3

briefing, design and construction

Making a building creates a focus on the future. The idea of 'the project' needs to harness enthusiasm, an optimism that we can influence our environment to create better places for learning, more cohesive communities, innovative research and greater universities.

Engagement is required that instils a sense of purpose and consequently runs over into a productive fit between the physical opportunities of the building and how it is used. These are the ingredients for successful buildings.

Gabriel Aeppli's opinion piece on briefing and construction reflects on the importance of shared understanding, mutual respect and defined responsibilities to achieve ambitious goals. The description of the London Centre for Nanotechnolgy is included here, rather than as a case study at the end of the book, as it raises so many issues pertinent to Parts 3 and 4, and will hopefully help the reader reflect on the interrelationships and importance of each stage of the process.

Fiona Duggan describes methodologies to ask the right questions of the right people to determine the brief.

Andy Ford describes the challenges facing the university sector to achieve improved environmental performance, in order to lead the way towards living within the means of our planet.

Optimising good outcomes through the design and construction process is discussed by Ian Taylor, highlighting the importance of continuity in the project team, commitment to ambitious outcomes, and proactive contracting to achieve quality.

3.1 BRIEFING TO OCCUPATION: LONDON CENTRE FOR NANOTECHNOLOGY OVERVIEW

Gabriel Aeppli

OPINION and CASE STUDY

Science and engineering research is essential for human culture as well as for finding the solutions to today's social, technical, environmental and medical problems. With classroom education at large state universities under competitive pressure (e.g. from lower cost private providers taking advantage of modern information technology and from online learning) for the first time since its development in the 19th century, the importance of student participation in research for their university education has become much greater. What distinguishes successful institutions is experience in dealing with new problems based on prior knowledge, requiring moderation and interpretation by expert colleagues, followed by creative calculation and experimentation. There is a demand for buildings which makes it possible to assemble the interdisciplinary and inter-generational teams needed to invent theories and perform experiments that are important both intellectually and practically.

In the example I discuss below, I will show how the development of such a building itself benefits immensely from an interdisciplinary approach involving the design team and end users.

I also believe that university buildings perform better when the academic users are engaged in their design and management, and are allowed to take some responsibility for ensuring their optimum operation and performance. Rather than a building project being run centrally by an estates department or a third-party developer, I believe projects benefit from direct relationships established between the design team and academic users, with facilitating project management. The end users, together with the design and construction team, should be given control, as long as the initial cost envelope is not breached.

The project below owes its unique success, including value for money, to an exceptional trust on the part of the University College London (UCL) administration at the time. In today's

English-speaking countries where public university administrators are much more anxious to exert central control than a decade-and-a-half ago, it is very unlikely that a similar project would be achieved with the same cost and performance.

If a substantial proportion of the earnings of academic departments is automatically diverted to university estates divisions, there needs to be accountability to deliver good building performance, and in a highly technical research building, maintenance of technical performance. Decisions taken on the development of the estate should take account of the potential development and expansion needs of academic departments.

The obvious solution is for the user clients themselves to be given more control over the funds they are earning (via overheads on research grants) for the occupation, maintenance and expansion of their laboratories. This means that if the estates divisions do not deliver cost-effective solutions, the funds can be used for external service providers. This will align estate management and development much more with the interests of the front-line workers of the universities. Such an approach is demonstrated by the success of the design and build phase of the London Centre for Nanotechnology (LCN), which was due to the full engagement of the prospective residents with the project whose costs they fully understood and over which they shared control.

LEARNING FROM THE LONDON CENTRE FOR NANOTECHNOLOGY

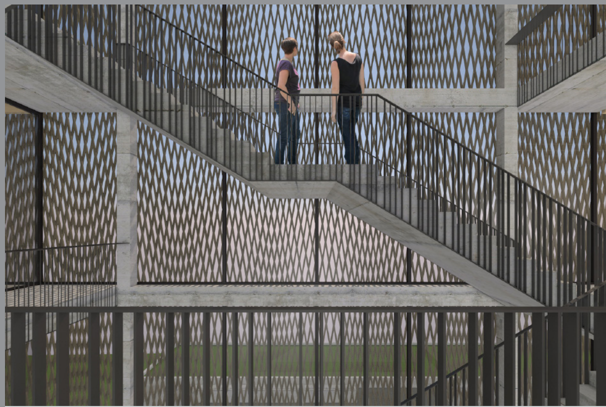
Scheme designs for London Centre for Nanotechnology (LCN, completed 2006; Figures 3.1, 3.4, 3.5, 3.6), an interdisciplinary academic research facility at the heart of the UCL campus in London, and PARK INNOVAARE (PiA, design 2016; Figures 3.2 and 3.3), a public/private partnership near Zürich, Switzerland. The Swiss scheme will provide space for government and corporate research laboratories operating at the interfaces between technical fields. It employs a similar strategy to that developed at LCN: maximum cost-effectiveness and flexibility are achieved by a simple box-design with the highest value laboratories closest to ground level, a standard lab core/office perimeter layout for above-grade floors, and exploitation of stairwells(rendering for PiA in Figure 3.2, photograph of LCN in Figure 3.4) as social spaces. Figure 3.6 shows finished nanobiotechnology laboratory at LCN.

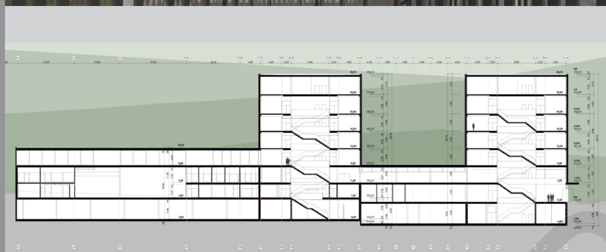
▶ **Figures 3.2 and 3.3:** *PARK INNOVAARE (PiA) Villigen: Staircase visualisation and cross section - Erne AG Holzbau / Hornberger Architekten AG 2016*

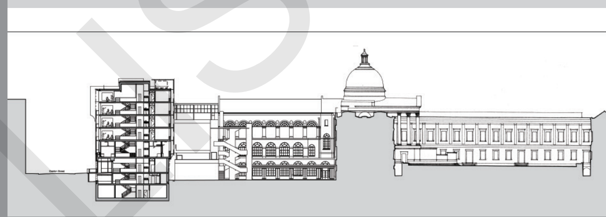
▶▶ **Figures 3.4 and 3.5:** *London Centre for Nanotechology - staircase and cross section - Feilden Clegg Bradley Studios*

▶ **Figure 3.1** *The London Centre for Nanotechnology*

▶ **Figure 3.6** *LCN typical laboratory*







THE LONDON CENTRE FOR NANOTECHNOLOGY

The LCN was a small project at a rapidly growing university. It is an interdisciplinary research institute held jointly between UCL and Imperial College London. Nanotechnology is defined by the ability to design, measure and manipulate matter on the nanometre scale (0.000000001 metres, or roughly the amount that human fingernails grow in one second). The formation of the LCN entailed construction of an entirely new building on the Bloomsbury site of UCL, and renovation of space at the Imperial College campus in South Kensington. The first occupants of the new building would be existing staff from several UCL departments in the engineering, biomedical and physical science faculties.

The budget was provided by the Strategic Research Infrastructure Fund of the Wellcome Trust and the UK government, which was designed to revitalise UK university facilities largely during the first part of the last decade. By international standards, the monies (£13.9 million) and site size (400 sqm) for the UCL project were decidedly modest – peer research centres in Europe, Asia and the USA were being constructed with budgets typically in the US$ 50–150 million range.

The dense urban site is very close to the major and busy Euston Road and below- and above-ground rail lines, including stations characterised by strongly accelerating and decelerating trains. Therefore, the site seemed decidedly sub-optimal (especially given the modest funding) for a nanotechnology research institute which, by its nature, demands laboratories well-isolated from vibrations, electromagnetic noise and temperature fluctuations. However, the site also had positive features, deriving most notably from the embedding of the LCN in the fabric of a large urban university with particular excellence in biomedicine, which is a key application area for nanotechnology, and the unique multicultural metropolis that is London. On the strength of the latter, the then Provost and President, Sir Chris Llewellyn-Smith, decided to proceed in spite of the significant technical risks.

The site and building envelope itself had been selected previously for a centre devoted to instrumentation for optical astronomy, with a planned occupancy of perhaps 40 people. It had only a single basement, and six levels at or above ground, encompassing considerable atrium space. When this project was rejected UCL, at the behest of academic staff, decided in 2000 to create a nanotechnology building with the same envelope and footprint. In the interests of efficiency, they employed the design team of the optics centre. Because of the radically different and more diverse scope of activities characteristic of nanotechnology, a complete redesign of the building was required. Given the need for laboratories with low levels of acoustic and electromagnetic noise, Feilden Clegg Bradley Architects, who had visited a number of similar projects in the USA, and the Director-designate of the new centre made a case for a second basement. This was the most important decision in the early design phase, as the second basement is where the high-value LCN experiments are performed, notwithstanding the dense urban location.

THE BRIEF

The design brief was simple – to house and promote the solution of important problems in fields from information technology to biomedicine using interdisciplinary teams from UCL working especially with partners from Imperial College. This brief encompassed both technical and social requirements. The former accounted for the demands of housing sophisticated nanofabrication and nanocharacterisation tools, while the latter arose from the need to create meaningful interactions between scientists from different disciplinary silos, generations and institutions.

