Energy Efficiency

GBE Lecture
RIBA Part 1 Year 2
LSBU 2016/2017

- Technology 4 Energy and Resource Efficiency in Design module
- a further 5 technology lectures, as follows:
- Semester 1, Technology 2 (i.e. Bachelor BA2 students)
- Monday 17 October (9.00-11.00am) Room E327
- Tutor: Je-Uk

Lecture 1: Lilly's Brief to me

- Energy and Resource Efficiency in Design (emphasizing the key issues)

Note from Je-Uk

- It is very important that students are aware of the key issues regarding sustainability in architecture in order to learn how they can incorporate into their design proposal from the initial stage.
- So your lectures in week 3 and 4 is perfect timing considering they are at very early stage of design.

My response:

- 1st seminar Energy
- 2nd week Resource Efficiency

Energy

- Business as Usual: missing all the global targets
- Building Regulations, SAP, SBEM, IES
- Voluntary standards: EcoHomes, BREEAM, Code for Sustainable Homes, Code 6 and industry response
- Zero Carbon Hub: Outputs, missed opportunities and dropped targets
- Driving down demand: SuperE, AECB, PHPP, Minergie, Carbon Lite, EnerPHit, Carbon Lite Retrofit
- One Planet Living: 10 issues
- Calculators: Areas, Temperatures, U values, Energy demand, elemental %, fuel choice, Carbon
- Passive v Active
- Solar Gain and Loss through glass: Calculators
- Thermal Mass and its exploitation
- Daily to Inter-seasonal storage
- Thermal Bridge > Thermal Break / Thermal Flanking > Thermal insulation
- Thermal Insulation: Conductivity, Convection, Radiation, Wind wash
- Fabric-First, Service-Last
- Wind and Air tightness: Built-Tight, Ventilate-Right
- Moisture Permeability: Vapour-Closed v Vapour-Open (EVT)
- Overheating: Build-Light, Insulate-Right, Solar-Tight
- Ventilation/Cooling: Passive v Active v Mechanical V A-C

Sustainability Definitions

- What does sustainability mean to you?
- What is your definition?
- Most people do not know or understand Sustainable and cannot define it
- What is the difference between Environmental and Sustainable?
- Sustainable = Economic + Social + Environmental in equal measure or in balance

Economic = Takes profit into account.

- Business as Usual = Profits before People before Planet
- Business as Usual = Missing all the Global Targets
- Fiduciary Rules apply = Make a profit for your shareholders (but at what cost?)
- Some tell porkies (greenwash) to sell more
- VW and others have been caught out (but some customers remain loyal to brand)
- But Monsanto (GM seeds) John West (Tuna) Tesco (Food) Martel (Barbie and Ken) Lego (Bricks) and others have learned that they cannot ignore customers (and non-customers) when they join forces through social media campaigns

Social = Takes people into account

- (They are your business, Health and Wellbeing, Living wage+, Prosperity, Local)

Environmental = Takes planet into account

- (resources, pollution-free, waste-free, efficient, effective)
- Setting global targets in local legislation (UK still to ratify the Paris Agreement, let alone regulate)

GBE HERACEY™

- Healthy Environmental Resourceful Appropriate Competent Effective Yardstick
- Was coined to offer a definition in place of Sustainable with an emphasis on Environmental

Background:

- Mainstream construction industry's perception of 'green' and its consequent efforts seem to be predominantly focussed on main energy substitution by renewable energy and/or renewable heat otherwise know as 'eco-bling' (incentivised by government refunds) or energy saving by insulation.
- Whilst these are significant issues, they are by no means the only ones,
- insulation is the most important and least visible, least 'sexy'
  - (lower energy demand and depending on fuel chosen, lower carbon)
- renewables are the most visible and least important
  - (until financial grants come into play)
  - (lower carbon, lower resource consumption)

Eco-bling includes:

- In many cases they do not make sense unless joined up with other systems
- Solar Panels
  - Solar Thermal Hot water
- Solar Thermal
  - Under-floor heating via inter-seasonal storage;
  - energy arrives at the wrong end of the year
- Photo Voltaic
  - into low voltage circuit and appliances
  - or into dispersed generation grid
- Photo Voltaic & Thermal
  - Combined heat and power
- Rooftop wind turbines
  - into low voltage circuit via batteries
  - electric car
  - Dispersed generation grid

