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# Surveys, Tests, Analysis, Audits Evaluations

# Refurbishment: Surveys

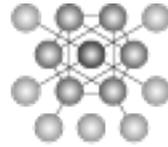
- Before attempting to do anything to a building
- You need to know what you have and how it works
  - Geography, Geology, Landscape, Biodiversity
  - Historic & Recent Surveys
  - Site and building surveys,
    - Physical Measured Survey, scanned 3D surveys
  - State of Repair surveys
    - Pre-demolition/Pre-refurbishment audits
  - Services tests
  - Infra-red survey before and after
  - Airtightness test before and after
  - Acoustic test

# **New Build: Surveys**

- **Before designing any building**
- **You need to know your site, any existing building on it and resources found there**
  - **Geography, Geology, Sky, Weather, Ground Water, Landscape, Biodiversity**
  - **Historic & Recent Surveys**
  - **Site and building surveys, Physical Measured Survey, scanned 3D surveys**
  - **Site Services tests**



# GBE



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# Geography

- **Height above:**
  - sea levels, river level, tidal river levels, flood plains
- **Exposure, surrounding topography**
  - Atmospheric pollution maps:
    - See: Galvanizer's Association: Millennium Map
- **Sloping or flat**
  - Rain catchment areas,
  - ground water movement: risk of removing stored heat
- **Plot or building relative to pavement and road**
  - Room for outbuildings: porches, conservatories, fuel stores



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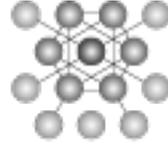


# Sky

- **Horizon**
  - Site at or above, (exceptionally below) sea level
- **Views**
  - To exploit
  - Or surrounded by buildings or trees & bushes
- **Solar access**
  - Shading by land masses, landscape, trees, hedgerows, clouds (persistent over rises)
  - Overshadowing by other buildings,
- **Overshadowing of other sites by this site/building**



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# Weather

- **Prevailing wind**
  - direction and strength
  - Shielding by buildings, landscape, trees
  - Wind pressure and buffeting, eddy currents
- **Precipitation: Rain, hail, snow,**
  - Wind driven rain index, permeable material penetration
  - Flood potential,
  - Frozen snow thawing on roofs overwhelm outlet/upstands
- **Humidity pockets: Mists and Fog**
  - Affect paints, stains and weatherboarding
  - Potential mould
- **Cold pockets or cold channels**
  - Mist, fog or condensation
- **Sun**
  - Drying action
  - Sunlight
  - Solar heat gains



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# Prevailing wind

- **UK: Usually from south west from Atlantic or via Ireland and Irish Sea**
  - UK Winter: from north or east
  - Usually moisture laden
- **Wind driven rain Index BRE Digest**
  - Wind rose
- **Local wind modified by geography, landscape and other buildings**
- **Own building modifies surrounding wind conditions by eddy currents and concentrations**
- **Internal +ve and –ve pressures caused by external wind**
  - Effect on external envelop
- **Internal wind pressure & buffeting causes rattling/slamming doors, loft hatch lifting, ceiling tiles lift**
- **Potential to drive active ventilation systems**



# Landscape

- **Trees & Hedgerows**
  - **Coniferous (shading all year)**
  - **deciduous (solar shading in summer, solar access in winter)**
  - **Zone of influence:**
    - wind, sun, light, shade, shelter, biodiversity, rain, humidity, coolth
    - pollen, fruit, berries, seeds, leaves, sap
    - Roots drying moisture sensitive soils, uprooting pavements
  - **Tree Protection Order (TPO)**
    - Old age or groups, can be applied for by public
- **Hedgerow**
  - bat flight navigation paths, bird and animal green grids, bird and animal habitation
- **Grasses, Plants and Shrubs**
  - **Turf: Wild turf, grass for compost, turf for loam,**
  - **Plants and shrubs: for compost,**
- **Reclaim, stockpile, keep healthy and reuse**



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# Survey: Legal

- **Site boundary**
  - Boundary maintenance obligations
  - Shared drain maintenance obligations
    - Shifted to LA or Utility maintenance responsibility
  - Landlord/tenant boundary/responsibility
- **Rights of way**
- **Right of light**
- **Protected views**
  - Lay lines
- **Ancient rights**
- **Way leaves**
  - Over head cable and maintenance zones
  - Underground, under pavement cables
- **Covenants: obligations on occupier/owner**
- **CPO Compulsory Purchase Orders**
- **Adopted or not adopted roads**



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# Surveys Financial

- **Utility Bills**
  - Energy
  - Fuel
  - Water
  - Calculate consumption
- **Compare with:**
  - Whole building heat losses
  - Whole building heat gains



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# Surveys Energy

- **EPCs Energy Performance Certificates**
- **DECs Display Energy Certificates**
- **Take care they may be worse than useless**
- **They can be obtained on-line**
- **Could be based on satellite imagery of the site**
- **They can be based on kerbside surveys by google maps street view like surveys**
- **with little or no attempt to really understand the truth**

# GreenDeal Assessments

- Take care can be worthless
- Tick box exercise with photographic evidence that they were there
- Little or no intelligence needed
- Inadequate training
- Compromise possible/inevitable
- As bad as EPC
- Probably worse



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# Biodiversity: Site

- **Bats & Birds**
  - Flight paths
  - Food sources, Trees pollen, fruit, nuts, hedgerows, plants, flowers,
  - Nesting seasons: avoid disturbance
  - Potential inhabitants of building
  - Light sources, vulnerability to predation, disturb time of emergence
- **Insects: everywhere**
  - Exclude them or welcome them?
  - Exclude some: discourage, prevent or kill others? 17



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# Historic Surveys

- **RCHME Royal Commission for Historic Monuments of England in Swindon became part of English Heritage in 1999**
- **(equivalents in Scotland and Wales)**
  - 1 of 6 planning applications goes to them
  - They are the keeper of the List
    - Listed buildings (450,000 in England)
  - History of individual buildings
  - Conservation Areas
  - Social & Economic History of communities and areas
  - Ariel Photography surveys
  - Map collections
  - Send Address/postcode
    - they return list of information available
  - Selective Restoration:
    - Advice on what date to go back to
  - All on-line now <http://www.englishheritagearchives.org.uk>



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# T&C Planning

- Recorded information at Town Hall**
- Is it in a Conservation Areas**
- Is the building Listed?**
  - Listed buildings (450,000 in England)
  - Limitations on alterations
- Covenants**
- Boundary Condition restrictions**
- Building Use, Occupancy levels**
- Advertising & Signs**
- Trees and TPOs**



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# Building Control

- Recorded information at Town Hall
- Building Use, Occupancy levels
- Boundary Condition restrictions
- Increasingly on-line
- Capacity to be altered
  - Foundation load bearing capacity
  - Air rights buildings Victoria Plaza I & II
  - To add weight we had to remove weight



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# Archaeology

- **Historic Buildings are often in historic land full of archaeology**
  - Something the ground may be historic and the building not and visa versa
- **Religious land**
  - Hallowed ground
  - Church yards
  - Burial grounds
    - Black Death pits, some diseases persist
  - Cemeteries

# Old & Recent Maps, Surveys & Drawings

- **Ordinance Survey**
  - Current Maps
  - Historic Maps (ask client's family to investigate)
- **Local Library**
  - Historic Maps
  - Local Social History
- **Environment Agency**
  - Flood Risk maps
  - Pollution hot spots
  - UXB: Unexploded bomb maps
- **T&CP and Building Control**
  - Deposited plans, conversion to digital: inconsistent
- **Public utilities: buried services: unreliable**
- **Prior use and pollution potential**
  - Milk, ink: corrosive to concrete; Gas production: Pollution