THE PROCESS

The design process had to take into account the budget constraints as well as the interdisciplinary nature of the project. Key features were::

1. Design team appreciation of what the end users (scientists) wish to achieve using the new building.
2. End user appreciation of the challenges facing the design team.
3. Dedication to finding off-the-shelf solutions to all problems, ranging from the sourcing of staircases to the electrical shielding of laboratories.
4. Realisation that good designers share much common ground, as creative professionals, with scientists; a research institute is a professional partnership with many similarities to a good architecture practice.
5. Simply structured procedures for accommodating the different needs of disciplines under a single roof.

6. Direct discussions between end users and building designers, engineers and contractors, with minimal overheads in the form of intermediation by others.
7. A collegial and timely approach to value engineering between the project team responsible for delivery and the end users, focusing on practical solutions to deliver features necessary for building performance, even if costs seem to have escaped control.
8. Clear awareness on the part of both the design/construction team and the end users of costs, performance, schedule and the associated trade-offs, allowing, among other benefits, the maintenance of change order discipline.
9. Tracking of realised value and contingency spend (this project followed the USA pattern – not common for projects of this type in the UK – of including a substantial contingency budget) as simple project health metrics understandable by all stakeholders.

Execution consistent with points 1–9 implied a single point of contact on the client side, with dual reporting to the scientists and the UCL estates division, who worked together with a partner at FCB (who had the overall coordination as well as the design role) to arrange meetings and workshops, initially for identifying the project vision, and as the project evolved into ever more detail on technical specifications and execution.

The process of close engagement between the design/build team and the clients extended to the construction phase, during which joint value engineering kept the costs within budget on completion. It also allowed the timely detection of, and a well-calibrated response to, a major under-specification of the cooling needs in the building. It is difficult to imagine how any conventional approach relying on intermediaries would have outperformed our partnership among creative professionals in solving this major problem, identified only after construction was well under way.

Friday afternoons were generally reserved for visits to the construction site by the client, and permitted in-course inspections as well as the establishment of shared objectives between contractors and scientists.

SCHEME DESIGN

The key feature of the building is its division into two vibrationally isolated blocks: a stairwell and lab-office complex. The stairwell block also includes the lift serving all floors, restrooms, kitchen areas and furnished landings and functions, as the social spine of a building with a large height-to-width ratio. In addition to encouraging social interactions, its inviting nature, provided partially by its scale, light and specific items of visual interest, including alternating hardwood (furnished landings) and resin flooring, and a semi-transparent lift enclosure, also encourages preference for stair climbing over lift use, with associated health and energy benefits.

The lab-office block contains high-value laboratories and service areas in the two basement levels and ground floor, a 200 sqm clean room on level 1, standardised laboratory core/office perimeter layouts for levels 2, 3 and 4, and level 5 accommodating a server room and small cluster for supercomputing and a large open-plan office area uniting scientists and LCN administrative staff.

LCN: the clean room and associated service corridors occupies all available space on its level, and contains three fingers, with ascending levels of cleanliness and occupied by surface-processing apparatus, wet benches and characterisation tools. Between the latter two fingers, there is an electron beam 'write room' for the top-down creation of ultra small structures. A smaller clean room for an electron/ion beam microscope/fabrication tool was installed on level–2; this laboratory was later modified to host additional machines, including an electron/ion tool with a cryogenic stage for nanoneuroscience, and a scanning tunneling microscope for writing individual (dopant) atoms into silicon wafers, with the eventual purpose of building quantum computers.

For the specialist facilities, most notably the clean rooms, the chief client representative was strongly assisted by a clean room specialist, hired by UCL during the design/construction phase; the presence of this specialist on the client side was crucial for the success of the construction project.

Gas, water and compressed air lines and associated machinery, cabinets and scrubbers (gas reaction columns), as well as data lines and other utilities were all designed and delivered as part of the project. Considerable effort also went into the design of electrical distribution systems with appropriate reliability for their intended clients, and separate earths were provided for some laboratories. The clean rooms were also within the original project scope. Costs were controlled by insisting on a downward progression of laboratory performance specifications from high to low, ascending from level –2 to 4.

OPERATIONS

Once a building has been designed and constructed, it must be maintained and modified for safe and efficient use. Accordingly, the project team, including the architects, engineers and end users, held extensive meetings with the relevant members of the UCL estates division during the design and construction phase. The need for scheduled maintenance, rather than relying on the principle of 'fix it after it breaks' was emphasised. After project completion, the chief client representative (the single point of contact described in 'The Process', above) during the design and construction phase became the LCN facilities manager, whose remit was to ensure proper functioning and evolution of the project for the end users. A role subsequently added was that of chief safety officer for the LCN. A particularly important duty for the facilities manager was to form the interface between the scientists and the UCL estates division concerning both maintenance and modifications. On his retirement, however, he was replaced by others who did not have his prior experience in the estates division or his deep understanding of the building. Preventive maintenance was not prioritised by UCL– a lapse which did not affect operations immediately, when the LCN and its components were still new and under warranty – but has more recently led to needless downtime. Furthermore, notwithstanding large overheads paid to UCL from LCN research income, an adversarial culture, with lost productivity, evolved from debates about liabilities due to inadequate maintenance, loss of documentation, and a lack of intellectual ownership of the sophisticated building.

THE OUTCOME – SCIENCE, TECHNOLOGY AND TRAINING

Over the years since project completion in 2006, the building has a played an important role as a technical and social enabler for nanotechnology in London by providing state-of-the-art facilities in a setting optimised for the social interactions which are a prerequisite for interdisciplinary problem solving. The building – alongside the high calibre staff recruitment which it enabled – was a key tool for introducing to the non-biomedical faculties at UCL a culture of performing difficult, high-impact experiments at home. As desired, the net outcome has been high-impact science and engineering, and numerous successful alumni holding positions worldwide.

The underlying design philosophy of isolating noise at the source, the high-to-low floor hierarchy of lab specification and the use of simple off-the-shelf products for noise mitigation paid off in the form of scientific results fully competitive with those from more bespoke, expensive laboratories in more isolated locations. In addition, the building design, including open-plan offices on levels 2–5, has been flexible enough to allow the accommodation of approximately 50–60% more researchers than originally planned. Research laboratories have also been successfully modified, and the major problems are now overcrowding and inadequate maintenance (cleaning and cosmetic upkeep have been adequate) of what remains the most sophisticated building associated with the non-medical faculties of UCL.

Recently, a decision was made to construct an outdoor terrace platform in the vacant lot behind the LCN, which forecloses further expansion.

▲ **Figure 3.7** *The London Centre for Nanotechnology : double height basement laboratory - with subsurface daylight window and built-in crane - for single atom*

3.2 RETHINKING THE BRIEFING PROCESS

Fiona Duggan

THE CHANGING LANDSCAPE OF HIGHER EDUCATION

In a world where access to information can increasingly take place anytime and anywhere, learning environments that provide compelling here-and-now learning experiences are becoming ever more important. Such environments are about encouraging students, staff and others to come together in memorable settings – to engage in a lively programme of events, gain access to a wide range of resources, take advantage of places to work collaboratively, find quiet spots to pause and reflect, and make time to relax and socialise. At the same time, as blended-learning approaches combining face-to-face and online activities become more common, and research/enterprise/innovation activities become more diverse in their partnerships and locations, it is increasingly difficult for higher education institutions to accurately identify the types and amounts of space required to meet their needs. Current requirements are constantly changing, while programme change and/or growth are no longer a robust guide for future requirements. We need to find new ways to help institutions articulate and validate their space requirements.

SEEKING THE MOST FEASIBLE WAY FORWARD

The primary purpose of any briefing process is to plot the most feasible way forward, a best-fit approach that seeks to align the following key project parameters:

- vision
- needs
- space
- budget
- time.

This process relies on understanding and appreciating the different ways of thinking and doing that each participant brings, with the most innovative briefs being those where project parameters are woven together in unexpected ways. A compelling project *vision* sometimes grows out of grappling with very particular circumstances rather than engaging in unconstrained, blue-sky thinking. User *needs* tend to be better met by asking people *what they do* rather than *what they want*, as this opens up the potential to explore with users a whole range of settings (existing and yet-to-be-defined) that might effectively meet their needs. Types and quantities of *space* can be arrived at in a variety of ways, including change-the-rules (e.g. using existing space differently, calculating new space differently), rationalise, remodel, extend, new-build and relocate. Funding strategies where *budget* seeks to balance capital, operating and life-cycle costs, might result in a portfolio of owned, shared and borrowed space. Deciding factors around *time* might include the degree of organisational/academic change desired, procurement route options and funding availability.

In short, the specific characteristics of each parameter will largely shape the client brief. The role of the leader of the briefing process is to articulate and guide the process, focusing on value-for-money decision-making and opportunities for desired change. Radical academic or organisational change can sometimes be achieved at little cost, such as reassigning under-used departmentally owned space for shared faculty use, which can generate an increase in cross-disciplinary collaboration. On the other hand, high expenditure can sometimes have minimal impact; for example, a relocation project based on a user brief that reinforces the status quo may limit opportunities for academic or organisational change.

