International examples of service-driven innovation in construction

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1 Introduction

In an international review of innovative practices to inform construction sector improvement from a services perspective it is instructive to look at the EC trend analysis on innovation strengths and weaknesses by country[1]. Their figure below (piii) highlights various points. One is that Sweden, Finland and more recently Denmark, the "innovative leaders", have impressive levels of innovation and that this appears to be linked to their all round performance on all seven innovation dimensions. So these should be good countries to include, especially as the first two are also "sector innovation leaders" specifically in services, as set out in the EC Sector Innovation Scoreboards[2]. It is also implicit that comparisons with the US would be of interest as the EU often judges itself against this benchmark (along with Japan, which it has not been possible to pursue in the time available). Interestingly the pattern of strengths and weaknesses in Sweden mirrors, but of course exceeds, that of the UK (p146).

The point mentioned above, about the all round performance of the "innovation leaders", also reinforces the benefit to be had from "improving areas of weakness [rather] than further improving areas of strength" (pii). This points away from a spill-over strategy and, in construction, highlights the need for a serious consideration of small companies and new perspectives, such as the services viewpoint raised in this report.

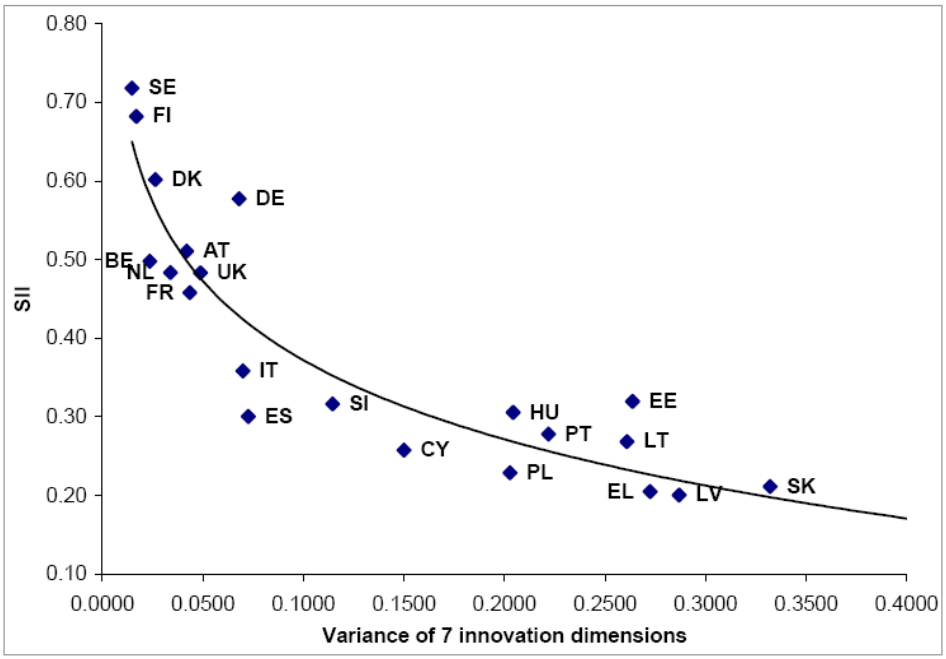


Figure 1: Negative correlation between variance and EIS performance

[1] Arundel A and Hollanders H (2005). Innovation Strengths and Weaknesses. European Trend Chart on Innovation, European Commission.

[2] It is worth noting that, despite providing expanded coverage, the sector innovation scoreboards still do not include construction.

Focusing on the build up of the UK's relative position:

- the UK excels around the educational dimensions of graduates and life-long learning;
- It is average on many other indicators, but;
- It lags significantly on public funding to firms for innovation (46% of the EU average) and, notably, SME collaboration in innovation, which lies at only 79% (p145).

Over the last fifteen years there has been a burgeoning of the services literature, but the key characteristic of the services perspective is captured by Gronroos' seminal expectation-perception gap model given below[3].