Other systems

- make some sense in new build and sometimes less sense in retrofit:
- Autonomous sewage
  - avoid bringing water back into house and
  - avoid getting back to potable quality
- Grey water recycling
  - bath and basin water
  - irrigating soft landscape
- Rainwater harvesting
  - irrigating landscape, washing cars, flushing toilets, clothes washing machines
- Ground source heat pumps in permeable pavement sub-base and rainwater runoff from warm roofs
  - acting as a solar panel
  - recycled sub-base
  - bacteria living in sub-base cleaning water

Briefing process:

- Whilst the following shows the state of non-engagement in the industry and the governance that drives it
- It lists many schemes and standards that can be adopted into project briefs
  - to help your clients achieve sensible buildings to occupy and/or run their businesses from
- If you client does not ask, then you should be driving your client as far as they permit
- And better still doing what they need to do without their knowledge and within their budget
  - Make these schemes part of your agenda
  - and make it what you do normally,
  - and improve on them when you can

Environmental Assessment Methods

- Mainstream has begrudgingly and superficially engaged with environmental design, specification and construction; driven initially and predominantly by initially voluntary or increasingly development control enforced:
- Environmental Assessment Methods (EAM) mainly created by Building Research Establishment (BRE)
  - EcoHomes (now only Scotland)
  - Code for Sustainable Homes (CfSH)
    - Code 6 and industry response
    - One up man ship (BRE Innovation Park)
    - £1m investment to demonstrate Incompetence reigned
    - (now abandoned, dispersed to other regulations)
  - BRE's EAM (BREEAM); for many different building types
    - (Office, Retail Sheds, Sports (London 2012), others)

Other EAM

- Defence Related EAM (DREAM),
  - Industrial shed, Office, Single, multiple occupancy or family Residential, (SLAM)
- Civil Engineering EAM (CEEQUAL)
  - (Now BREEAM Infrastructure)
- Health building EAM
  - NEET now BREEAM Health
- Most reinforced by reference to BRE's Green Guide to Specification (GGtS). (more about GGtS later).

Other specific issues:

- Ska Fitout and Refit (Office, Retail, new and better: Higher Education)
- Biodiversity for Building (BCT)
- SPEAR (Arup's own)
- Other inter/national schemes:
  - GreenStar (Aus), LEED (USA), etc.
- WELL (USA Health and Wellbeing)
- One Planet Living: 10 issues

Missing Targets?

- Efforts to drive down building energy demands are focused on by:
- England and Wales: Building Regulation Approved Document L (BRADL)
  - None yet aimed at meeting global targets
  - Code for Sustainable Homes higher targets allegedly decanted to Building Regulations.
  - Zero Carbon target recently dropped by government,
  - Zero Carbon Hub funding dropped
  - See Zero Carbon Hub publications
- Scottish: Technical Standards

Voluntary/Enforced EAM

- (more about EAM before and later)
- Code for sustainable Homes Code 1 (useless) to 6 (Zero carbon target) is now dropped

Pushing harder: energy standards

- Initially voluntary and increasingly development-control required,
  - (New-build and refurbishment)
- Passivhaus (Germany) for new-build
- Association of Environment Conscious Building (AECB)'s CarbonLite.
  - (Passivhaus for UK climate & energy mix)
- EnerPHit (Germany)
  - Passivhaus for retrofit
- AECB's CarbonLite Retrofit
  - for UK climate and energy mix

Other national and international schemes:

- Canada's Super E, preceeded Passivhaus but tangled with timber building supply)
- Switerland's Minergie's 4 schemes (with eco options)
- Austria book of 130 Passivhaus complient construction
  - 130 eco versions

Pareto's Principle – The 80-20 Rule

- 20% of your efforts achieve 80% of your results the last 20% need 80% effort
- Striving for 100% reduction in energy demand is very difficult
- Replacing Zero as a target with Low (Say 80%) is achievable with the industry we have
- We may have skills training but care is either missing or not permitted by fiduciary rules

Compliance Schemes:

- SAP Standard Assessment Procedure
- Carbonlite demonstrated that this tool is inadequate for low energy building, it continues to be revised.
- TSB Retrofit programme project teams found it is pretty poor at modeling anything other than simple new build, without extensions, solar spaces, porches, attic and roof level insulation, without making sense.
- SBEM for non-domestic buildings when it was launched the M&E Professionals challenged its competency until to was rewritten until it made sense.
- PHPP Passivhaus Planning Package UK Governments TSB encouraged its use to judge it as an alternative to SAP
- DSM, Dynamic Simulation Model,
- IES VE software (used to write the Building Regulation but government were questioned, why a private company? Reaction gave it to another private company BRE

GBE Whole building Calculators

- Calculators: Areas, Temperatures, U values, Energy demand, elemental %, fuel choice, Carbon

Performance Gap

- Improved U values combined with very poor and stagnant airtightness targets, results in buildings that fail in the 'performance gap' between design and implementation; caused by:
- College knowledge
- Lack of understanding
- Poor detailing
- Weak specification
- Skills but lack of care
- Inevitable inadequate construction;

Leading to:

- cold, drafts, thermal by-pass and uncomfortable buildings
  - bio-based building materials are often dense and can achieve improved airtightness without membranes
- thermal bridges, interstitial condensation, rot and structural failure
- Bio-based materials with hygroscopicity offer moisture management that can enable recovery from poor conditions or poor construction.
- Bio-based air-tightness membranes can let the building breath and lose any interstitial condensation

Design Approaches

- Fabric-First, Service-Last
- Thermal Insulation: Conductivity, Convection, Radiation, Wind wash
- Thermal Bridge > Thermal Break / Thermal Flanking > Thermal insulation
- Passive v Active
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Wind & Air tightness: Built Tight Ventilate Right

- Some of mainstream are creating buildings with better U values and better airtightness but without providing adequate dedicated purposeful ventilation, resulting in two potential issues:
- Condensation activating ever present spores into mould with potential for asthma, toxic mould, unusable buildings and risk of death
- Bio-based materials with hygroscopicity offer moisture management that can enable recovery from poor conditions.
- Unhealthy materials and finishes, off-gassing into the building, affecting occupant's health with some serious consequences
  - Biobased materials can avoid many of these issues, whilst plant based solvents have similar issues, which other plant extracts can avoid.

Winter heat loss v Summer heat gain

- Building Regulation Approved Document L (BRADL) is preoccupied with U values resisting winter heat loss and fails to engagement with decrement delay of summer solar radiation heat gains.
- This missed opportunity results in 20% of UK housing and many other buildings suffering from overheating.
- The industry's preoccupation with thinness of construction and fiduciary rules (obligation to make a profit for shareholders) means it uses the thinner (petro-chemical) and/or cheapest (synthetic-bound mineral fibre) insulation materials in inappropriate locations where they fail to protect from and exacerbate overheating.
- Both of there materials let solar heat in and reduce conduction heat flow getting out, leading to overheating, poor wellbeing in occupants and in extreme, but not unfamiliar conditions, to their death.
- Bio-based materials benefit from decrement-delay characteristics that address summer overheating whilst their thermal resistivity addresses winter cooling.

Refurbishment Failed & Abandoned Schemes

- UK's GreenDeal (Energy Focussed Domestic Refurbishment) and Energy Company Obligation (ECO) have been carrying out whole house external insulation to reduce heating demands, in tens of thousands of houses.
- There are examples of blatantly ignoring thermal bridges created at services interfaces, perimeters and abutments.
- These will inevitably lead to water penetration, surface or interstitial condensation and mould and subsequent ill-health of occupants.
- Bio-based materials with hygroscopicity offer moisture management that can enable recovery from such poor conditions.
- Historic fabric which is characterised by porous materials and moisture permeable construction including solid masonry walls need moisture transport, hygroscopicity and breathing insulation/cladding/lining systems to avoid the risk of rot, frost damage and mould.
- Bio-based materials have these characteristics in abundance.

BRE Green v Green Green

- BRE also contributes to failures by 'forcing' designers to specify methods of construction using conventional materials from those listed in GGIS.
- GGtS uses Life Cycle Assessment (LCA) as its criteria for Greenness.
- GGtS also openly ignores important alternatives including bio-based materials and methods of construction.
- The consequence is high embodied energy and embodied carbon new additions to the housing and other building stock.
- Bio-based materials sequester carbon dioxide during growth and after manufacturing processing these materials remain carbon negative and enable carbon negative building in construction.
- Bio-based insulation materials offer low embodied energy and carbon in manufacturer as well as low energy and potentially low carbon buildings in use, most other materials cannot claim both.