WORKING MORE EFFECTIVELY WITH UNCERTAINTY

As future requirements become more difficult to articulate with confidence, developing the client brief takes on a more collaborative process requiring multi-disciplinary input from the outset. This process tends to work with typical requirements initially, actual requirements gradually coming into focus as project parameters become better understood. The merit of this, *typical needs first, actual needs later* approach is that it allows the client brief to develop in more detail as more information becomes available. It is also an inherently sustainable approach whose loose-fit character supports organisational and spatial change over time.

In defining initial user requirements, a framework is sought that will accommodate a range of typical group sizes and needs, to build in sufficient flexibility for change over time. While each project is different, general patterns around group sizes and basic requirements can be ascertained.

Learning programmes tend to address particular pedagogies and staff-to-student ratios via group sizes of, say, 5–7 students, 10–12, 20–30, 40, 80, 120+. Timetabled hours vary with the institution but are typically 10–12 contact hours a week, depending on the subject area, with independent peer group learning becoming an increasingly important component of programme delivery. With this kind of information, hypothetical scenarios can be shaped, thereby deepening discussions around possibilities, early on in the briefing process.

In defining initial space requirements, working with existing information, generic space norms, precedent studies and hypothetical space models, actual space needs start to become clearer through user engagement. Trends in recent years include an increase in the amount of space devoted to commons, initially in teach+learn spaces, but increasingly appearing in workspace too. Workspace is shifting to include a more diverse mix of individual and collaborative settings, in open and enclosed configurations, for both live-in and drop-in users. Support space is becoming more sophisticated as it expands to meet the needs of ever more diverse activities and users throughout day and evening. Circulation space is no longer solely seen as balance space to be kept as efficient as possible, but as playing a key role in way-finding strategies that seek to enhance general awareness, provide opportunities for informal interaction and create a sense of identity and belonging.

The space provided/required by most buildings tends to follow a similar pattern:

- 50–60% core activities
- 10% supporting amenities
- 15–30% circulation
- 20% core.

The space provided/required by most campuses also tends to follow a similar pattern:

- 30–50% learn space, which we subdivide into commons (social, library, general purpose ICT), general (lecture theatres, classrooms, project spaces) and specialist (teaching labs, workshops, studios, performance, etc.).
- 15–30% work space, which we also subdivide into commons (social, meetings, tea points, admin hubs), general (staff work-stations, enclosed/open) and specialist (research labs and workshops).
- 10–15% support space, including catering, student services, amenities, facilities management (stores, security, maintenance).
- 20–30% connect space, i.e. gathering places (such as atria), all horizontal circulation (entrance lobbies, corridors, fire routes through open-plan areas).
- 15–20% balance space, i.e. vertical circulation (stairs, lifts), toilets, building services (ducts, equipment, plant, loading bays).

In defining place-making principles, campuses are increasingly responding to the needs of learning programmes with a variety of attendance options. For those on traditional full-time programmes, contact time varies considerably between 10 and 30 hours a week. Block-mode programmes take a variety of formats, such as 3 days (Thursday–Saturday), 5 days (Wednesday–Sunday) or 3+2 days. Full-time programmes will increasingly become a fast-track option, while block-mode programmes will provide pace-of-choice options. Online options are currently seen as a work-in-progress, with the evidence to date suggesting that online works best alongside face-to-face activities (e.g. flip-teaching, where material is studied online in advance of contact time, which focuses on discourse). Institutions are increasingly partnering with businesses to meet the employment demands of students (full-time students who want work placement opportunities, part-time students who often need their employer's support to pursue academic qualifications), as well as providing opportunities for students to develop and showcase work skills through volunteer programmes, exchanges and participation in research and enterprise initiatives. As programmes become less fixed in time and space, campus place-making focuses on creating environments in which learners will want to linger.

Place-making principles commonly in use vary considerably in scale, from application within a single building through to multi-campus estates:

- Routes that facilitate way-finding, build general awareness, showcase activities, create opportunities to meet and linger.
- Hubs that cluster resources together in primary locations, to create centres of activity that can be efficiently and effectively supported, with provision for extended-hours access where appropriate.
- Neighbourhoods that provide diversity via the particular characteristics of both users and space.
- Thresholds that provide clear, intuitively understood, transitions between public, invited and private space.

FINDING A WAY FORWARD

The request: we want a corporate leadership centre (vision) to deliver executive learning programmes to our most senior staff (needs). We think we need about 2,000 sqm (space). We don't have any money (budget). We want to open the centre within the next 12 months and deliver programmes for the next 5 years (time).

The resulting brief: a collaboration project with a hotel group for a weekday leadership centre and a weekend hotel. 3,000 sqm refurbished space. Financed by hotel group with leadership centre renting 2,000 sqm for 180 days/year over a 5-year period. Refurbishment of an existing building to minimise construction time. Separate identities maintained by signage that flips over from corporate to hotel use to suit weekday and weekend activities.

LISTENING TO USERS, LISTENING TO BUILDINGS

The briefing process should encourage users and buildings to 'listen to each other', so that each set of requirements is informed by the other, in pragmatic and creative ways. The goal is sustainable place-making – environments that will effectively accommodate the evolving needs of users, estates, institution and environment for as long as it is economically viable to do so.

In listening to users, the aim is to understand their existing activities and their aspirations for the future. Together, there can be an exploration of the kinds of role space might play in supporting both continuity and change. As a project moves into construction, the focus should shift to preparing users for the changes ahead and providing assistance throughout the settling-in period.

Conversations with users will generally include the following topics:

- People: numbers/types of users involved – students, staff, partners, others
- Programmes: full-time, part-time, work-based, online
- Pedagogies: traditional, emerging
- Processes: support systems
- Place: time spent on campus, online, elsewhere
- Personality: brand and identity
- Priorities: must have, nice to have
- Precedents: national and international exemplars.

'Listening to buildings' seeks to understand existing conditions, including spatial characteristics and the potential opportunities or constraints involved. It is then possible to explore opportunities for enhanced efficiency (net to gross, sqm/user, £/sqm, etc.). and enhanced effectiveness (flexibility, adaptability, etc.). There can be a focus on the kinds of uses that existing space or sites might be suitable for, some of which may challenge user requirements already under discussion.

‘Conversations with buildings’ could include the following topics:

- Site: location, presence, access (permanent)
- Structure: structural grid, loading capacity (60+ years lifespan)
- Shape: floor-plate configuration, heights (60+ years)
- Skin: building envelope (30+ years)
- Services: environmental systems, easy to maintain, upgrade, replace (20–30 years)
- Services: technology systems, easy to maintain, upgrade, replace (5–10 years)
- Scenery: layouts that are reconfigurable (year-by-year)
- Settings: user-friendly, plug+play, flexible (day-to-day).

To enable users and buildings to listen to each other more effectively, institutions should establish a project governance model that includes representation across a wide spectrum of interests and responsibilities – the everyday needs of users to carry out their work effectively and enjoyably, the long-term needs of buildings and campuses to accommodate change in affordable ways. A key feature of this approach is to make explicit the roles, responsibilities and decision-making powers of all involved, so that each participant’s attention is focused on those issues that they are best placed to address.

A typical project governance model might include the following roles:

- Project leader: providing project vision and leadership
- Project sponsor: setting project parameters, ensuring value for money
- Steering group: keeping the project on message, on time and on budget
- Project champion: engaging all stakeholders, coordinating activities, managing communication
- User groups: articulating needs, testing what-if scenarios, providing feedback
- Technical groups: ensuring specific requirements are met (services, ICT, catering, etc.).

Different priorities will come into focus as a project develops:

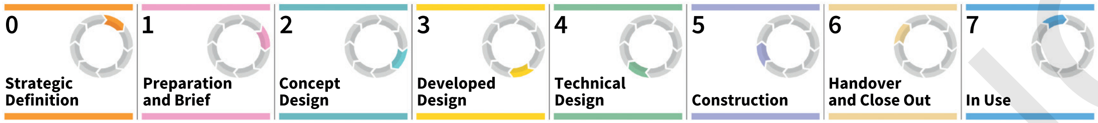
- Site decisions are about the intended long-term future of building/s and their surroundings. Conversations will focus on location and presence.
- Base-build decisions are about long-term flexibility and adaptability (responding to changing needs over time). Conversations will focus on structure, shape, skin and services.
- Fit-out decisions are about medium-term flexibility and adjustability (allowing for regular reconfiguration). Conversations will focus on services and scenery.
- Furniture decisions are about short-term flexibility and agility (supporting day-to-day needs). Conversations will focus on settings.

Setting out the briefing and design process in this way clarifies what conversations need to be had when and who needs to be involved. The goal is to balance the desire of those who will be using the space to keep options open for as long as possible, alongside the concern of those providing the space to freeze requirements as early as possible in order to progress design and stabilise costs. This involves timely decision-making – not too late, which increases the risks of incurring additional costs and/or delays, but also not too early, when decisions are more likely to be based on existing ways of doing things, insufficient information and/or little awareness of possibilities that may be potentially well within reach.

Figure 3.8 *Articulating project values*

SPACE CRITERIA	EFFICIENT	EFFECTIVE	EXPRESSIVE
For student	meets my requirements	supports my learning	makes me feel proud
For faculty	supports our programme	encourages creativity	reflects our identity
For estates	affordable operating costs	facilitates change	demonstrates values

Figure 3.9
RIBA PoW stages



HAVING TIMELY CONVERSATIONS

Developing the client brief is first and foremost a social process in collaborative sense-making. It is about knowing who needs to talk to who, what needs to be talked about when, what is important to who and why.