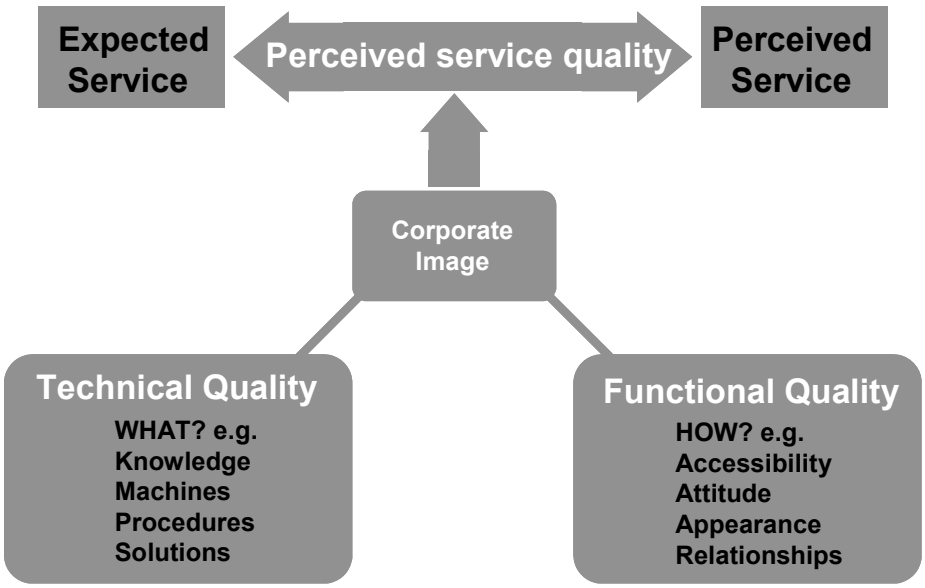


Figure 2: Expectation – perception gap

This highlights that success in services is entirely dependent on the client's judgement of the gap (positive or negative) between their expectation of the service and their perception of the service actually "consumed". That is, it has everything to do with the interactive delivery of the service, hence the importance of both *what* is done and *how* the service is delivered. The focus crucially has to be, not on features of the service, but on benefits to the customer. Hence the importance in this perspective of taking construction right through to the built artefact as "consumed" by users, with an emphasis on the benefits and value they (clients and users) derive from the built environment so created, delivered, maintained and adapted. A whole life cycle view is crucial, but it must be driven by the clients / users' needs.

In selecting countries and examples to consider the above has been taken into account, but primarily a search has been made to uncover and illustrate a range of interesting

[3] Gronroos C (1984). Strategic Managment and Marketing in the Service Sector. Bromley, Chartwell-Bratt.

and stimulating possibilities that can complement and extend the existing innovation paradigm. It is hoped that this will lead to more in depth studies and proposals.

A range of case studies will be presented in this report and out of these some major themes will be sought. The cases are as follows, layered from taking the client / user perspective more seriously, up through project level initiatives, to more generalised industry initiatives. Generally they are drawn from abroad, but where an interesting UK parallel is known it has been included:

- Client / user level
  - → USA: Using neuroscience to create built environments to treat Alzheimer's
    - ✓ UK: Using neuroscience to create good learning environments in schools
  - → France: Using customer feedback to tune hotel environments
    - ✓ UK: Using customer feedback to tune the retail environment
  - → Denmark: Creating an effective and influential clients' forum
- Project level
  - → Australia: Pulling benefits through to the use phase with an iconic project
  - → USA: Example of the 4Cs model of project excellence
  - → Australia: Example of the 4Cs model of project excellence
  - → Singapore and Hong Kong: Incentivising quality in products and processes
- Industry level
  - → Sweden: Competitive Building initiative to drive industry innovation
  - → Australia: Innovation through SMEs – the role of the CRC

In each case the aim has been to:

a) set out the motivation, history and features of the approach used
b) make an assessment of the utility of the approach used
c) give an indication of the possible lessons for the UK.

The cases are based on written material, which is referenced, and discussions with a wide range of individuals, who are listed in the Appendix.

2 Client / User level

Taking a services perspective at its most fundamental means starting with the client / user, working to understand their needs and responses to the built environments created and then fully taking this into account in the design, construction / adaptation and delivery future built environments. The subsections that follow look at this first from the point of view of basic human needs, then around the influence of explicit customer requirements and finally consider how an effective voice for clients at a policy level can be achieved.

2.1 USA: Creating built environments to treat Alzheimer's

Background and features of initiative

With an ageing population there is a growing issue in America, and in many other countries, around the care of patients living with Alzheimer's. For these people their brain degenerates and they become less able to cope on their own so that care in a community-based residential setting or a clinic of some sort becomes necessary.

Professor John Zeisel is a sociologist who after nearly a decade teaching at the Graduate School of Design at Harvard University, founded Hearthstone Alzheimer Care, which focuses on developing and managing Assisted Living residences for people living with Alzheimer's in and around Boston, Massachusetts and New York City, and the Hearthstone Alzheimer's Foundation which focuses on studying the effects of design and other non-pharmacologic interventions with this population. Hearthstone Alzheimer Care facilities are created using a holistic design approach driven by an analysis of the residual functioning of these patients' brains underpinned by insights from neuroscience[4]. The residences are all typified by the following practical characteristics, described on the company's website[5]:

- **Exit Control Doors:** These are designed to blend into the setting and have coded pushpads to limit residents' access to unsafe areas outside the residence without upsetting them and creating catastrophic reactions
- **Walking Paths:** Visually engaging paths with easily identifiable destinations transform aimless wandering and pacing into purposeful walking, thus encouraging residents to move around the residence safely and independently
- **Individual Privacy:** Providing residents with both privacy and the opportunity to be surrounded by familiar furniture, décor, and treasured objects aids them in maintaining a sense of self and improves their recollection and memory
- **Common Spaces:** Common areas designed to accommodate residential elements and spatial difference—with special attention given to kitchen, living room, and activity spaces—provide residents with the cues they need to behave appropriately
- **Outdoor Freedom:** Residents' access to safe and supportive healing gardens provides them with cues to time of day and seasons which reduces disorientation and sun-downing as well as comprehensible stimulation and a healing relationship to light, fresh outdoor air and the natural world

- **Residential Scale:** All rooms and furnishings as well as programs are designed to reflect a residential setting - to feel "homey"—reinforcing hard-wired brain elements that reduce anxiety and aggression
- **Autonomy Support:** Both Hearthstone's environment and programs encourage residents to use their remaining abilities to carry out daily routines and support them in doing so
- **Sensory Stimulation:** Sounds, sights and smells are managed so sensory stimulation is familiar and meaningful, over-stimulation is avoided, and total reliance on often damaged verbal skills is avoided

[4] Zeisel, J., J. Hyde, et al. (1994). "Best practices: An Environmental-Behavior (E-B) model for Alzheimer special care units." American Journal of Alzheimer's Disease **9**(2).
[5] www.thehearth.org

The experience of the specially planned residential treatment settings[6] is noticeably more homelike and less institutional than typical hospitals or care homes, with residents amongst their own effects, variety in the spaces and clear social foci in the kitchen area and the sitting room. The design is carefully tuned to be safe and controlling to quite an extent, but achieves this subtly without feeling threatening. The "environment" provided is not just physical, but articulates with individualised care regimes supported by a computerised system of patient records and staff actions. This reflects a strong service principle of viewing the experience in its totality from the user's perspective. However, in this review the emphasis is on the physical environment.

