty in their brutalism and all suffer in some way in environmental performance. The political impact on the Industrialised system in 1950s Britain resulted in a loss of the grid in architectural language. The concealment of the structure and an emphasis on rationalisation created *"visual squalor; technical over emphasis can lead to anti social building, an end in itself devoid of humanity, where the medium is the only message"* (Delaney 1970). In retrospect it is sometimes difficult to perceive why buildings are the way they are, the fashion of Brutalist and Industrialised architecture were of the era and promised a more egalitarian world. But like all things, they can be easily corrupted by politics and by myopic decision-making. The lack of both architectural continuity and adequate time to properly detail the RTC design scheme meant that the largest multi site development in the history of the state delivered an ugly, uncomfortable building with a poor environmental performance. The result is a costly uninspiring space that has become a victim of politics and drudging. For all the haste and cutbacks we have been left with second-class institution in second-class accommodations, compromised by a political expediency burdening all users with a legacy of greater cost and lesser utility.

Today's RTCs are still in use and beyond their physical lifespan. In the context of EU directives should have been retrofitted to nearly zero energy performance by January 1st, 1999.