BRIEFING

Conversations around the RIBA Plan of Work Stages 0–1 aim to understand the key project parameters. This involves some uncertainty and it is important to maintain openness and curiosity about possible directions to pursue. The focus is on establishing a clear *statement of intent* where none of the big questions are left unanswered. Topics to be addressed include client aspirations, academic vision, business case, image and identity, approximate building size, principal spatial components, site/location issues, funding characteristics, anticipated timescale, phasing strategy (if required), decision-making processes and potential risks. The information provided should be comprehensive enough to guide and inspire, not so detailed that it cannot continue to evolve through design dialogue. Client involvement is primarily focused on key decision-makers. Activities include:

- reflecting on the existing situation (aspirations, attitudes, work processes, space use, client perceptions, etc.)
- learning from others (site visits, case study reviews, etc.)
- exploring possible scenarios (a very effective way of opening up thinking)
- focusing on aspirations.

> **The strategic brief** provides an overview of the client's requirements regarding users, space requirements and operational systems.
>
> **The concept brief** develops these requirements alongside emerging design ideas.
>
> **The project brief** tests developing requirements against developing design ideas, in order to establish requirements in more detail.

DESIGN

Conversations around the RIBA Plan of Work Stages 2–3 work towards mutual understanding. This involves appreciating diversity and normalising conflict as project hopes and concerns are revealed. The focus is on establishing a series of client briefs at progressive layers of detail. The process is iterative, where project priorities are elaborated, tested and refined (or changed) in response to information becoming available.

Activities throughout include articulating, testing and adjusting requirements to meet the objectives of both users and providers/managers of space, understanding the different priorities that may be involved and developing the design scenario that best fits the complexity of needs involved.

TECHNICAL DESIGN

Conversations around RIBA Plan of Work Stage 4 are about commitment and appreciating what is and is not negotiable. The focus is on checking that the brief and design are fully aligned. For the client team, it is about all stakeholder needs converging into a cohesive whole. For the project team, it is about all professional input converging into a coordinated whole. The knowledge that both client and project teams now have provides an excellent opportunity to pause and touch base with project priorities. The process used to achieve this is known as value-management. This stage is the last major opportunity to ensure the best possible alignment between brief and design, and should include the possibility of radical changes. Unfortunately, most value-management processes do not allow for this level of openness around change, perhaps because of the time, energy, resources and emotion that have already been invested in the project. This underestimates the power of the knowledge now available to make brave decisions where one can be fully aware of the benefits and costs likely to be involved. Not testing the brief as part of the value-management process can make for a less successful outcome.

CONSTRUCTION

At RIBA Plan of Work Stage 5, there is a major shift in attitude – all the big decisions have now been made and it is full steam ahead. Client conversations are about managing expectations and the anxieties some users may have as the project becomes more real. User engagement moves from *preparing the building for its people* to *preparing people for their building*. The focus is on ensuring as smooth a transition as possible, while generating enthusiasm and confidence among all users for the opportunities and challenges ahead. Activities include keeping everyone informed and involved, preparing a countdown programme, allocating tasks and responsibilities, familiarising users with new space and technology, and saying goodbye.

HANDOVER

At RIBA Plan of Work Stage 6, the team discusses working through transition. Conversations focus on organising good endings and new beginnings; providing settling-in support. For users, the real project is just starting – learning how to work in their new space. Activities may include preparing welcome packs, providing on-hand support for glitches, implementing new workplace protocols and celebrating arrival.

BUILDING-IN-USE

RIBA Plan of Work Stage 7 develops an ongoing culture of reflection-in-action – what works well, what could be better, what action can we take? It is also about appreciating the pace of change an organisation can tolerate. Conversations focus on aftercare – helping users settle in and addressing any issues arising. It is an opportunity for everyone (client, design and construction teams) to capture key lessons for future projects. It is about continual monitoring and fine-tuning. Activities include follow-up action team meetings, user group feedback sessions, post occupancy evaluation and widespread sharing of experience.

IN SUMMARY

The role of the briefer is to create and protect an evolving conversational space that brings the requirements of users and buildings into clear focus, and to do so while being mindful of building programmes, budgets and the need for timely decision-making. The most rewarding projects are those that find their voice in ways which surprise and delight everyone involved. In the words of one client, *'We didn't expect to end up here, but what a great place to be.'*

▼ **Figure 3.10** *Conversations that develop over time*

IMAGINE	ELABORATE	ACCEPT	PREPARE	SETTLE-IN
what if ...?	typical requirements	specific requirements	first-users' requirements	in-use requirements
what are the big questions?	make timely decisions – not too early, not too late	maintain priorities and long-term view	commence handover process	fine-tune as necessary
who needs to be involved?	tolerate uncertainty while striving towards specificity	clarify what is and is not negotiable	communicate and involve everyone	support users through transition

3.3 BRIEFING AND DESIGN FOR SUSTAINABILITY

Andy Ford

When approaching the design for a new campus one should begin by considering the input from the educators. This is their show and, as designers, we need to enable, understand and then push the envelope.

When asked about the future of higher education, these are the points educators raise:

Democratisation of knowledge and access: the internet and digital technologies are reshaping the way we share information and deliver education. Knowledge is now often accessible outside the university environment and even some courses are becoming accessible to all.

Globalisation: mobility increases, competition intensifies and the global marketplace of ideas means broader access to student and academic talent. Universities are franchising and setting up campuses away from their home location.

Funding paradigms: in the UK tuition costs have tripled. The idea of higher education as a public good, and the financial viability of the university as either a research centre or teaching institution is threatened. Students are much more demanding, feeling they are more consumers than ever before.

Bridges with industry: these may drive innovation but at a loss of control of the curriculum. Influencing the curriculum by external top-down pressure is a very sensitive area easily viewed as intruding onto academic freedoms.

So what does the changing nature of higher education mean for campus design within the context of a sustainability agenda that is becoming increasingly urgent for society and universities in the future?

THE ROLE OF THE UNIVERSITY

The campuses of the future must be highly connected, flexible and sustainable. Accomplishing the first two design objectives while delivering the third will be a tremendous challenge. These days campuses (as with nearly all buildings) must approach a near zero carbon standard of performance.

A zero carbon built environment is a challenge faced by the whole of society. However, universities do not just provide courses for practical policy and industry driven outputs but also uphold society's ideals, vision and potential. Higher education provides the opportunity for people to meet and interact with the brightest minds to form long-term links and ambitions in environments that value knowledge and its use for the greater good.

Society values them for this and should provide universities with the best access to technology and the research environments needed to make progress. The reality of climate change makes such progress all the more urgent.

For low carbon sustainable communities the university campus must become the laboratory for this future. Many exemplar buildings are constructed on campuses and the universities rightly pride themselves on them. It is time to go beyond this. Individual buildings are not a community; a campus is.

Universities must be live laboratories for the transition to a low carbon sustainable future. They need not only to educate, but to demonstrate the changes needed along the entire building supply chain. Higher education creates and trains the industry's decision makers and practitioners. What they learn shapes the built environment for the decades that follow. This means that university ambitions must precede the country's ambitions. The timelines to low carbon are clear to 2050 and guidance is available to help demonstrate how this might be achieved[1] but our view is that those for universities should be a decade shorter to allow time for two to three cycles of graduates to leave and enter the world of work and 'life'.

In 2011, Royal Academy of Engineering research proposed a programme for university centres of excellence in sustainable building. This suggested that £30 million seed funding over five years would deliver cumulative savings in excess of £1 billion by 2030.[2]

WHAT ARE THE CARBON REQUIREMENTS FOR CAMPUSES?

The carbon footprint for universities is massive and projected to increase. Student populations have increased by a factor of five over the past 30 years and this number is likely to continue growing. UK university estates' annual turnover is £27 billion, equivalent to the fourth largest FTSE company. Universities occupy 26 million sqm of space (more than 2.5 times the government's estate), with annual energy costs of ~£200 million.[3] Recent trends in academic buildings have concentrated on improving facilities rather increasing built area, through a combination of infilling, replacement and refurbishment. All of these offer a tremendous opportunity to improve energy performance, sometimes at little additional capital cost.

UNIVERSITIES AT THE VANGUARD

The future campus will need to be progressively more low energy and low carbon. The UK government, in response to the Committee on Climate Change (CCC), has required that universities achieve carbon reduction targets for their campuses of 43% below 2005 (equivalent to 34% below 1990) by 2020 and 83% below 2005 figures by 2050 (equivalent to 80% below 1990).

Some suggest these are too slow for the sector, which must lead the way and demonstrate knowledge about how to deliver such results across the nation by the 2050 deadline. This view is supported by the Higher Education Funding Council for England (HEFCE) in the carbon reduction target and the 2008 strategy for higher education in England.[4]

These are large steps and in line with the whole built environment targets. Key is the need for universities to present and guide the rest of society towards how such figures might be achieved – so universities should consider higher targets.