Assessment of the approach

This all sounds good, but does it have positive practical outcomes? Typically Alzheimer's patients display symptoms of agitation, aggression, depression, social withdrawal, misidentification and paranoid delusion. These can be measured using well established behavioural health measures and this opens up the fascinating possibility to assess the impacts of different built environment contexts, of course controlling for the degree of illness, use of drugs and the intensity of staff support.

In a study to make such an assessment[7], involving clinicians, 427 residents in fifteen special care Alzheimer's units were assessed. These units were selected to display variation on the dimensions listed above (such as camouflaged exits) so that statistical analysis could determine the effectiveness of each variable. None of the clinics rated highly on all eight dimensions, so the environmental design characteristics were rated for each and statistically combined in the research. The results clearly show a positive pattern of correlations between the behavioural indicators and features of the physical environment after controlling for other influences, that is:

- Reduced aggression and agitated behaviour and fewer psychological problems can be linked to privacy and personalisation in bedrooms, residential character and an ambient environment that residents can understand;
- Reduced depression, social withdrawal, misidentification and hallucinations can be linked to common areas that vary in ambience and exit doors that are camouflaged.

On the face of it, clearly identifiable benefits and reduced symptoms can be achieved in the treatment (not cure) of Alzheimer's through the careful design of the care environments provided. The paper from which these results are drawn goes on to make clear that "the greatest likelihood for this approach to make a significant contribution is to consider environment as one of at least three modalities – pharmacologic, behavioural and environmental – for improving the quality of life, health and behaviour of people with Alzheimer's disease" (p710).

Possible lessons for the UK

The implications of the above work are significant for provision of similar specialist care facilities in the UK. We have a similar demographic shift towards an ageing population and the principles set out in this case could potentially also translate well

[6] Based on a visit by the author

[7] Zeisel J, Silverstein N, et al. (2003). "Environmental Correlates to Behavioral Health Outcomes in Alzheimer's Special Care Units." The Gerontologist **43**(5): 697-711.

to care in the home strategies. There are significant gains to be had in terms of quality of life for the patients, with particular insights to address the very challenging costs and practicalities[8] of providing care.

In the context of this study the lessons are very powerful. They indicate how, by focusing on the needs of users and the neuroscience of the illness, it is possible to finesse designs in a number of quite simple ways. Providing they are then put together holistically, the results can be dramatic. This requires an effort to increase understanding of users' real needs at quite fundamental levels and here insights from neuroscience have proved vital in providing a basis from which to move towards design principles that can guide action.

2.2 UK: Creating good learning environments in schools

Background and features of initiative

The above work and many other perspectives came together at a workshop on 8-9 March 2007 entitled Senses, Brain and Spaces[9]. This involved twenty-seven experts covering five major dimensions: user groups (offices, schools, retail, and housing, with this last focusing especially on the specific needs of the elderly); sensory aspects (sound, smell, sight, including colour and light, artificial and natural, and natural planting); design (linked to the user areas), neuroscience expertise (related to the area of design and environment, such as on way-finding in buildings); plus a final group to encompass psychologists, sociologists and creators, focusing on individual responses associated with spaces, such as feelings on status, control and belonging.

From the work of the group it became apparent that there aspects of spaces do have compelling impacts, but that the curvilinear nature of these impacts and the interactive effects lead to complex design decisions. For example:

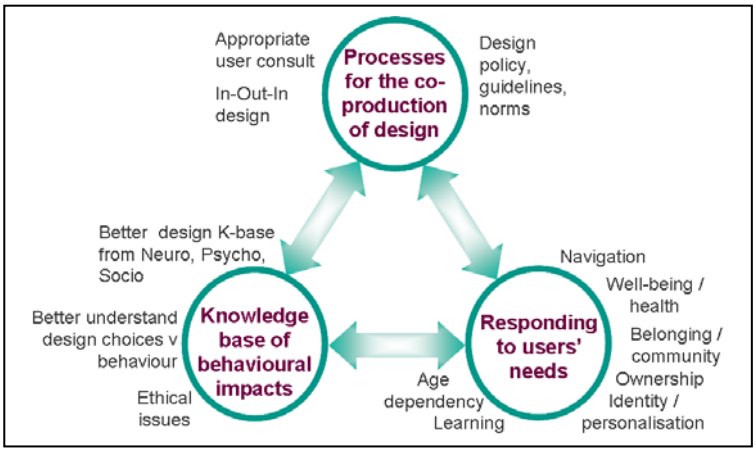
- For colour, the curvilinear issue of avoiding over or under stimulation and the importance of difference and balance, mediated to some extent by natural expectations, eg dark below and light above.
- Related to air quality, the varying decay curves for the perception of different smells depending on their natural source or otherwise.
- Taking natural light, the battle between the natural desire to be close to the window versus the problem of glare (with the former often winning!) played out in social settings where the number of people and their positions in a room make a significant difference.
- In acoustics related to performance, the interaction between the space and the performer, as well as the audience, in terms of "playing the room".
- The case of artificial lighting, that can tap into natural circadian rhythms with powerful impacts on involuntary emotions, complicated by the quite counter-intuitive effects of various coloured lights.
- Planting, that is bringing the natural environment indoors, with powerful impacts on mental processing, but also related social interactive opportunities too.