# Land/Letting/Estate Agents

- **Assess property values**
  - Don't over improve a building if its value cannot be realised
- **Determine what is in demand**
  - Proposals to meet the demand
- **Determine sites for temporary planning permission for logistics/consolidation centres: materials in, waste out**
- **Interreg SEEDS project on temporary use**

# Refurbishment: Above Ground Surveys

- **Boundary definitions**
  - Proximity of public footpaths to buildings
- **Building footprint**
  - & Out buildings
- **Hard, soft and wet landscape,**
  - Ground levels and falls
- **Streetlights & Street furniture**
- **Overhead cables: Passing or attaching, rail catenaries**
- **Street & Traffic signs**
  - attached to buildings and boundaries to be retained or re-established
- **Flood lines:**
  - **Historic and recent**
- **OS datum marks**
  - Not to be destroyed or covered

# **New Build: Above Ground Surveys**

- **Boundary definitions**
  - Proximity of public footpaths to site
- **Hard, soft and wet landscape,**
  - Ground levels and falls
- **Streetlights & Street furniture**
- **Overhead cables: Passing or attaching, rail catenaries**
- **Street & Traffic signs**
  - attached to buildings and boundaries to be retained or re-established
- **Flood lines:**
  - Historic and recent, in vicinity of site
- **OS datum marks**
  - Not to be destroyed or covered

# Below Ground Survey: Brownfield

- **Archaeology:**
  - Potential to delay project
  - Potential to influence design
- **Brownfield**
  - Slabs, thicknesses, areas
  - Foundations: Layout, types, dimensions, depths
  - Basements
  - Buried services, chambers or culverts
  - Backfill: pollutants, gasses and chemicals
- **Suitability for reuse insitu**
  - Transfer slabs?
- **Suitability for recycling**
- **Quantities & cost of arisings disposal**
  - Inert, mixed, hazardous

# Below Ground Surveys: Geology

- **Topsoil**
  - Thickness, (stockpile, keep it healthy and reuse it)
- **Sub-soils, sand, gravel and rock**
  - Types: Layers, thickness, levels, depth, slopes
  - Value Engineering
    - Impact on drilling for GSHP
    - Likely arisings
    - Consider GSHP whilst SI drilling rig is present
    - Avoid basements in areas of stone
- **Pollutants:**
  - Ground gases: Radon (radio active gas from rock)
  - backfill: Methane, Acid Rain gasses
  - oil spills/drips, petrochemicals, hydro-carbons

# Below Ground Survey: Ground water

- **Water table**
  - seasonal: take note
  - **Springs, aquifers**
    - requires special care with material choices, treatments
    - Bluewater retail and leisure, care with material and run off
    - Historic map surveys
  - Ground water movement, direction, speed
  - Buoyancy for buried tanks and basements
- **Percolation/storage potential/capacity**
  - Filter drains
  - Soakaways
  - Permeable pavement
- **Water Bodies**
  - Ponds, Lakes,
  - Rivers, streams,

# Surface Survey: Water

- **Green Infrastructure: Blue Ribbons**
- **Historic rivers:**
  - Culverts
- **Canals & Tunnels**
- **Water Bodies**
  - Ponds, Lakes,
- **Water courses**
  - Rivers, streams,
  - Diverted, sluices
- **Flood plains**
- **Wetlands**
  - Bogs
- **SUDS Sustainable Urban Drainage Systems**
  - Green Roofs, Permeable Pavement (percolate or capture), Swales, Settlement Ponds, Rain Gardens Rainwater harvesting

# Below Ground Survey: Services

- **Surveys:**
  - Infrared, radar, sonar/echo/acoustic, divining, cctv in pipes
  - Recording: Hieroglyphics paint spray
- **Below ground infrastructure**
  - Finding space for harvesting and treatment kit
- **Surface inspection plates and access covers**
  - to below ground chambers, stopcocks and meters
  - Normally at changes of direction
  - below ground drain routes between chambers and to sewer connection,
  - Lift covers and determine invert levels, (take care: Methane)
  - Services routes into building, out to chambers and beyond
- **Above ground control or connection boxes**
  - Utility services and signs attached to buildings/boundaries

# **Physical Survey: Hazards: Existing Building**

- **Surveys of empty buildings:**
  - never one person unless procedures in place to check for non-returners
  - and rescue within a reasonable period
- **Unprotected holes in floors: risk of falls**
- **Unlit spaces: all risks possible**
- **Unstable walls and inadequate floors and roof structure: Risk of collapse**

# Physical Survey: Hazards: Existing Content

- **Sharps:**
  - recreational drugs paraphernalia: needles and blades
  - deliberate placement with intent to harm
  - In places where hands go instinctively:
    - handrails, window boards, ironmongery
- **Mould and rot, spores: respiratory risks: can be fatal**
- **Asbestos: long term effect**
- **Hazardous historic paints**
- **Birds, Rats: live and dead, droppings**
  - Droppings if extensive: off-gassing: can be fatal
- **Dried up water seals: Sewer gas: Explosive potential**
- **Leaking pipes: Gas: Explosive potential, avoid sparks**



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# Lead Paint Test

- Free test service
- Lead Paint Safety Association
- Anyone living or working in the UK
- Dust wipes used for sampling disturbed paint dust
- on any surface:
  - tools, floors, skin, protection equipment

18/02/16 • [www.lispa.or.uk](http://www.lispa.or.uk)

# Paint build up survey

- A simple test to investigate paint build up is to run a sharp blade edge at right angles to the surface,
- Work back and forth until layers of paint are revealed one at a time
- Lead paint is not obvious
- Red lead primers were commonplace
- dark green layer may indicate arsenic recipe paint or primer (poison)

# Physical Survey: Existing Building

- **Physical measured survey of:**
  - Building fabric, cavities, thermal bridges,
  - Internal: borrowed lights, ironmongery (self closing?),
  - Materials, thicknesses, profiles, sizes, cavities, voids and connectivity
  - Furniture, fixtures, fittings, staircases (immovable?)
  - Existing insulation: materials, thicknesses, extent, age and state of repair, thermal bridges
  - Ground floor: Construction, ventilation
  - Airbricks
  - Windows, doors, rooflights,
  - Basements: construction, ventilation, damp, services, drains
  - Flood damage: damp, mould, rot, erosion
  - Roof valley and parapet gutters, sumps, hoppers: debris

# Physical Survey: Existing Building Details

- **Archaeology in the building fabric**
  - Reading history from elevations and plans
- **Any details that need to be repaired or recreated**
- **Detail profiles**
  - Plaster mouldings
  - Timber mouldings
  - Stone mouldings
  - Brick mouldings
- **Any details that are valuable and might go missing during the works**
  - Architectural Salvage: Theft Alerts



# Physical Survey: Repairs of Defects

- Previous repairs can reveal previous defects
- If the house is old, it will probably come with alterations and works that have addressed particular defects
- e.g. damp, draughts, leaks, etc.
- These defects are a useful guide to how the building has performed in the past and will guide the designer to address the particular issues that are unique to the building as part of the refurbishment process

# Archaeological Building Survey

- **Archaeologist carried out survey**
  - Drew every brick, stone, slate, timber
  - Timbers even shows centre of tree rings
  - Accurate profiles for reproduction
- **Additional fee: (if you don't ask.....)**
  - Advised on what to keep, repair, replace;
  - how and potential sources
- **Mortar analysis**
  - Strengths, constituents
  - Advised on recipe for repairs,
  - Advised on sources of sand and lime