Recent performance is not greatly encouraging – electricity use on on a per sqm basis has stayed largely constant since 2008, although the corresponding carbon per sqm dropped, owing to a reduction in the grid carbon intensity. Heating (non-electrical) use per sqm has dropped in the period and the corresponding carbon has reduced too. However, overall, most of the carbon reduction appears to be associated with the grid carbon intensity reduction. This analysis suggests that any actual electrical load reduction through improved management and lower energy systems is being offset by

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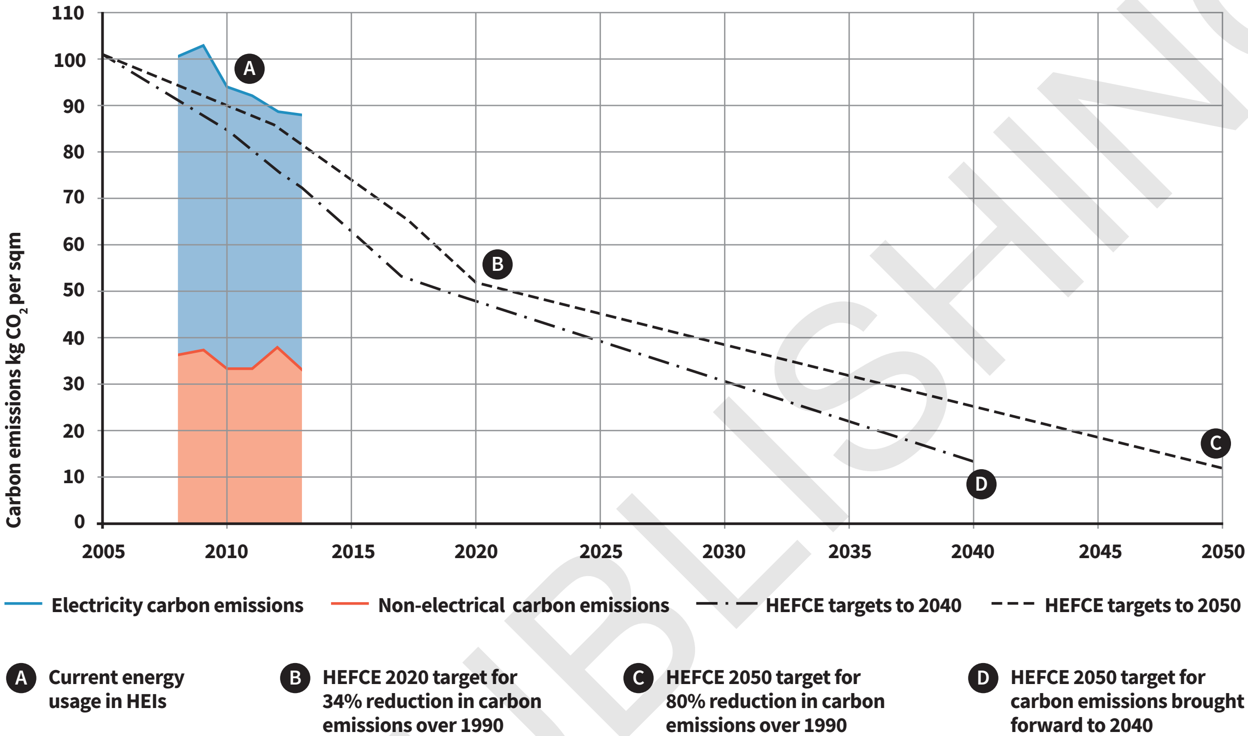
Figure 3.11 *Carbon emissions in English higher education institutions (HEIs), 2008–2013 compared with carbon targets to 2050*



This shows the estate carbon pre square metre against the projected HEFCE targets from 2005 to 2050, and the HEFCE targets if they are brought forward by 10 years as suggested. The targets allow for estate growth, estimated from growth in the period 2008 to 2013. This shows how significant improvements in carbon intensity would need to be made to achieve the targets, likely including electricity and heating demand reduction as well as gid decarbonisation. The overall reduction in carbon of the current HE building stock is caused by the reducing grid carbon density.

increased energy demand per sqm. Refer to Part 4 for further discussion on building performance in use.

DISPLAY ENERGY CERTIFICATE TARGETS

Display energy certificate (DEC) targets provide a neat illustration of this. It is that the 2013 average university DEC rating (using the CIBSE University Campus benchmark) is 97 (or a high 'D')

Only 30% of DECs are currently C or better, and under 1% of DECs are currently A. Target average DEC scores to achieve the 2050 trajectory would be:

- 2017 – 73 (high 'C')
- 2020 – 58 (mid 'C')
- 2050 – 14 (mid 'A')

Current sector performance in DECs is discussed further in Part 4.

We identify three approaches to achieving these new targets:

1. Reduce local and distributed energy supply carbon impacts.
2. Establish ways to fix carbon reductions once established through good management and cultures.
3. Follow progressive initiatives to drive down loads from small power devices, particularly relating to research (which could be challenging).

INNOVATION

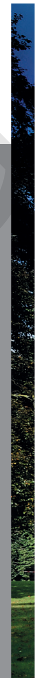
As research institutions, many universities are keen to explore how they can embrace innovation in their estate. This can include novel environmental approaches – in some instances in collaboration with academic departments, as illustrated in the following examples.

Centre for Efficient and Renewable Energy in Buildings
London South Bank University [6]

CEREB is a partnership between London South Bank, City and Kingston Universities. Each has related courses and other ventures which link to CEREB. The partnerships provide CEREB with a more diverse skills base and allow more projects to be delivered.

Centre of Excellence in Sustainable Building Design
Heriot-Watt University, Edinburgh [7]

This is one of four such Centres established at UK universities in collaboration with the Royal Academy of Engineering which, together, form a national network to demonstrate and exchange best practice in teaching and research for the sustainable built environment.



EXAMPLE
CREATIVE ENERGY HOMES
UNIVERSITY OF NOTTINGHAM ARCHITECTURE DEPARTMENT [9]

Green Close is a street of ecohouses, constructed in partnership with industry, and run by the University's Department of Architecture and Built Environment (see Figure 3.8). The Department has built a series of houses which investigate different technologies including micro smart grids, energy storage and demand site management – the 'Creative Energy Homes'.

EXAMPLE
SUSTAINABILITY HUB
HOME FARM, KEELE UNIVERSITY [5]

The Hub supports the development of sustainability both within and beyond the higher education sector. It is home to the MSc Environmental Sustainability and Green Technology, and provides consultancy work to industrial partners, puts on continuous professional development (CPD) activities and lectures, welcomes hundreds through the doors every year for training and conferences, and to find out about new developments in sustainability research.

▼ **Figure 3.12** *Sustainability Hub, Home Farm, Keele University*

EXAMPLE
ENERGY TECHNOLOGIES BUILDING UNIVERSITY OF NOTTINGHAM [8]

This building is home to research into: renewable energy using a biofuel combined heat and power (CHP); low energy lighting and intelligent controls; heat recovery ventilation with earth tube supply; responsible material selection including recycled materials to the concrete frame; and hydrogen production and filling stations with electric car charging points.

▲ **Figure 3.13** *Energy Technologies Building, University of Nottingham*

▲ **Figure 3.14** *Creative Energy Homes, University of Nottingham Architecture Department*

EXAMPLE
URBAN SCIENCES BUILDING
UNIVERSITY OF NEWCASTLE

This is a new building incorporating test bed strategies, including energy scavenging and storage technologies, building micro-metering and direct current test beds linked to PV panels avoiding losses incurred by DC-AC inverters. All of these can be integrated into research programmes and key items can be easily replaced as technologies evolve.

▶ **Figure 3.15** *Urban Sciences Building, University of Newcastle*

For energy-focused design teams the possibilities inherent in working with a professional and engaged client such as a university are rewarding. Items key to developing successful and ever-improving environmental performance from projects are listed below:

1. Agree the environmental aspirations at the outset.
2. Develop achievable targets through the design process.
3. Measure results in use.
4. Form an ongoing design partnership/work with the same design team over multiple buildings.
5. Demand every building to be better than the last.
6. Be consistent and persistent in the demands.
7. Do not add too many innovations at once – it confuses results.
8. Utilise controlled innovation – if something works do it again – but better.

CONTINUOUS CONTROLLED INNOVATION

A prime UK example of this approach is at the University of East Anglia (UEA), which has worked steadily for 20 years towards energy and carbon reduction.

The building services engineers Fulcrum worked on five buildings on the expanding campus in the 1990s culminating in the Elizabeth Fry building, which achieved building performance unsurpassed over the following decade. The designers learned that it was important to take clients to visit exemplars which pushed the boundaries,both in the UK and Europe, allowing the client to question and probe the users unhindered. This way the clients learned what was possible and could understand what to ask for and why design features were being suggested. They condensed these key lessons into a brief against which the buildings could be judged. In this way, both designers and client could agree what was possible.

A visit to Scandinavia was used to explore the appropriate appointment of consultants. As a result, responsibility for delivering detailed advice on fabric thermal performance was uniquely placed within the building services engineers' fee agreement. The decision to eliminate distributed heating and cooling systems to increase simplicity within Elizabeth Fry also came from this visit. It was possible to convince the engineers, and it allowed the client to give their informed consent to a design focusing on a fabric thermal store solution and high levels of fresh air ventilation and heat recovery.

Product manufacturers were engaged as part of the early stages, with meetings focused entirely on low energy and high comfort in a holistic way. The designers insisted on a process of leaving things out rather than adding new systems in, covering everything from orientation, window size and performance to structural integration of services.

As a result, the fabric was designed first, with specialist assistance on thermal detailing delivered to near PassivHaus standards and comfort through a ventilated concrete slab. The building was visited by the PROBE[10] (see page 124) team after two years of operation to explore its performance in detail, both from the perception of the occupants' professional support and energy consumption figures. It was revisited 12 years later to compare these results. In both cases, results were publically published – a step that should be required nationally of all buildings that claim exemplar status. These results showed that energy use had increased 20% following refurbishment with increased lighting and open-plan occupancy. Basic airtightness issues that were identified a decade earlier remained.