[8] Lansley, P. (2001). "Building research and the quality for life." Building Research & Information **29**(10): 62-74.
[9] http://www.rgc.salford.ac.uk/peterbarrett/m/?s=10

- At the interface of comfort in relation to heat and noise, the notion of curvilinear iso-annoyance curves across which the utility of possible improvement actions could be judged.

Linking this to insights from neuroscience and in particular the work of Rolls[10] it is evident, first, that the influence of the primal dimension of human functioning will strongly influence our emotional responses to spaces. It does not seem unreasonable to suggest that this is likely to be rooted in key dimensions of "naturalness" that should arguably infuse the design process. Indeed, supernormal stimuli, such as the noise from man made artefacts, such as cars and guns, can produce super strong emotions because the stimuli are much more intense (unnatural) than those in which our present emotional systems evolved and the subsequent responses are not necessarily adaptive (p450). Second, brain functioning highlights the personal way in which individuals build connections between primary reinforcers and complex representations of learnt secondary reinforcers. Taken together with the situated nature of memory, these personal value profiles lead to highly individual responses to space. This provides a sound basis to raise the potential importance of "individualisation" as an additional, key, underlying design principle.

The workshop identified that as well as improving our knowledge base of the (often unconscious) behavioural impacts of spaces on individuals there is a need to articulate this with responding to users' needs at a more practical, sociological level and to effective processes so that design can be appropriately informed by both (see Fig).



Link to these arguments the fact that there are major changes in the way children's brains function at different ages and the tremendous potential to contribute to the better design of schools should be apparent. Thus, a project has been established between Manchester City Council and SCRI at Salford University to work together to link the evidence base about the learning impacts of multiple sense experiences to design decisions for primary schools. Owing to the dynamic complexity of the effects, an action research approach is being taken focused on one school initially. The plan is to learn from post-occupancy analyses of previous schools built plus the experience of the designers and constructors and, critically, the educators. The new insights created will be fed into an augmented briefing and design process, including a facilitated workshop with the leading neuroscience-architecture advocate. The impacts will then be tracked through construction and into use.

[10] Rolls E T (2007). Emotion Explained. Oxford, Oxford University Press.

Assessment of the approach

It is too soon to assess the impacts of this approach, however, on the theme of *naturalness* there is some evidence about the impacts of day-lighting on learning. The Heschong Mahone Group[11] classified 2,000 classrooms in the United States for their day-lighting levels. Then controlling all other influences and using multi-linear regression analysis found positive correlations between the variables: that students progressed 20% faster in maths and 26% faster in reading in those rooms with the most daylight compared to those with the least. However a replication study[12] of different schools with different climate and curricula to see more fully the interactive affects of other variables, found daylight was not significant in predicting performance. Further analysis showed that other characteristics associated with day lighting, which did not exist in the earlier studies, such as noise, were affecting performance with negative effect. This illustrates both the potential scale of the positive impacts and the complexity of achieving them. On *individualising* spaces, workshops in the US have reinforced the notion that for schools, "one size does not fit all".[13]

There are of course lessons to be derived from work related to other building types. As examples, studies in a Swedish hospital on heart surgery patients, showed that the viewing of nature reduced their stress and need for analgesia compared to those in control groups[14] and the positive effect on hospital infections rates achieved through introducing high efficiency particulate air (HEPA) filters[15].

Possible lessons for the UK

On schools specifically, there is a huge building programme in the UK and an acute desire to improve pupil achievement. Thus, the potential for insights from neuroscience and an understanding of multi-sense experience to improve the design of learning environments is tremendous. However, like the specialist clinics covered in Section 2.2 this will have to play right through from those briefing for the spaces having a richer (evidence-based) understanding of what can be achieved, to those using the schools having a full understanding of which levers to pull to maximise the learning effect of their spaces. The fact that the Building Schools for the Future programme is under review and the primary school phase is only just starting in earnest makes any initiative in this area very timely. Ideally training and guidance for all those involved will be created, say powerfully illustrated through a multi-dimensional virtual environment.

Moving beyond schools, there should be general lessons for creating briefing and design processes that release users' knowledge and is informed by evidence about the

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[11] Heschong Mahone Group (1999). Daylighting in Schools. Fair Oaks CA, Pacific Gas and Electric Company.

[12] Heschong Mahone Group (2003). Windows and Classrooms: A Study of Student Performance and the Indoor Environment. Fair Oaks CA, Californian Energy Commission.

[13] Academy of Neuroscience for Architecture (2005). One Size Does Not Fit All.

[14] Ulrich R (1991). "The Effects of Interior Design on Wellness: Theory and Recent Scientific Research." Journal of Health Care Interior Design **3**(1): 97-109.;
Ulrich R, Quan X, et al. (2004). The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity. Designing the 21 st Century Hospital Project, The Center for Health Design.

[15] Joseph A (2006). The Impact of the Environment on Infections in Healthcare Facilities. Concord CA, The Center for Health Design.