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# Historic Graffiti

- Recent revelation in past few years
- A study of internal surfaces of historic buildings: churches for example
- Graffiti scratched in plaster and stone as old as the buildings
- Now preserved as historic social commentary

# Physical Survey: Building Structure

- **Visible structural elements**
  - Deflection, compression, creep,
- **Invisible structure: non destructive test**
  - Bounce or spring in floor, leaning on partitions, vibrations, rolling ball test
  - Rebar detection devices
- **Exposed structure**
  - Assessment of size to load
  - Inspect for defects, notches in timber, etc.
- **Consider for reuse, reuse in new works**

# Scanned 3D Survey

- Developed on Retrofit for a Future
- 3D scanner placed in middle of room
- 3D scan, imported to 3D CAD model
- Determine high and low points in plains
- Determine setting out point for dry linings
- Design linings (don't create cavities from solid walls)
- Data feed to CAD CAM manufacturing
  - Workshop in a shipping container on a lorry
- Panels cut to accurate size
- Room fit out in 90 minutes

# CSI Crime Scene Investigation

- **Conservation Officer put off most wealthy prospective purchasers with onerous conditions on development**
- **They give up and the building rots for another decade before somebody incredibly wealthy comes along who can pay the now considerably higher costs of repairs**

# Physical surveys: Existing Building Services

- Services, boilers, fires, tanks, cylinders
- appliances, types, ratings, capacities
- Radiators, sizes, locations, valves,
- All pipe routes, flues, penetrations, insulation & housings,
  - including redundant pipes, ducts. Etc.
    - Heat loss potential
- air bricks, pipes
- Penetrations into/through insulation zone:
  - heat losses
    - Meter cupboards & Fire places

# Local Resource Surveys

- **Existing empty redundant buildings**
  - Potential reuse with new purpose
  - Potential source of end of life, reclaimable materials, or recycled materials
- **Potential site for new buildings**
  - Potential in-site resources
- **Potential materials**
  - Surplus to requirements:
    - Materials Exchanges
  - Recycled, Secondary or manufactured materials
  - Salvage Reclamation yards
  - Plantations
  - Remanufacturers & Manufacturers
- **Create a local website for others to add to**
- **Interreg Cradle to Cradle Network**
  - identified numerous in mainland Europe
  - One architect does one for every project



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# UEA RPS



- **Architectural Competition winning team entry**
- **Norwich Norfolk East Anglia Biobased and Green materials products database**



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# Audits

# Energy Audit: Existing Building

- Different seasons is useful
- Gas, electric and water separately
- Over a week including working and non working hours or days
- Check meters morning and evening each day for 5 days including Friday and Monday
- See consumption spread: e.g.
  - 50% working hours, 50% not working hours
  - 20% weekend
  - 30% server

# **Carbon Audit: Existing Building**

- **Analyse the Energy Consumption**
- **Consider the types or fuel used for:**
  - heating, ventilation, cooling, cooking, water heating, power, appliances, etc.
- **Consider the carbon content of the fuel**
  - Consider swapping to alternative fuels:
  - grid electricity > green tariff electricity > site made renewable electricity: wind, PV
  - Electric heating > gas heating > renewable heat: Solar thermal, G/A/WSHP

# Water Audit: Existing Building

- Mains water connection, pressure & consumption
- Water extraction
- Water saving measures
- Water storage, distribution and insulation
- Water heating fuel, methods and installations
- Rainwater collection & reuse measures
- Permeable pavement collection storage or ground water table top up
- Ground water table, movement, collection and extraction
- Ground water temperature and thermal pollution risks
- Historic and current ponds, aquifers, springs
- Soluble salts in water or soil
- Mains sewer connection
- Autonomous drainage/sewerage

# Pre-Demolition Audit

- Demolition Protocol
- ICE and EnviroCentre
- Pre-Demolition Audit
- Bill of Pre-Demolition Quantities
  - Materials
  - Quantities
  - State of repair

# Reclamation Audit

- **Salvo: Architectural Salvage Sector**
- **Crafted materials**
  - Potential for reuse
  - Antique value
  - Reclamation value
  - Ease of reclamation
  - Resale value

# Existing Pre-demolition, Pre-refurbishment, Pre-alteration Audits

- **Methods of construction**
  - Materials used
  - Extent, quantities, quality, description
  - Avoid carbonated or sulphate attacked concrete and repairs
- **State of repair**
  - Reclaim/Reuse ability
  - Frost damage, Rot (wet and dry rot)
  - Flood damage, moisture vulnerable materials
- **Bill of Pre-demolition/alteration quantities**
  - Determine reuse on site quantities
- **Material exchange:**
  - excess to requirements to others for reuse off-site



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# Evaluations

# Post Occupancy Evaluation: Newly Built

- **'Soft' attributes**
  - Ventilation
  - Temperature
  - Lighting
  - Noise Levels
  - Effects on Productivity
  - Effects on Health
  - Building Design
  - Overall Satisfaction
- **'Hard' attributes**
  - Energy Consumption
  - CO2 Emissions
  - Sustainability Measures
- **Feedback loops**
  - Wish lists
  - Briefing tools
  - Templates

# **POE: Newly Built Inhabitants: Human**

- **Post Occupancy Evaluation (in new build)**
  - Heating and ventilation habits
  - Water use habits
  - Perception of building's problems
  - Perception of building's good points
- **Tap into specialist skills to see solutions**
  - Collective knowledge brought to bear on problems
  - Potential solutions: they are closest to them
  - Make them part of the briefing process
- **Utility Bills to judge the real costs**
- **Knowledge of local history**
  - Flood history

# POE: Newly Built Inhabitants: Nature

- **Where?**
  - Roof voids
  - Eaves
  - Cladding
  - Under raised buildings
- **Bats, Birds, Bees, Wasps,**
  - £5000/bat fines for disturbance
  - If they can get in heat can get out
  - Very careful interventions
  - No change, mitigation or adaptation
- **Insects: everywhere e.g. Ants (avoid termites)**
  - If they can get in/out heat/cold can get out/in too

# Existing or New: EPC and DEC

- **Energy Performance Certificate**
  - Based on SAP or SBEM
- **Display Energy Certificate**
- **Improvement Measures Report**
- **View with a large dose of scepticism**
  - Especially house EPCs
  - Who did the survey?
  - What level of competence?
  - What level of guesswork?
  - What assumptions?