½ W 2 L > Unhealthy Products

- Recent drives to reduce waste to landfill, mean a lot of materials are recycled into new products, reclaimable and waste wood turned into wood panel products bound together with synthetic petro-chemical binders or adhesives.
- Manufacturers are persistently required to respond to requests for cheaper goods.
- They inevitably resort to strong chemicals to deliver cheap competent materials.
- These new cheap goods often off-gas solvents or Volatile Organic Compounds (VOCs) into the surrounding air leading to indoor air quality (IAQ) issues.
- Combine that with airtightness and poor ventilation this leads to very unhealthy conditions and ill-health.
- Bio-based materials can avoid many of these issues.
- Whilst plant based solvents do have similar issues, bio-based extracts can avoid more of these issues whilst bonding ingredients.

MMC reduces waste allegedly

- Current preoccupation with Modern Methods of Construction (MMC) are seen to solve one of the housing problems in the UK: 'demand outstrips supply' which results in prices of new homes being driven up
- This issue will not be solved unless developers are willing to drop their insistence on high profit margins and their reluctance to build until the demand is high and profits maintained

Offsite prefabrication is seen as a means to:

- Build fast on site, (plus corresponding manufacturing time in the factory)
- Build more punctually on site, despite the weather
- Manufacture more reliably, competently and assemble more simply on site (but rarely cheaper)
- Build with less waste on site
  - Assuming it has been designed to minimise waste, acknowledging the size of stuff
  - Assuming the factory is also run on lean, waste-free principles

Timber is an obvious choice for 'cut-on-site' but also for MMC in a variety of technologies:

- Light timber frame (LTF) including: Insulated Structural Panel Systems (ISPS)
- Structural Insulation Panel Systems (SIPS)
- Solid Wood Systems (SWS) including: Cross laminated Timber Panel (CLTP)

MMC is seen as a faster method of construction

- CLTP is now often Value Engineered (VE) into projects replacing concrete high-rise structures
  - Site overheads can be significantly reduced with rapid construction systems
- SIPS manufacturers often VE their panels into projects for rapid assembly on site

Innovative Methods of Construction (IMC)

- are a departure from MMC and can originate from any source
- Straw and other thatch have historic origins but have recently been used in a panelised rainscreen application
- Turf roofs reinvented as part of living roofs (green or brown, intensive or extensive)
- Green walls are living planted walls often as a rainscreen cladding
- Green walls as climbers growing up offset wire systems
- Gabion walls filled with wooden logs, cut branches and twigs, creating spaces in the interstices and inside hollow cores creating habitat for numerous sized wild life species
- Extensive research is on-going in the world of fungi as a potential source of a replacement for plastic insulation used for packaging, protection and thermal insulation as well as a replacement for timber based building boards
- Algae have for some time been researched as an energy source and potential source for other outputs.

Framed Systems

- are increasingly being explored which can readily replace concrete, steel or hardwood
- Glued laminated timber (GLT)
- Laminated Veneer Lumber (LVL)
- Composite sections are used extensively:
  - Offering lightweight, man-handle-ability, versatility, services accommodation,
  - Using: Softwood, LVL, timber panel product webs, metal web components
  - Composite sections cut from round wood

Build-Light, Insulate-Right, Solar-Tight

- A criticism laid at lightweight timber framed construction is that they can readily overheat
- Without masonry wall solar protection; additional heat can present itself
- With the right thermal insulation materials and sometimes a combination of materials
  - Summer Solar heat gains can be prevented from entering
  - And then not have to worry about removing it
  - Bio-based materials have the Decrement Delay & Resistivity characteristics needed to solve this
- In contrast MMC using plastic insulation for high performance and thinness do not solve this problem
  - Plastic insulation some of which are not moisture permeable create barriers to moisture transfer through walls, floors and roofs, the only way out for moisture vapour is through timber framing which then becomes vulnerable to failure

Resource Efficiency Next week

Feedback

- These files are created by generalists with a big dollop of green flavour
- These files are updated from time to time
- We are not experts so from time to time these file may get out of date or may be wrong.
- If you feel that we have got it wrong please let us know so we can put it right

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