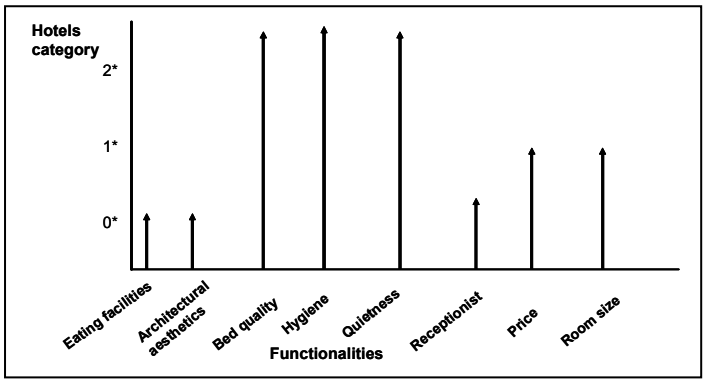
panoply of human needs. The major challenge is that evaluating the contributions of the various factors on the overall physical environments is difficult owing to the interplay of factors, and here, once base standards have been met, there is often no clear guidance on priorities. This is a gap that could be very fruitfully closed with multidimensional modelling techniques, once the base data has been established[16].

2.3 France: Using customer feedback to tune hotel environments

Background and features of initiative

The French hotel chain ACCOR[17] has a long record of innovation which is currently the subject of study by CSTB[18] and has also been reviewed in the Harvard Business Review in the past[19]. ACCOR operates in five continents with other 4,100 hotels and has forty years of expertise in hospitality. It is the world-leading chain in the budget, economy and mid-scale sectors, ranking fifth in the global hospitality industry based on offering 486,512 rooms at the end of 2006.

In the mid-1980s the lower end of the hotel sector was suffering from over-supply and stagnation. Accor's management decided to respond with a radical change to create a major change in the value offered to its customers so creating a new competitive position. The re-positioning was based on a careful consideration of the value profile on offer to customers respectively for 1* and 2* hotels. Then a radically new offering was designed that removed aspects that were expensive, but customers didn't really seem to value, such as: architectural aesthetics, lounges, restaurants, large bedrooms, receptionists. This placed it below 1* hotels, however, using the savings other aspects that matter a lot to customers were raised to above the level of 2* hotels, namely: bed quality, hygiene and quietness. Then this new brand "Formule 1" was offered at only a little over the rate for a 1* hotel with great success in the market.



Behind this market-facing analysis is an infrastructure and tradition of comprehensive innovation activity. Running from France's first corporate university to radical, modular offsite manufacturing of the bedrooms. These latter innovations halved the cost of construction and linked to the reductions in staffing demanded by the new

[16]Higgins S, Hall E, et al. (2005). The Impact Of School Environments: A literature Review. London, Design Council., (p36)
[17] www.accor.fr/gb/index.asp
[18] This section is based on presentation material and correspondence with Frédéric Bougrain, a researcher with CSTB.
[19] Kim W and Mauborgne R (2004). "Value Innovation: The Strategic Logic of High Growth." Harvard Business Review **Best of HBR 1997**.

business model led to a highly viable package, whilst at the same time providing customers with very comfortable beds in quiet rooms for around half the cost of a 2* hotel. The stream of innovation has continued with the launch in 1999 of the "Suitehotel" brand, a 30 sqm modular suite for the price of a conventional mid-scale room. This built on the company's successful manufacturing experience with "Formule 1". In 2006 the company built the first hotel in France to "High Environmental Quality" standards and, now, in 2007 "All Seasons" rooms are being prototyped. Their effort extends strongly into how the hotels are operated. For example high energy costs led around 2005 to a "Hotel Environment Charter" to raise awareness with staff, but this was buttressed by the provision of benchmarking data across the group and innovative longer term contracts with Siemens to invest to achieve energy saving targets.

ACCOR maintains this level of innovation through senior management commitment, a dedicated innovation and design department and a team approach to realising new hotel concepts. ACCOR act as "lead user", but engages all the other stakeholders in the development process so achieving co-production of the solutions that address both design / construction and maintenance / operation. Crucially ACCOR "innovates but also replicates". Thus, investments and experiments that work are consciously sucked into normal business, a process facilitated by the manufacturing nature of the volume production going on.

Assessment of the approach

The success of ACCOR, as a business that has on several occasions redefined its own market position, would seem to testify to the benefits they have derived from being consciously innovative. The approach is creative and comprehensive, but at its base depends on a simple check list driven by assessing value from a customer's perspective:

- Which factors are taken for granted by the industry and should be eliminated?
- Which factors add little to customer value and should be reduced?
- Which factors create significant value and should be increased?
- Which factors should be offered that are not currently available in the market?

It is interesting that a direct link is made from soft factors, such as customers' perceptions, to the conceptual design of the whole business model of which the built element is one integrated element. This then links directly to technical and practical innovations to efficiently and effectively satisfy the customers within the new business model. The power of the approach appears to be to a great extent a result of this holistic thinking.

Possible lessons for the UK

ACCOR have a big business and so a significant flow of projects, however, for any client with a reasonably big portfolio there are powerful messages around value-driven innovation. This could apply to a wide range of sectors and this includes the public sector.