# Existing Building: Intra-Red Surveys

- Test Heating system and controls
- Survey for anomalies
  - Hot spots from outside
  - Cold spots from inside
  - Warm nests from inside
    - (usually over hot spots: boilers, un insulated cylinders)
  - Air Vents: venting, blockages and leaking
  - Services Appliance: functioning
  - Services pipe locations: inadequate insulation & leaks
  - Damp building fabric
  - Condensation risks

# **New-Build: Surveys Intra-Red Thermography**

- **Check Insulation is installed and continuous**
- **Check services are insulated**
- **Check for thermal bridges**
  - Including door and window perimeters
- **Test Heating system and controls**
- **Survey for anomalies**
  - Hot spots from outside
  - Cold spots from inside
  - Air Vents: venting, blockages and leaking
  - Services Appliance: functioning, wear and tear, friction
  - Services pipe locations: air or liquid leaks
  - Damp building fabric
  - Condensation risks



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# Follow up IRT

- Infrared Thermography Survey Anomalies:
- Use moisture meters to determine if anomalies are moisture or other causes
- Non-destructive non-invasive moisture meter readings
- [www.tramexmeters.com](http://www.tramexmeters.com)

# Existing or New: Endoscopic Cavity Surveys

- **Infrared Thermography Survey**  
**Anomalies:**
- **Use Endoscope to look inside any cavities hollow, partially or fully filled**
- **Ensure adequate lighting to observe**
- **Inspect for insulation:**
  - Yes or no
  - Extent/thickness
  - Position and gaps
  - Slumping/cavity bridging
- **Bats and Birds**



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# Current Problem

- **Cambridge University**
  - & Insulation Supplier/installer
  - Walls: cavity v solid, materials, linings, etc.
- **Buildings surveyed, assumptions made**
  - Logistics prepare kit, materials, labour
- **Arrive to carry out work**
  - Assumptions found wanting
- **Have wrong kit, materials, labour**
  - Aborted visit, time wasted,
- **Better surveys to avoid repeats**
  - Better survey kit and analysis software



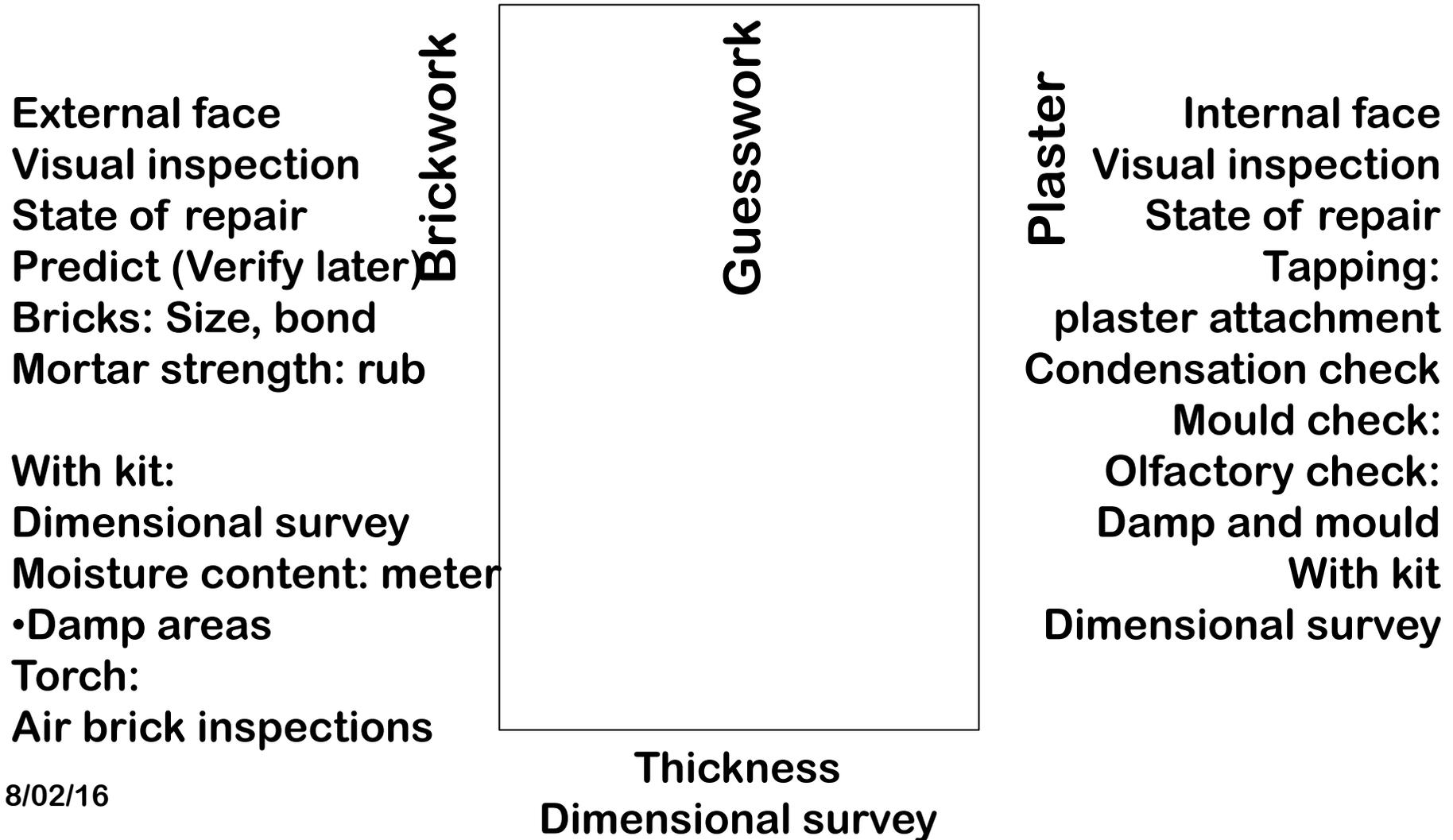
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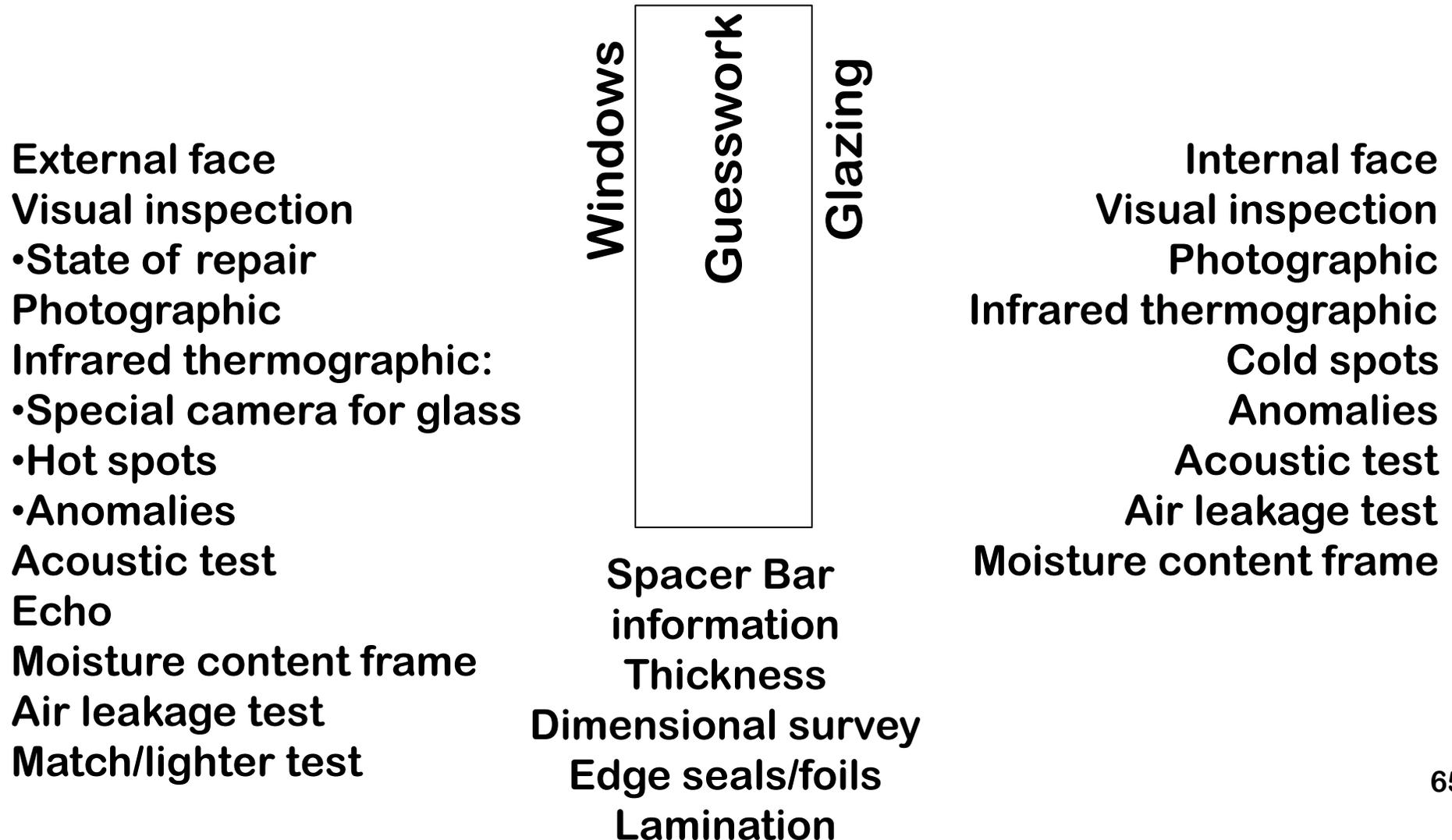
# Current Research