Buildings such as Elizabeth Fry demonstrate why universities emphasise performance as well as efficient design. As owner-occupiers, the client had a vested interest not only in the sustainable design and construction but in the reduced costs that came with it. The Manchester School of Art, later in this section, is another good example of this approach.

ENGINEER-OUT THE ENGINEERS

The Elizabeth Fry building offers a caution against the tendency to over-design. Sustainability must be simple. Building services often act as a risk-mitigation exercise, designing for the worst case plus a safety margin rather than for the averages and designing the building to even out the peaks. It is extremely easy for design to tend towards complexity and it should be the role of a nominated member of the team to actively challenge decisions.

Natural ventilation solutions are particular culprits here and all those involved need proper consultation; simple conflicts such as windows being closed because of noise, clashing with window blinds or security concerns can destroy an apparently simple strategy. The response of motorising and adding sensors can appear logical but simply adds complexity and further frustrations for users and issues for maintenance. Challenging such ideas must be done early in the design process and a vigilant eye kept, ensuring such ideas do not creep in later under the guise of cost-saving.

PASSIVE DESIGN

Well-designed buildings that rely on passive measures for environmental control are generally more popular with their occupants and in many instances use less energy than their mechanically conditioned counterparts. In particular, the academic cellular office model and the low occupancy often found in the sector are well suited to the demand control offered by natural ventilation. Control of building form, careful façade design, use of thermal mass and control

◀▲ **Figures 3.16 and 3.17** *The Forum, University of Exeter, WilkinsonEyre*

of internal gains are all key to ensuring good passive performance; it must not be forgotten that ventilation is required in winter as well as in summer, and the façade design must ensure that draughts are not an issue.

Passive buildings – with appropriate user training where necessary – can also be more resilient to changes in use, and are generally easier and cheaper to operate.

Where passive performance alone is not adequate – for instance in the centre of a city or where the building form or use make it impractical – mixed mode operation is often a good solution, with mechanical assistance required when it is particularly warm or cold, or in selected areas only.

Large atria and streets – popular in universities such as Exeter and Nottingham Trent – can be designed to capture passive solar gain in winter, particularly if the energy can be stored in surfaces during the season; whereas atria and streets can help to cool spaces in summertime when they are in shade. It should be noted that the challenge in many modern buildings is the avoidance of overheating rather than dealing with issues of heat loss in winter.

University buildings present particular challenges with regard to environmental performance which require particular attention during the design stage:

- Low utilisation and unusual occupancy patterns: how can we avoid wasting energy by conditioning unoccupied spaces yet ensure that they are comfortable when required?
- Seasonal use: buildings are principally designed for students, academics and researchers, yet conference and summer courses provide significant income and there are obvious differences in the requirements of students through the academic year. How can facilities cater equally for these different uses without simply over-providing?
- Rapid turnover of occupants: whether viewed on an annual, weekly, daily or hourly basis, buildings and spaces often have transient occupancies. It is often not clear who has ownership of spaces and their control. How can universities avoid the 'default to on' and engage such a wide range of occupants in environmentally sensitive operation of their spaces?
- Continually evolving funding sources and methods of teaching, learning, living and research: how can estates accommodate future demands that are unknown?

RENEWABLES AND OCCUPANCY

Solar low carbon sources of energy must be collected and the area required for this purpose must be protected from shade. Wind energy requires safe exposure to wind and all are challenging when the scale of energy need is considered in the context of individual buildings.

This makes energy efficiency and accurate prediction of energy demand a top priority in correct briefing. The question of how many people will be where, when and doing what must be answered clearly and accurately.

Renewables in the form of biomass (in whatever form) requires knowledgeable design and operation, which is generally outside the scope of typical facilities manager experience and requires specialist input and maintenance. Biomass also requires storage and delivery, and a reliable source of fuel, or commonly they are provided with duplicate gas as back-up. Sadly, in many cases the back-up takes over as the primary source due to its relative simplicity and reliability. This totally undermines the purpose and it is vital that client buy-in is achieved and the cost of operation includes skilled operation and maintenance.

To avoid such overdesign the whole team should be involved with the brief preparation. Occupancy in particular should be discussed openly with the implications recorded and incorporated. It is perhaps worth emphasising that occupancy when designing for low energy should be the form of an occupancy profile over time, ideally for each room.

These should also indicate anticipated fluctuations over the year. This is of particular importance on university buildings, as their occupancy can vary enormously and running for maximum occupancy in a holiday will lead to much waste.

LONGEVITY

For a building to be truly sustainable, it must have a long life. In rapidly changing times, this means that it should be easily adaptable to cater for future uses, many of which may not exist at this time. Who could have foreseen the impact that mobile IT devices would have on the lives of students today – and how this has affected the way in which our buildings function? The IT revolution is in turn triggering new ways of accessing information – while MOOCs have not had the impact which some expected, there is no doubt that there is a slow move towards blended learning – whether this is formalised or not. Student expectations are higher than ever, and in an increasingly global market this change is likely to take place at an increasing rate.

Buildings – and the spaces between them – must be designed to allow for future developments; in the absence of a crystal ball to predict future subject matter and curriculum delivery methods, it is vital that many buildings will need to avoid being bespoke to a particular department or group, and that a 'loose fit' strategy must be followed, with the ability to change layouts and uses, spare capacity in services installations and additional space for future plant enhancements.

One key aspect of building longevity is to ensure resilience to the effects of climate change. Setting aside the cooling effects of possible changes to the Atlantic Jetstream and Gulf Stream, climate change is of course expected to result in a general increase in global temperatures combined with more extreme weather events. If buildings are designed appropriately – including attention to façades, use of natural ventilation and other passive measures such as thermal mass – then there is no reason why this should not be achievable in most cases.

In some cases, for instance in Central London or in buildings with high heat gains, this resilience may not be achievable, and in this case the mechanical systems should be designed to allow simple upgrading to respond to changes in use or climate.

ESTATES AND BUILDINGS

In many universities, the buildings form part of campus developments. These offer great opportunities to ensure that the relationships between buildings are optimised, providing useful external spaces and appropriate connectivity. Buildings with similar functions can be grouped together to encourage collaboration and, if suitably designed, can allow departments to 'flex' and promote interdisciplinary working. Centralised timetabling of spaces – which is often used to improve space utilisation – can also increase the chance of interaction between academics and students, particularly from different subject areas; the 'water cooler moments' that often generate the most stimulating ideas. Connectivity for future

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campuses does not only apply to people and information: an additional benefit of grouping buildings together is that they provide opportunities to reduce energy use and carbon emissions through enhanced plant efficiency.

There has been a move in recent years towards more centralised energy systems, reversing the trend of the previous two or three decades. New and improved technologies in energy production and distribution, combined with increased energy costs and environmental awareness, have made such installations commonplace. For instance, there was an increase in the number of CHP installations in UK universities of over 120% between 2009 and 2014, now they now account for over 13% of total energy consumption.

District energy systems are at their most powerful when a variety of buildings are located in close proximity to each other, and where different load profiles and characteristics can enable total plant capacity to be reduced; in some instances, waste heat from buildings – such as IT server rooms and load-intensive areas – can be reused in other spaces. Ground source heat pumps can enhance performance further by storing energy in the ground on a seasonal basis. Lastly, centralised systems offer great opportunities to improve resilience, as well as the ability to upgrade and change plant as technologies change, evolve and improve, rather than having to deal with each building on a piecemeal basis.

WHAT ABOUT THE ROLE OF HEATING AND COOLING NETWORKS?

There is tremendous potential for improved efficiency through heat networks and long-term heat storage. It has also been noted that factors such as climate change, increases in IT loads and highly glazed designs are all increasing the need for cooling solutions. We must rethink how we can maximise the efficiency of our networks to deliver both heating and cooling.

Consider that heating and cooling are both essentially energy management. You move heat away from places that need cooling towards places that need heating. Treating heat as a resource across a campus can lead to tremendous energy savings overall.

A good example of this working in practice is Eindhoven University of Technology (TU/e) in the Netherlands. It has a heat and cold storage (Aquifer Thermal Energy Storage – or ATES) installation, which is one of the biggest of its kind in Europe. The ATES has been executed with two central rings: a cold ring and a warm ring. 70% of the TU/e campus is connected to the ATES network, which allows buildings to exchange heating and cooling with the ground as needed throughout the year.

The buildings forming part of the Campus 2020 projects are fully heated by means of the ATES in combination with a heat pump and low-temperature heating (in these buildings no natural gas is used for the heating). Likewise, the cooling of the buildings (high-temperature

▼ **Figure 3.18** *Central university library and the Faculty of Mathematics & Computer Science (W&I) by Ector Hoogstad Achitecten - part of the Compact Campus 2020 masterplan for Eindhoven University of Technology, Netherlands*

cooling) is realised by the ATES. There are currently 32 boreholes serving the network, soon to be extended to 48 (24 cold and 24 hot wells). Water flow is 2000 m^3/h now extending to 3000 m^3/h in final format with a design heating/cooling capacity of 25MW.

By storing heat and cold in the soil, TU/e annually saves some two million kWh of electricity and more than 300,000 cubic metres of gas.