The lessons are that, driven by a customer perspective of value, a comprehensive approach can be taken to radically and progressively innovating. That to achieve maximum impact this should link a clear understanding of customer needs to

innovative business models supported by innovative technical solutions for the whole life cycle of the facility. That innovating should be strongly linked to replicating successful solutions. It can be noted too that CSTB see real value in more widespread use of the ASTM standard[20] with its framework of seventeen dimensions of building functionality and serviceability.

For smaller, less sophisticated clients the opportunities to retrieve investment in new approaches or to change the market are less, but the power of understanding and being driven by customer value profiles is still very relevant.

2.4 UK: Using customer feedback to tune the retail environment

Background and features of initiative

Major retailers have around 35-40,000 customers passing through their doors and operate in an extremely competitive environment. For them property is a very significant investment, but is clearly seen as a means to the end of selling to consumers. So it is instructive to analyze how Sainsbury's approaches this challenge[21]. The fundamental basis of the approach is to constantly listen to their customers (and staff) and understand their needs and then to exploit the continuous flow of project work on their stores to very efficiently meet those needs. The investment of time and energy to capture those needs is extensive:

- For a *new* store:
  - → Market researchers will interview a 200 potential customers making up the likely profile for the location
  - → Those 200 will be brought in for facilitated focus groups in groups of 30-50. the fixed parameters are spelt out eg overall size of shop and then through discussion issues such as the following are revealed:
    - ✓ The retail offering for which there is demand in the context of local tastes and competition – will a fish counter be popular; is there a popular local butcher already?
    - ✓ The local employment situation for staff
    - ✓ The local traffic issues – when is congestion high re schools / factories and will bus routes work or even be relevant? What sort of parking provision is favoured?
    - ✓ Important aspects of the environment of the shop, layout, aisle widths, lighting etc
    - ✓ Local preferences about produce reflecting regionality
  - → Similar discussions are held with staff
- For a *refurbishment* the same process is followed, but the discussions with existing customers and staff are much more focused as they have direct experience of the store and a range of practical improvement possibilities are revealed.
- For each *existing* store about ten calls to customers are made each week informed by the company's record of their shopping behaviour to better understand the impact of the store on their propensity to buy. This is reinforced by specific data

[20]ASTM (2000). ASTM Standards on Whole Building Functionality and Serviceability. Conshohocken, ASTM.

[21] The following is based on two interviews with Neil Sachdev, Commercial Manager for Sainsbury's since March 2007 and before that with Tesco for over 28 years, with the responsibility over the last 6 years to deliver Tesco's UK Growth strategy and cost savings plans.

on sales every time a change is made anywhere in a store, say under-shelf lighting onto high end toiletries, which led to higher sales

- Each year two *concept* stores are developed to trial new ideas and for these the consultation and monitoring is specially intense, including full scale mock-ups in a warehouse around which feedback is sought from 200 customers and staff.
- Finally, and perhaps the most impressive indication of commitment to understanding customers (and retail staff), all 2000 staff involved in corporate services from the CEO down, and including property of course, spend every Friday of every week in the stores working alongside the staff on the ground.

Given all this information the question is how to use it to inform the design and operation of the stores. Here a decision has been taken to create a stable construction flow so that the learning can articulate with it in a progressive manner. So, stores are updated at five years and full refurbished every ten years. With around 460 stores this generates an annual programme of work of around 35 light and 65 intensive refurbishments, plus around 30 extensions and 15 new stores. Blueprints have been created for each generic size of store and these are developed and finessed so that the delivery of the stores is as efficient as possible. At Tesco's this led to a reduction in build cost from £250 to £115 per sq ft over five years. Taking a holistic view of engineering services, rather than letting consultants address, lighting, heating and ventilation and cooling separately led to savings of £1.5M per store. And beyond this, framework arrangements lead to very competitive pricing by suppliers, based on bulk purchasing, and with chosen consultants by providing a reliable flow of around 80% of the work. For standard items, however, competition is opened up to additional vetted bidders and e-tendering on an auction basis is increasingly used.

Assessment of the approach

It is beyond the scope of this report to assess the success of Sainsbury's, but they are patently performing as one of the major players in the retail market. A more apposite question for this study is: have the customer's views really made any difference? The extensive consultation described above allows stores to be tuned to local circumstances, but a lot of the feedback does confirm what is already known, however, there is "something always something new". Out of these processes the evidence has been gathered to: change the tradition of providing "warm" lighting to an emphasis on "natural" lighting; redesign layouts so that sweets are not placed next to checkouts as it irritated adults with children at a complicated part of the process of shopping; (from staff feedback) change layouts to keep stockrooms close to frozen goods to minimise warming time; progressively introducing self-scan checkouts as customer like (even though takes longer!); trialled popular concept by building a store around the "worlds" within one store to give local specialist shop feel, but found that in practice efficiency was more important to customers; ditto more complex aisle layouts.

Sainsbury's appear to invest heavily in both listening to customers and trying things out experimentally in a restless search for better built solutions to meet customer needs. In many ways customers want simplicity and stability in their shopping experience so that they can efficiently and quickly get the shopping done. So

designing stores that work smoothly and intuitively is a major aim and feedback from customers is key to understanding and achieving this. There is a belief that stores can be "better (for customers) – simpler (for the business) – cheaper. "If we are obsessed with the customer then we can usually get all three".

Possible lessons for the UK

For any client with a flow of projects, the lessons are clear. However competitive the market, or maybe this is a driver itself, investment in understanding customer / user needs and gaining continuous feedback should be a key driver of innovation. These major, sophisticated clients can then exploit their programme of work to codify good practices and make the processes involved as efficient as possible.