- **Cambridge University & SIG**
- **Attempt to be more accurate with surveys/visual inspections**
- **Develop the tools to do surveys**
  - Non-destructive
  - IR T, X-Ray, Acoustic/Echo, etc.?
- **One piece of kit to do all**
  - accurate analysis

# Visual/Manual Inspection



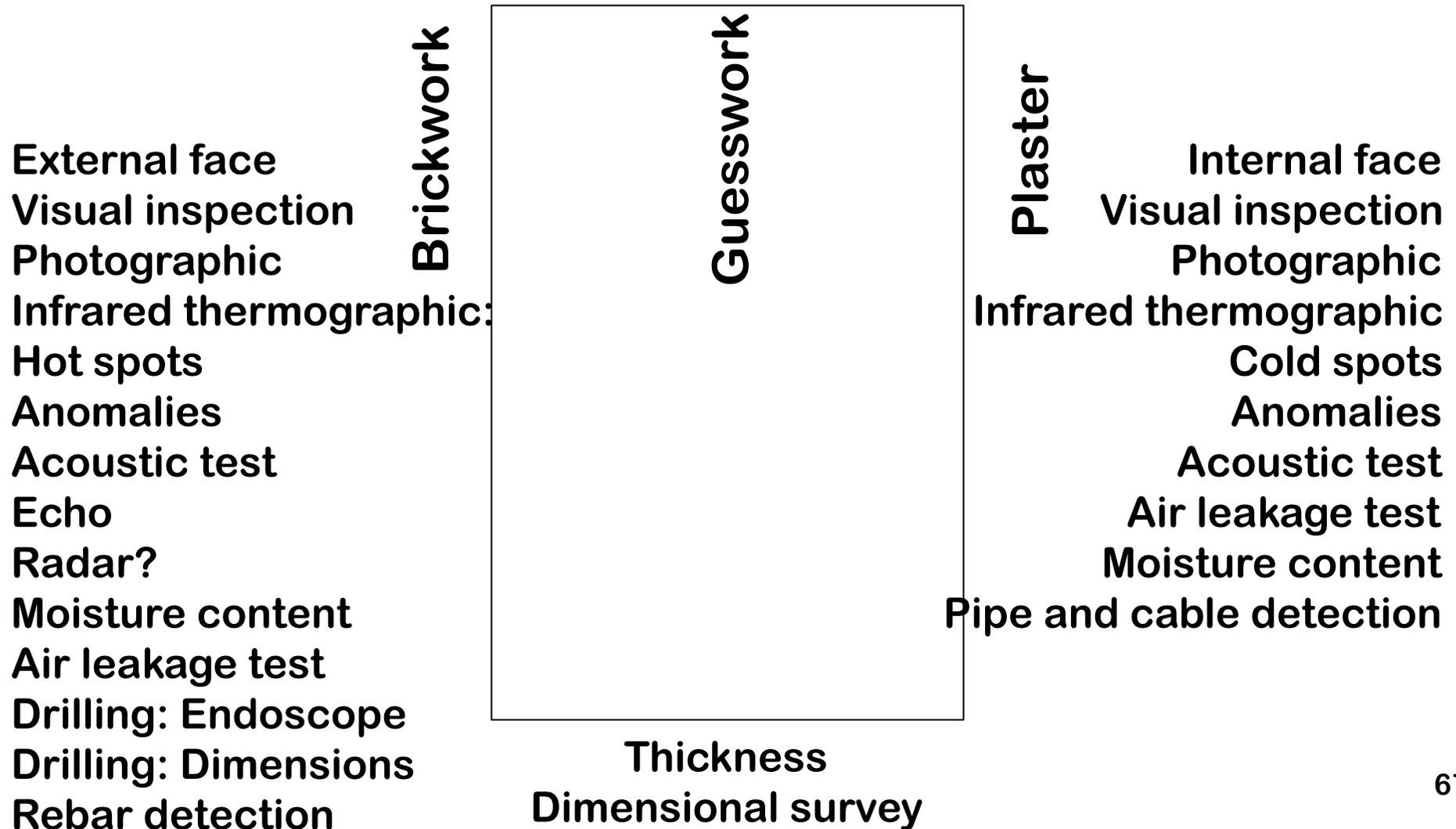
# Equipped test/assessment



# Flame Reflections

- Match or cigarette lighter
- Outside face of glass
- No brightly illuminated reflections
- Darker room internally
- Hold flame close to glass
- See the reflections from each face of each glass pane

# Equipped test/assessment





# Occupied Building Surveys

# Opportunities

- **Competent, accurate, thorough surveys**
- **Testing of existing**
  - Airtightness, IR Thermography
- **Thorough understanding of the existing**
  - Analysis of all survey information
  - Software analysis
- **Design the proposal**
  - Appropriate approach:
    - Methods, materials & technology
- **Whole House Plan: Final state**
  - Phased development or room by room

# **Infra-red survey: occupied buildings**

- **Radiators: cold spots due to sludge build up in bottom of radiator**
- **Radiators on external walls hot spots**
- **Leaky pipe hot spots**
- **Appliances on stand-by**
- **Electrical equipment generally**
- **Machinery state of repair ware and tear**
- **Proactive preventative maintenance**

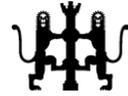
# Stages of reveal

- **Initial view and proposals**
  - Decant People
  - Decant Possessions
- **Remove furniture from walls**
  - Recheck proposals
- **Remove floor and wall finishes**
  - Recheck proposals
- **Remove & modify services**
  - Recheck proposals

# 90 minute Fit-Out

- **TSB Technology Strategy Board**
  - Retrofit for a Future competition entry
- **Project Solution**
  - Space survey: IR Scan > 3D survey
  - 3D CAD model
  - 3D CAD design of linings to fit space
    - & minimise waste from standard boards
  - CAD/CAM file > CAM cutting machine
  - CAM cut to suit panels > Space
  - Fit out room in 90 minutes, no errors

18/02/16 • **All delivered in a shipping container**



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# Tests

# Materials: Thermal Tests

- Not in buildings
- In laboratories
- Hot box test method
- Tests thermal conductivity, heat transfer, through materials
- To determine k value for U values
- Does not engage with Decrement Delay

# Existing & New Build: Airtightness Testing

- **To check**
  - Building fabric
  - Windows, doors
  - Leaks through joints and at perimeter of windows,
  - Services penetrations, etc.
- **To identify and temporarily close**
  - Ventilation: airbricks and louvres
- **To determine air paths**
  - from inside to out and within
  - Services penetrations
- **Carryout smoke wand test to find emergence locations**
  - Not necessarily at external wall
  - Many passages behind linings, skirting, etc.