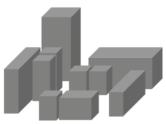
Both research and practice (e.g. TU/e) have shown that Cold Water Heat Networks (CWHN) offer significant benefits. University campuses are well suited to demonstrate these benefits, such as the forthcoming Balanced Energy Network (BEN) project at London South Bank University (LSBU). We are working to demonstrate this heat-sharing technology here in the UK, further linking in demand management of electricity and carbon capture and storage from high temperature fuel cells.

This would be a paradigm shift for how universities manage their heating, cooling and electrical loads. The very nature of estates management stands to change. The role becomes a constant monitoring of need and shuffling of temperature into and out of energy stores. Campus planning could be shaped around a CWHN. This is highly appealing to universities, which have a large mixture of old and new stock. By careful planning, matching new build with appropriate refurbishment, they can begin to balance the future heating and cooling demands and reduce the total need. Buildings could be strategically located to share heating and cooling demand, using borehole storage and waste heat recovery.

▼ **Figure 3.19** *Higher education estate carbon management*

A Existing estate

Understand the performance of the existing estate

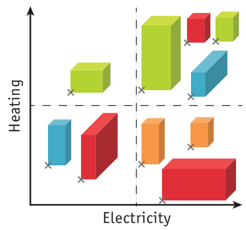


B Classify buildings

Identify categories review: age, servicing strategy, building type (science, engineering, general academic, non-academic, residential).

C Grade energy performance

Record annual energy use (electricity, gas, other) and floor areas. Compare across the estate and benchmark eg. CarbonBuzz. Identify high-energy users which may be suitable targets for intervention.

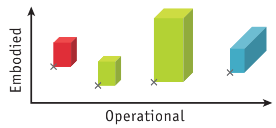


D Assess energy savings and compare with targets

Consider scope for operational carbon savings / reasons for high-energy use and interaction with occupants. Identify suitable interventions such as operational change, refurbishment and new-build options.

E Compare operational and embdied carbon

For each intervention, compare potential operational carbon savings with additional embodied carbon impact. A sense of scale is important: for HE typical lifetime embodied carbon impacts are in the range of 0.5 to 1 tonnes CO2e per sqm, whereas lifetime operational carbon emissions can range from 2 to 15 tonnes CO2e per sqm. As buildings become more efficient, the embodied carbon becomes far more dominant.

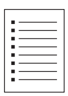


F Contextual factors

Consider contextual factors: heritage, future accommodation, changes in academic focus, wider society out-reach/integration, and construction disruption. Estate management and the institution's future plans influence these factors.

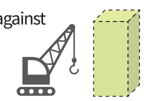
G Redevelopment brief

Using the contextual factors and the interventions identified in stages D and E, create the redevelopment brief. Capture the embodied and operational carbon performance expected for each building, using its unique characteristics.



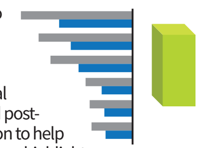
H Design and delivery

Evaluate design against the expected performance set out in the redevelopment brief. Ensure energy use of the scheme is measured appropriately. Review design calculation methods to reflect operational characteristics and predicted usage. Methods such as CIBSE's TM54 can provide a robust framework for accurate energy use prediction. Use Soft Landings processes.



I Operational performance

Carefully manage to ensure savings materialise in use. Carry out detailed monitoring, seasonal commissioning, and post-occupancy evaluation to help identify changes in use, highlight opportunities for improved efficiency and make suggestions for future buildings.



3.4 DESIGN, CONSTRUCTION AND HANDOVER

Ian Taylor

This section summarises important issues which affect project outcomes during the life of a development project with reference to Feilden Clegg Bradley Studios' Manchester School of Art as an example project at each stage.

PEOPLE: DEVELOPING TRUST AND A SHARED VISION

Post-occupancy studies of new buildings are demonstrating clear links between positive client engagement in the briefing and the design process, and subsequent good user satisfaction and building performance in use. When the user client group has been closely involved in the visioning and detailed briefing process, an engaged operation of the building develops which brings out the best in the use of the facilities. This should not come as any surprise. What is surprising, however, is that so little effort is put into ensuring that client project teams and their counterpart design teams and contractor teams retain consistency through the different stages of the project process, losing so many opportunities for better understanding of the context of decisions at each stage.

Continuity in these processes is a critical factor for success. Once a clear overall strategy defines the parameters for an individual project, so that priorities in the context of the university's ambitions are established, the success of any project is dependent upon the understanding, skills and drive of the individuals and teams involved.

- A strong project champion – a senior client figurehead – should remain involved throughout to hold onto the vision to help steer decision-making through the opportunities and challenges of the process.
- Continuity of the client team members, so that ideas can develop through each phase of the project, this should include the early involvement of both users and the facilities management (FM) team so that decisions on operation and maintenance are made within a common understanding of the aspirations for the project.
- A clear strategy for choosing the project team, identifying the skills and attributes that are sought from the construction industry in terms of design, management, cost control and construction will influence how and when the university chooses to appoint the design team. This selection process should be used to provide clear parameters for the priorities of the project, so that the skills of the team are suited to the ambitions of the client body. A design competition may be inappropriate for choosing skills in dialogue and briefing, while a developed, construction tender could elicit strengths in programming and process.

These factors create the context for the project and set the stage for the development of the brief through a creative dialogue with the client: prioritising where design effort and money is best spent to the overall benefit of the project. A building design project is, by its very nature, a vehicle that enables us to imagine a better future, and the process of that journey should in itself be an enjoyable and stimulating one. The best projects are those where a synergy develops between client and design team without too much intermediary project management, and where the solutions that arise through the process exceed the expectations of the client.

PEOPLE: THE MANCHESTER SCHOOL OF ART

This project established, and subsequently benefited from, strong working relationships between client, users, design team and contractors.

The architects had previously completed a successful project for the university, and a trusting relationship had developed with the estates office as a result of the approach and success of the earlier building.

There was a visionary and proactive Vice Chancellor, strongly advocating the benefits of good design and championing the importance of the physical estate.

The Dean of the Manchester School of Art wanted to engage in the design process in the pursuit of a transformational building for the school. Professor David Crow led a team who were interested to explore how the new environment could respond to their teaching ideas, and help shape a new collaborative culture. He wrote:

The chance to redesign the school for the 21st century was a dream job. We have a fantastic team of staff in the school who all recognise that this is an important moment for the school and the city. It is a moment that marks a change in art school education and it reflects the wider cultural shifts in our society.

It is also a chance to break down old divisions and reactionary attitudes that frustrated me as a student many years ago. There has always been a sense of hierarchy between the various disciplines in art schools. For some reason the terminology and the names often get in the way of a fully integrated practice. We were able to use the estate project as a chance to help remove these attitudes and reveal the common ground. It has also enabled us to help bridge the gap between education and professional life.

Our new building is a chance to design a space with our architects that celebrates the inter relation of our various fuzzy edged disciplines and encourage our 21st century students to work alongside each other and enjoy the crossover rather than concentrating always on the differences. It is also a building that is proud of its product and shows the work to everyone who passes by.

Professor Crow's observations on the relationships between disciplines in the Art School working in the completed building resonate for me with the process of creating architecture – and the relationships which I feel are so important for the creation of successful buildings:

I have a very healthy respect for all our disciplines and have grown to realise that we learn from each other all the time, that the past informs the future, that theory informs practice, and practice informs theory. Our processes are neither linear nor predictable. Our subject areas are not defined by our tools and job titles are often misleading. It sounds like a confusing picture, but to us, to artists, designers, craftspeople, whatever we are called, it's a hugely exciting arena where anything is possible and everything is relevant.

THE DESIGN PROCESS

It is important to develop a good understanding of the expected quality, cost and time parameters for the project, and to highlight the critical features of the development. Benchmarking against other buildings and spaces within the same client's estate, as well as visiting precedent buildings and exemplar schemes is useful. The design team should establish how the building will be operated and maintained, and encourage serious debate about whole-life value to inform decision-making affecting capital cost by consideration of in use costs, performance, adaptability and sustainability targets.

The design team should take care to understand the levels of experience of the university client body – some of whom may never have been involved in commissioning a building and may not readily understand two-dimensional drawings and building jargon. The designers and client team should agree on appropriate presentation methods (using models, drawings and other presentation techniques) to ensure that ideas can be explained in order to enable the client group to engage in the briefing and design dialogue. At all stages, the use of models and mock-ups to demonstrate scale, design ideas and to establish quality standards is invaluable.

It is useful to set out a clear programme for design development, to help the client understand when different decisions need to be made. It is important that this ties into a consultation programme so that separate internal client engagement and stakeholder consultation can genuinely feed into the design process

▲ **Figures 3.20 and 3.21** *Manchester School of Art, Feilden Clegg Bradley Studios*

at the most suitable times to benefit the outcomes in a timely manner.