For those with fewer projects the size of the investment that can be afforded will be less and the capacity to justify sub-optimal results for individual projects because of the on-gong learning will be really quite difficult to argue. However, this case highlights what can be achieved if customers' needs are placed at the centre of the construction process – and ultimately this is a frame-of-mind that any in the industry can adopt, rather than a set of activities hat only a few can afford.

2.5 Denmark: Creating an effective and influential clients' forum[22]

Background and features of initiative

It is notoriously difficult to create and sustain a healthy clients' association in construction. This would appear to be a consequence of the highly heterogeneous nature of construction clients and their, often, temporary interest in construction. However, it is also self-evident that such a group must have areas of common interest and can potentially have much to offer in ensuring the demand side for construction has a voice.

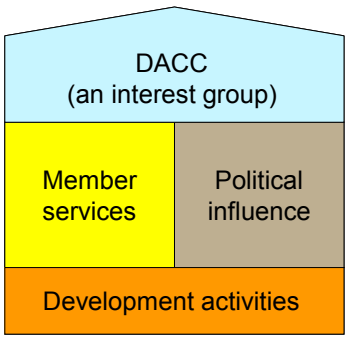
The Danish Association of Construction Clients (DACC)[23] is a rare example of a successful clients' organisation. It was established 17 June 1999 by 28 major construction clients. The initiative was inspired by the Ministry of Housing which saw a need for a strong, single voice from the demand side of the construction sector. The focus was on the professional client and their associated needs and demands. DACC works to achieve improvements in quality and productivity in both building and civil engineering. The needs of construction users are considered especially important. From the beginning the focus has been on a number of themes:

- Formulation of common views and interests
- Influencing framework conditions through dialogue with the authorities and other associations in construction.
- Engaging members in networking and exchange of experience
- Developing new knowledge and new methods and tools for members
- Developing training and courses for member employees

The organisation comprises nine board members, a number of work groups and a small secretariat taking care of day-to-day activities. The Ministry of Housing provided some initial seed funding (200,000 Euros over first three years), but the

[22] Since its inception Dr Henrik Bang has led the DACC secretariat and he has provided most of the detailed material for this section, supplemented by some involvement of the author with the work of DACC over the last few years, which particularly informs the reflection on possible lessons for the UK.
[23] See www.bygherreforeningen.dk

main source of funding has been members' fees. Members can be divided into four main groups: State and state owned clients; local government (regions and municipalities); housing associations; and private clients (developers and business). Crucially there has been a strict rule from the start that membership is not possible for any organizations with a supply side dimension, eg contractors and design consultants, but also developers.



In recent years the membership base has grown and currently comprises approximately 70 clients with 800 staff covering around 15-20% of the total demand for construction in Denmark. After a period in which the secretariat was part-time, then seconded, the decision was taken from the beginning of 2004 to establish an independent secretariat with a stronger profile, which now comprises three full time employees, with some student support. The annual budget is now ~£200k made up of 80% members' fees and 20% course / training income. DACC works in three strategic areas (see Fig) and in recent times:

- The number of work groups have increased to 10 with a high level of activity
- Several development projects with external funding (foundations) resulting in new tools, guidelines etc, for example around partnering..
- The level of training activities has been increased to a level of 5-10 new short courses annually and plans for modular training programme. Typical topics tendering and conflict resolution.
- The level of influence has increased through early involvement regarding new legislation and initiatives from public authorities and other construction associations.
- A more active stance has been achieved to the press and other media.

Assessment of the approach

DACC has been successful in establishing a common voice for all professional clients (across building/civil and public/private divisions) in Denmark. Contributing to the success has been the decision to exclude contractors and design consultants as members. However, the weakest point as to the membership base is the limited number of private clients, especially the absence of large manufacturing and service firms as members.

The funding of DACC through membership fees is quite limited, and subsequently the secretariat is quite small compared to those of the other associations in construction. However, many members contribute actively to the activities of DACC in "grass roots" fashion. This is an indication of growing client identity and community, with construction clients seeing themselves as part of a movement for gaining influence. This is achieved by questioning the status quo and the future development of framework conditions such as procurement procedures, standard forms of contract, handover / rectifying defects, dispute resolution procedures etc. These are issues for most if not all clients, but individually their scope to bring about change is limited, but 70 large clients adopting similar procedures for specific activities is a powerful force of change.

Possible lessons for the UK

Having a powerful, informed and credible voice from the clients of construction at a national level is a vital asset if construction is to be driven to innovate to become more customer / service orientated. In the UK efforts have been in train progressively over the last ten years or more to create a consolidated strategic focus around groupings such as CRISP and now the Construction Technology Platform. This has provided a focus from the supply side, but efforts to draw in a strong demand side perspective has not, seemingly, been so successful. There is a question as to whether a single national forum is actually desirable and it is notable that the Danish clients' association is strongly independent raising the notion of a vital dialectic between various stakeholder voices. This seems a looser, but arguably more dynamic and richer way to imagine creating a consensus around a meaningful shared vision for construction.

The lesson from Denmark seems to be that a lean and effective client grouping can be created with a very small investment of seed funding. However, its membership has to be strictly drawn from the demand side only and the association created needs to become independent of its original support and self-managing. It needs to provide a for a mix of members' needs including training, but its success will ultimately depend on having significant strategic influence on the framework conditions within which clients have to do business. Here it is crucial that Government legitimises the voice of the clients by consulting and responding to their views at the early stags of legal and policy developments.