# Existing & New Build: Post-airtightness tested building

- If there is sealants at every junction:
  - Between internal joinery skirting, door frames, architraves and walls, floors, etc.
  - Around Signs and fixtures, etc.
- The airtightness of the building fabric was not tested (big mistake)
- The airtightness of the finishes was tested, found wanting, sealant used to try to fix it (miles of sealant on show)

# Existing & New Build: Acoustic testing

- **Airtightness test will reveal problems**
  - Air leakage means noise leakage
- **Infra-red testing will reveal problems**
  - Thermal bridges are probably sound paths
- **Night time torch survey with eyes on far side of wall will reveal problems**
  - Ignoring glass, light leaks mean air paths

# Building: Acoustic Tests

- In buildings
- Through External wall
- Between Rooms via partitions
- Between Floors around floor edges
- Between Compartments via walls and floors
- Checking flanking sound around partitions above ceilings and below platform floors

# Materials: Acoustic Tests

- Not in buildings
- In laboratories or in showrooms
- Small model buildings,
- Each model with different insulation materials,
- sound source inside
- Listen to different effect each material has on noise escaping to external

# Fire Tests

- **Never in buildings**
- **In test Laboratories**
- **In test Rigs in test buildings**

# Estate & Letting Agents

- **Always decline to inspect heating and other plant**
- **Offered untested**
- **Buyer beware**
- **Or send in your own services surveyor**
- **If kit is found wanting, negotiate a discount**

# Existing & New Build: Services Test

- **Test Boiler for heating**
  - Run heating for Infra-red test
- **Test radiators for air locks and cold spots**
  - IR survey will spot them
- **Test pipes and drains for leaks blockages**
  - IR survey will pinpoint routes and leaks
- **Test Domestic Hot water**
  - IR will spot uninsulated pipes, valves, etc.
- **Test Water supply at all appliances**
- **Check meters for leaks and residual demands**
- **Test gutters for falls, leaks and outlets for blockages**
- **Test flat roofs for falls, leaks and outlets for blockages, low points for ponding, sediment and plant growth**
- **Test overflows for discharge back towards walls**

# Spark tests

- **In situ test (destructive)**
- **Stainless steel**
- **Grinding wheel**
- **Spark fork pattern reveals grade of stainless steel**
- **Reinforcement testing**

# Moisture and Humidity

- **Damp screeds/concrete floors**
  - before laying moisture vulnerable floor finishes
  - Moisture and Humidity readings
- **Timber moisture content**
- **Invasive/destructive moisture readings:**
  - Two pin moisture meters, push below surface
  - Protimeter
- **Non-invasive non-destructive:**
  - Suitable for historic fabric and visible surfaces
  - [www.thermexmeters.com](http://www.thermexmeters.com)



# Modelling: Physical

# Wind Test: Scale Models

- Wind tunnels e.g. BRE
- Scale models
- Distant: Suburbia modelled texture
- Local: Buildings modelled
- Vicinity: eddy currents around buildings
- Proposed Building: + & - wind loads, eddy currents around and over building

# Large scale: Acoustic Modelling

- Reverberation chamber
- Acoustic absorption chamber
- E.g. BRE

# Thermal Modelling: Analysis of fit-out

- E.g. BRE
- Model interior fit out
- Furniture, People & Computers (heat sources), Ventilation or Air Conditioning (coolth source)
- Effects upon the users, hot legs under desk, cold heads above desks



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# Modelling: Computer

# Energy Modelling

- **BRE SAP Standard Assessment Procedure for domestic building**
  - Building Regulation compliance procedure
  - For new-build not refurbishment
  - Seriously dumb if applied to refurbishment
- **BRE SBEM for non-domestic building**
  - Another BRE tool that took a long time to get working to the professions satisfaction

# Energy Modelling

- **CarbonLite**
  - PHPP for the UK climate and energy mix
- **PHPP Passivhaus Planning Package**
  - Domestic but increasingly non-domestic

# Thermal/Moisture Analysis 1

- U value
- Condensation check (static) BS 5250
- Uses BS EN 13788:2002 data
  - less accurate than BS EN 15026:2007

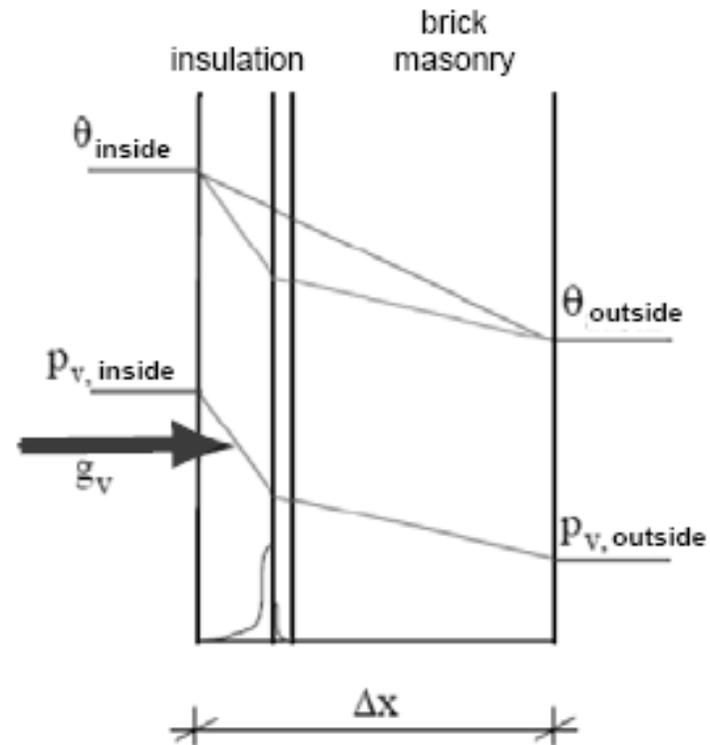
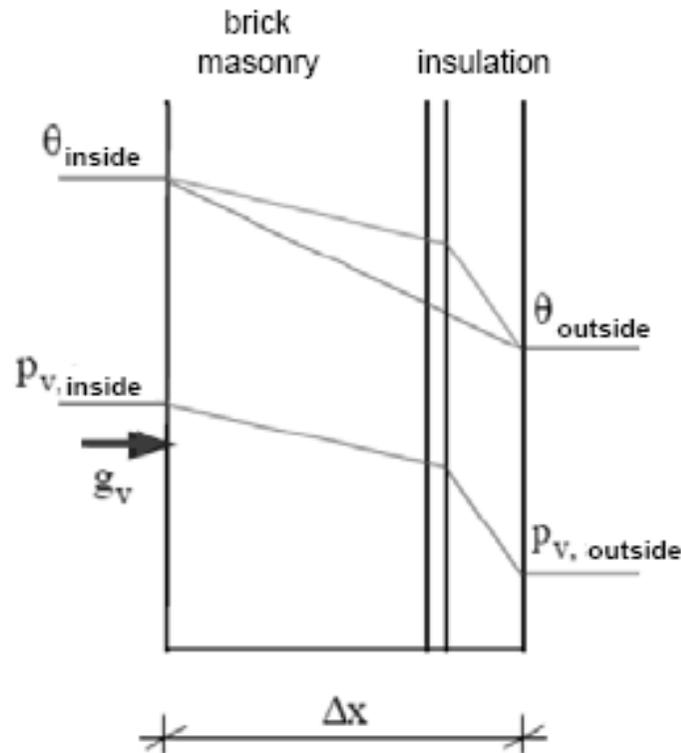
# Thermal & condensation (static)