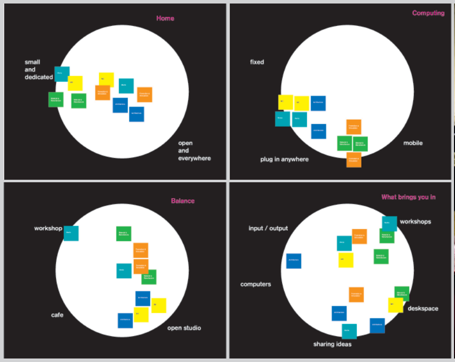
The design team response to the academic briefing, estates priorities and sustainability targets builds up through the work stages (as described earlier on page 93) and is usefully captured in design stage reports which should become ever-more detailed reference documents describing the project as it develops. Complex projects which require detailed coordination are well served by a design programme which allows for a comprehensive design team report at RIBA Plan of Work Stage 3 Developed Design, which should ideally be in advance of submission of a planning application, and before commencement of detailed design (RIBA Plan of Work Stage 4 Technical Design) There is often time pressure to submit both an early planning application and to commence technical design without a period to enable a strong 1:50 and 1:20 scale coordination process to be completed – both of which can add risk into the project, and could have adverse impacts on out-turn cost, quality and programme. Complex building briefs require careful thought, and time is needed to coordinate holistic solutions incorporating timely client input and review.

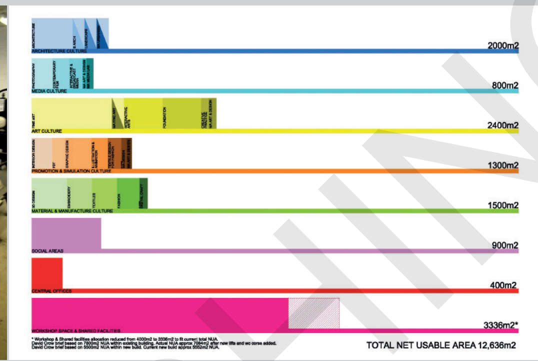
A well-integrated and strongly led design team is key to successful outcomes in projects which generally set demanding targets and have highly aspirational agendas. University clients deserve exceptional design and professionalism.

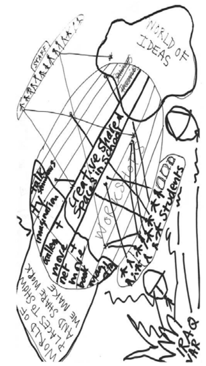
THE DESIGN PROCESS: MANCHESTER SCHOOL OF ART

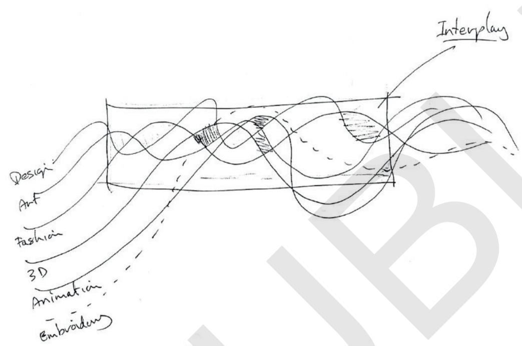
The design team need to capture the essence of the building brief, reflecting that back to the client so that the base functional data can be verified as correct, and so that interpretations of the brief can be explored in order to help prioritise issues and highlight the most critical features desired in new environment.

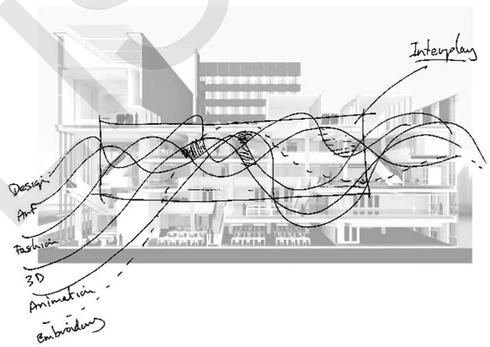
User consultation needs to be understood and categorised.







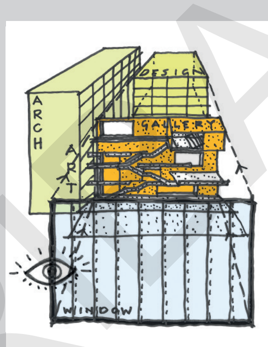


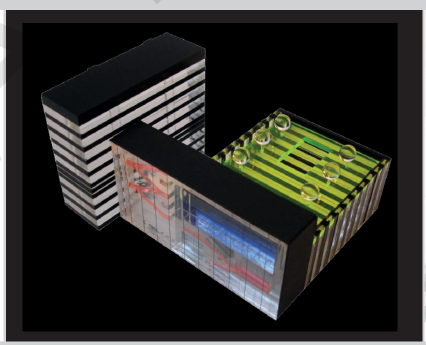


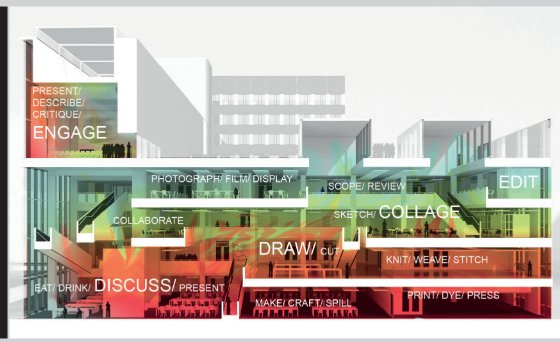
▲ ▲ **Figures 3.22, 3.23 and 3.24 (top row)** *Existing and anticipated uses need to be understood and represented in the brief*

▲ **Figures 3.25 and 3.26 (middle row left and centre)** *Ideas need to be well communicated*

▲ ▼ **Figures 3.27 and 3.28 (above and below)** *Different drawing styles and models are useful communication tools to represent design intent*







CONSTRUCTION

The positive impacts arising from continuity of staff experience and mutual understanding discussed at the start of this section equally apply to the individuals in the contracting building teams, and this has led many universities to develop framework arrangements with contactors (and design teams), which operate with varying degrees of success. The large scale of development that some universities are now engaged in can make frameworks attractive as long as cost issues are dealt with in a transparent and controlled process.

On the other hand, the specialist nature of certain projects is better served by one-off procurement in order to obtain very tailored services from specialist contractors and designers.

Highly constrained sites, either through their geography, urban context or building adjacencies sometimes create conditions which require significant construction advice early in the design process. Appointing contractors to give early advice, through framework arrangements or separate appointments to review access and building impacts is often critical for development decision-making. Mitigating construction impacts on the life and productivity of the existing estate – especially when a building project might run for the full length of a student's attendance on their course – become business critical issues.

The increasing use of less adversarial construction contracts, such as the NEC New Engineering Contracts, forms used in the UK is improving the building process and reflecting the idea of the more joined-up complete project team, where the contractor is seeking a similar set of successful outcomes as the client. Better integration between the client and contracting team is particularly relevant to the commissioning and handover process, where there can be genuinely improved outcomes by facilitating the early engagement of the client's building management team into witnessing commissioning and understanding the building systems on site, and then subsequently retaining the same client team to operate the building in use, alongside members of the contractor team to help optimise performance in the first years of operation. Any stand-off between contractor and building operator during the first year ('defects period') of operation resulting from apparent problems, can cause enormous damage to users' attitudes to their new environment. Contract terms must be established to enable more proactive responses.

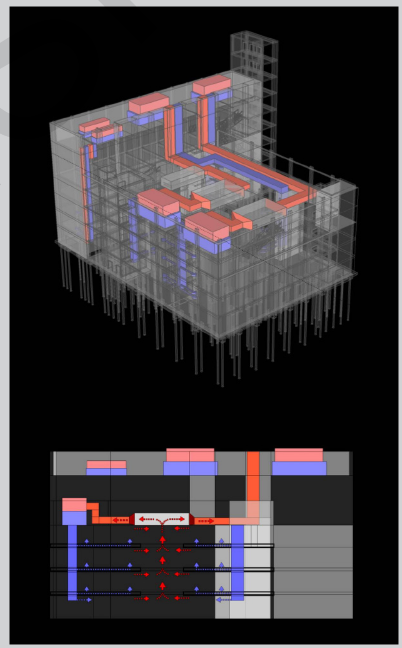
Once the building is handed over, much can be done to review and improve the performance of that building is in use, informing decision-making on the design of better spaces in the future, and influencing building design and strategic planning of the estate. Value and Performance are discussed in Part 4.

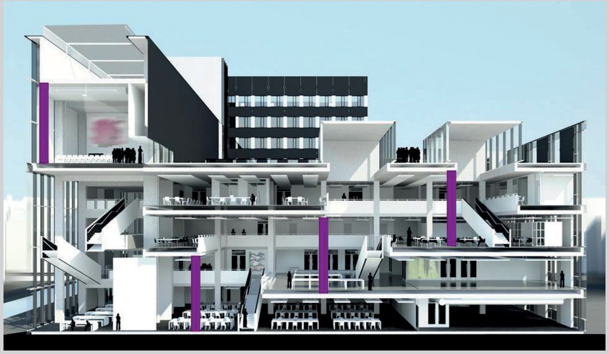
CONSTRUCTION: MANCHESTER SCHOOL OF ART

The design team needed to communicate design intent clearly for the contractor – providing clarity on the required quality of the completed building, and wherever possible engaging individuals in the contracting team to input ideas into construction methodology and best practice. On this project, the contractor was appointed before all the details for construction were complete, allowing for detailed development to incorporate contractor input.

▼ **Figure 3.29** *The detailed design of the façade was fine-tuned using tested mock-ups*

▼▼ **Figure 3.30** *Sustainable design features were prioritised with the contractor*





Figures 3.31
Development of the patterned feature concrete columns was a joint enterprise between mould casting manufacturers, the concrete contractor, the main contractor, architect and client