outside insulation

*small vapor flow into the construction*

interior insulation

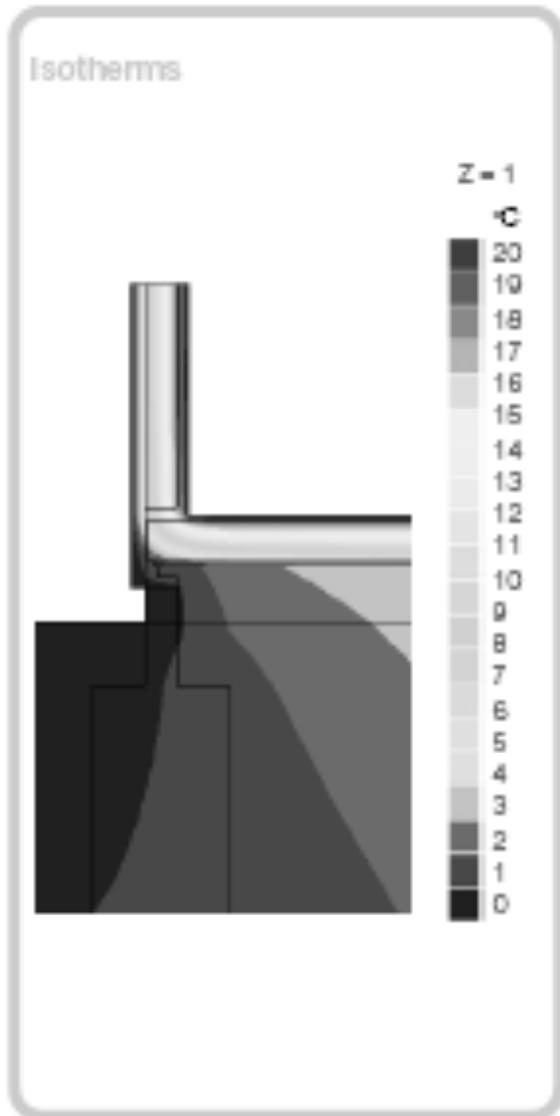
*large vapor flow into the construction*



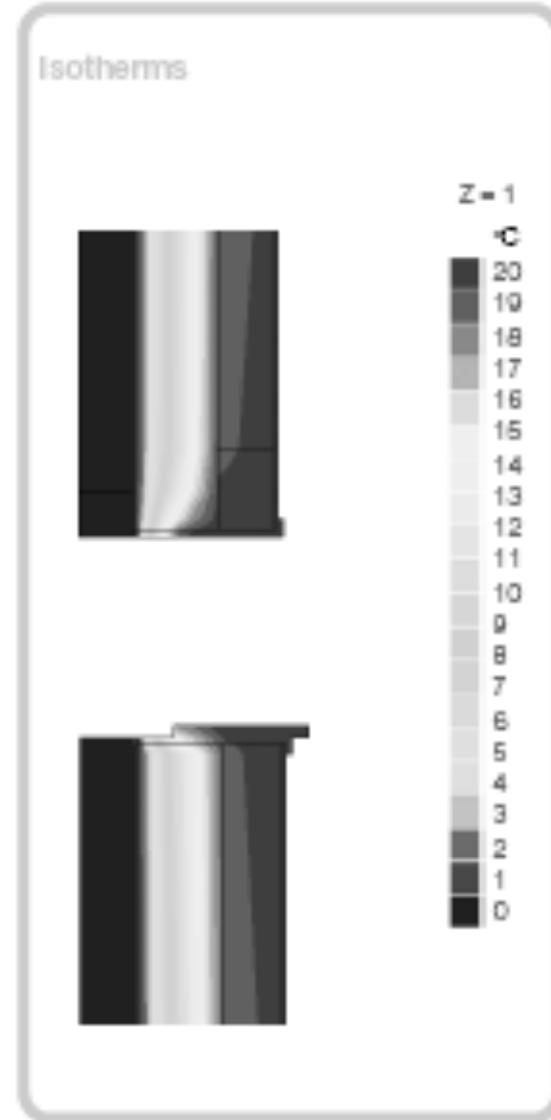
# Thermal/Moisture Analysis 2

- Thermal bridge analysis
- Psi calculations
- Building Regulations Approved Document L 'Part L'
- Rainbow rendered element junction sections
- Distortion due to thermal bridges

# Isotherms



18/02/16



95

# Thermal/Moisture Analysis 3

- Computer assisted simulation programme
- Heat and humidity transports (dynamic)
- to BS EN 15026:2007
- WUFI:
- [www.wufi.de](http://www.wufi.de)
- Via Ecological Building Systems is using their products
- Uses own data BS EN 15026:2007
  - more accurate than BS EN 13788:2002 used with BS 5250

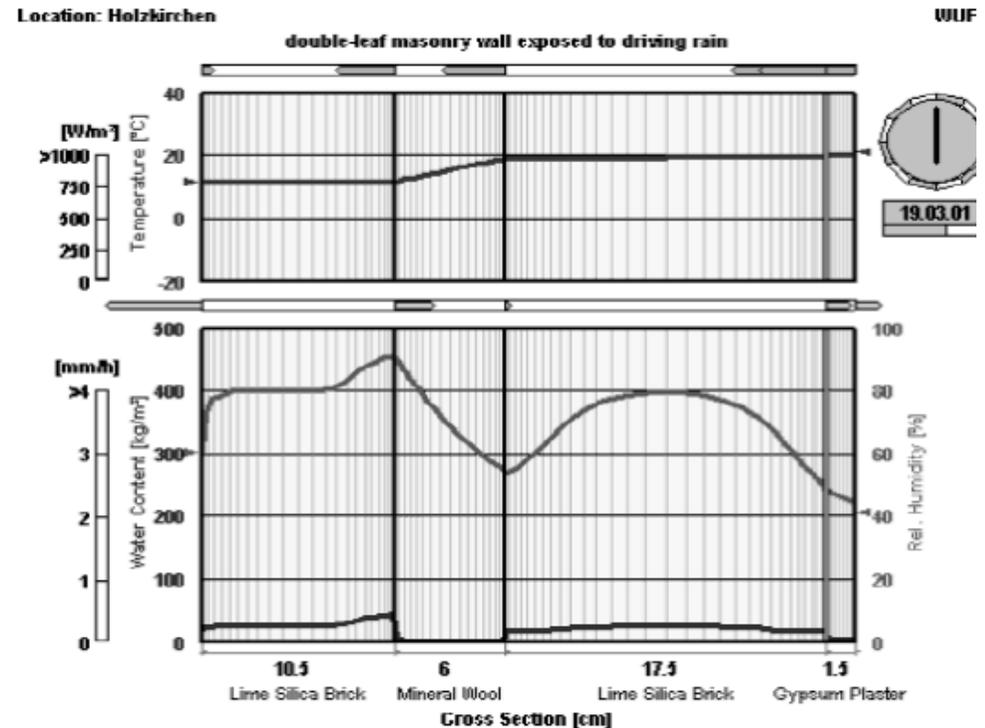
# Optimising the Hygrothermal Performance of Existing Structures

Computer- assisted simulation program for heat and humidity transports (dynamic) WUFI

- Real climatic data
- Inside and outside temperature
- Inside and outside humidity
- Light absorption
- Moisture storage capability
- Capillary action

(Data of one reference year at intervals of 1 hour)

Current BS EN 15026: 2007 provides higher accuracy compared with EN 13788:2002 in BS 5250.



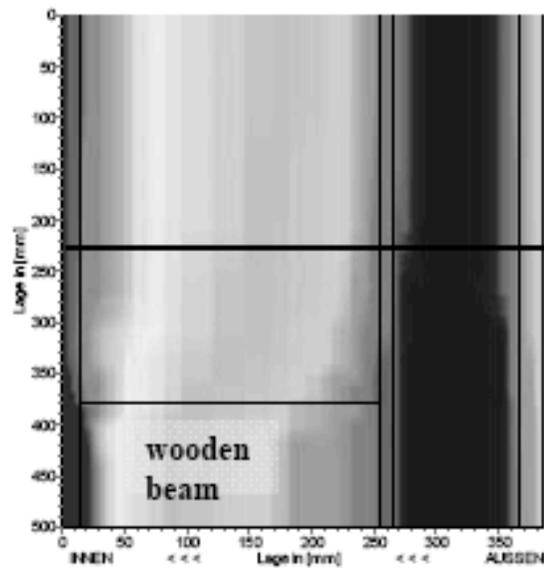
# Thermal/Moisture Analysis 4

- Software: COND, Delphin
- <http://bauklimatik-dresden.de/>
- Dr.-Ing. Rudolf Plagge  
Institute of Building Climatology  
University of Technology Dresden
- Via Ecological Building Systems if using their products
- Thermal bridge rainbow rendered section
- Combined with moisture penetration
- Over time
- Orientation taken into account



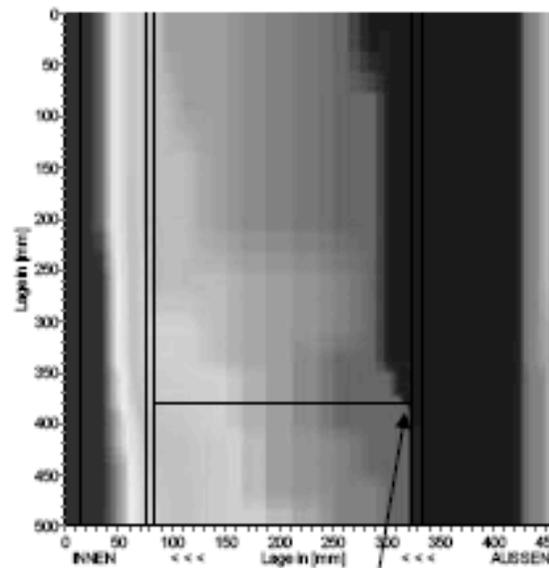
# Comparison of insulation loam cork without driving rain protection

no insulation



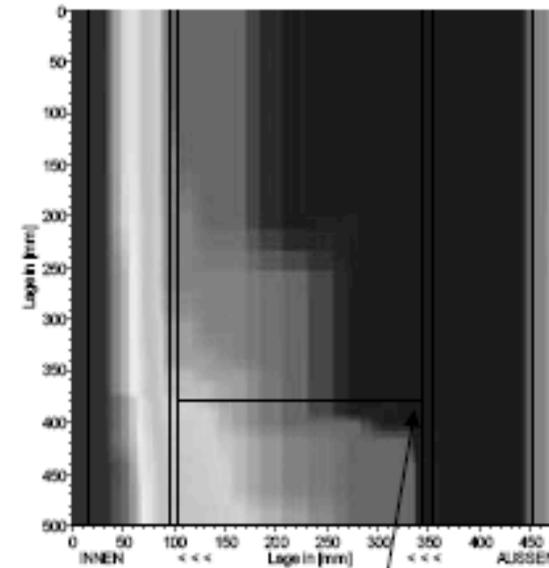
15 mm inside plaster  
 240 mm historic brick  
 10 mm historic mortar  
 120 mm historic outside brick

60mm WDL



94% rH

80mm WDL



96% rH

# **IES Consultancy services**

- **Fast and Accurate Dynamic Thermal Modeling Consultancy**
- **Dynamic thermal modeling is the superior way to simulate a building's environment**
- **Using IES VE software**



[www.GreenBuildingEncyclopaedia.uk](http://www.GreenBuildingEncyclopaedia.uk)



# How does it work?

- **By combining all the key factors to create a detailed mathematical simulation.**
- **These include climate data, building geometry, internal loads, operation schedules, fabric data and HVAC/renewable energy systems.**
- **At IES Consulting we use dynamic thermal modeling at the core of many of our consulting services. It is an important part of an integrated design process providing value to all team members- right from initial master planning and concept design stages to project completion. Like new constructions, existing buildings too can have their performance assessed.**

# Virtual Environment

- To achieve the most accurate and fast results, our team of experts use our Virtual Environment software - the most comprehensive thermal simulation software available.

# Green Building Rating Systems:

- **BREEAM - UK and International**
- **LEED® - USA, Canada and International**
- **Estidama - UAE**
- **GSAS/QSAS - Qatar**
- **Green Mark - Singapore**
- **Green Star - Australia, South Africa**



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# Analysis

# **Draw up & Overlay plans and sections to analyse:**

- **Structural system**
  - non-structural systems
- **Services routes**
  - Excessive service runs
  - Shorter service run opportunities
- **Analyse sections looking for:**
  - thermal bridges
  - air passages
  - Difficult to insulate spaces
  - Tight-fit details

# Existing: Survey > Analysis

- **Inspect Constructions**
  - Determine thicknesses and materials
    - Calculate U values
  - Survey wall, floor and roof areas
    - Determine heat losses
- **Propose improvements**
  - Recalculate U Values
  - Determine heat loss reductions
    - Aim for 80% minimum
  - Determine revised plant size for heat/cooling
  - Calculate pay back periods:
    - Costs, carbon, embodied carbon, embodied energy<sup>15</sup>

# Modelling: Fluid Dynamics

- Model section through building
- Immersed in water filled transparent tank
- Use coloured water flows and heat sources
- Understand air flows through building by watching water flows
- Understand how failures occur
- Test potential solutions
- Atrium don't always work as expected
- Perimeter wall window differential controls can solve them

# **Existing: Analysis: Permitted development**

- **In times of cost cutting/belt tightening**
- **Stay put and make the most of site**
- **Consider the rules about permitted development of a building or site**
- **Consider exploiting the rules to the limit**
- **Maximise the potential of building or site**

# Existing: Analyse

## Proposed Improvements

- Consider:
  - ‘Whole house/building plan’
    - Building fabric first
    - Renewables later?
    - Implications for details
  - Phased or zoned progression
    - Need for Decanting people/furniture
  - Cost of implementation
  - Proposed interventions
- Develop appropriate solutions
  - Understand sequence of detail assembly
- Avoid undoing and repeating work
  - Future proof details for later installations

# Existing Building: Analyse:

- **Before, during and after**
  - surveys, tests and analyse
  - with all the surveys and test results
- **Scrutinise the details**
  - Interrogate the data
- **Look for problems that need to be improved or eliminated**
  - Plan to resolve them
  - Resolve them
  - Don't compromise

# **New Build: Analyse:**

- **Before, during and after**
  - surveys, tests and analyse
  - with all the surveys and test results
- **Scrutinise the details**
  - Interrogate the data
- **Look for problems that need to be solved**
  - Plan to resolve them
  - Resolve them
  - Don't compromise



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