3 Project level

3.1 Australia: Pulling benefits through to the use phase with an iconic project

Background and features of initiative

The Australian Government's Facilities Management Action Agenda was announced in January 2004. One of the outcomes was the FM Exemplar Project: Sydney Opera House, to demonstrate FM as a business enabler. The work has been carried out by the CRC for Construction Innovation[24], a seven year unincorporated joint venture funded by the Government and involving a range of universities The aim of The FM Exemplar Project[25] is to use "applied research to contribute to the body of FM industry knowledge … and [to] showcase Australia's FM applied research expertise on the world stage" (piii).

The SOH business is significant in its scale, with some 1500 performances per year to 1.1 million patrons; 1000 other events are held each year and 4.5 million people visit; SOH has income of about $80M pa and spends about $19M each year on maintenance and capital renewal.

The project is focused on three main research streams:

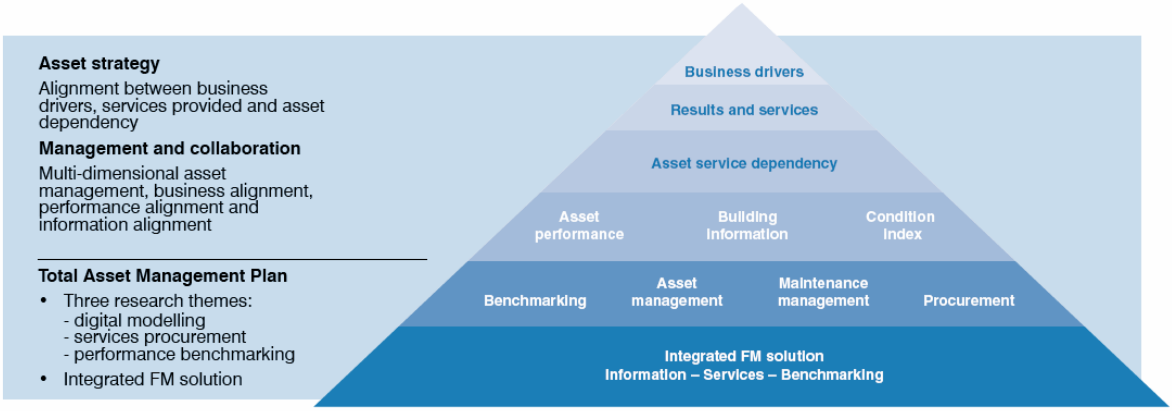
- digital modelling
  - → developing a building information model capable of integrating information from disparate software systems and hard copy, and combining this with a spatial 3D computer-aided design / geographical information system (CAD / GIS) platform.
- services procurement
  - → developing a multi-criteria performance-based procurement framework aligned with organisational objectives for FM service delivery
- performance benchmarking
  - → developing an FM benchmarking framework that enables facilities / organisations to develop key performance indicators and (KPIs) to identify better practice and improvement strategies.

These research themes were then linked to the SOH's overall Total Asset Management Plan and Strategic Asset Maintenance Plan so making a strong connection to the practical business of the opera house (see Figure below from p5 of the CRC report).

A lot of detailed work has been carried out by research teams working in the three chosen areas, mapping and trialling the linkage of the themes right up from

[24] The information for this section was provided through correspondence by Dr Peter Scuderi, Chief Operating Officer, Research and Commercialisation, of the CRC, through two detailed reports (referenced below) and informed by a tour of the SOH hosted by Paul Akhurst, Director of FM there.
[25] Cooperative Research Centre for Construction Innovation (2007). FM as Business Enabler: Solutions for Managing the Built Environment. Brisbane, Cooperative Research Centre for Construction Innovation.

operational issues to explicit connections with the overall business aims of SOH. A significant degree of fragmentation of data, decision-making and relationships has been revealed and with it the potential to make improvement through the more seamless integration of the parts.



Assessment of the approach

The project has made significant progress, but is still underway. Some stimulating initial findings have been strongly promulgated to the sector through high quality publications. These contain messages in the form of quite detailed case study descriptions, covering a number of issues. For example, the argument is made about the need for and benefits of linking integrated FM solutions to business objectives and this is played out in some detail illustrating the implications for cascading benchmarked KPIs within an "integrated performance hierarchy assessment model". This is extended to the infuse procurement practices with an innovative tendering process for outsourced FM services that included strong stakeholder consultation and representation, plus the need form those tendering to convince the SOH that they, for example, had "a personal passion for SOH – the icon" and "an understanding of 'inspiring experiences'" to get past the first sift (p16). The feasibility and value of digital modelling using an open data exchange standard, such as industry foundation classes (IFCs), is demonstrated. In fact this aspect has become such a linchpin for the necessary knowledge management to underpin many of the other innovations that can link integrated FM data to business performance measures that a separate report[26] has been produced on this subject.

This second report is solidly about using building information models (BIMs) again with SOH as the iconic case. The Opera House did not have digital models of its structure and of course is a very complex geometry. The opportunity then was to investigate how a standardised BIM model could support the FM function. This involves the digitisation of design documentation and operational and maintenance manuals within the data structure of a BIM. Tests with partial BIM data, provided by several of the SOH's current consultants, demonstrated that "the creation of a complete Sydney Opera House complete model is realistic" and that IFC-based exchange is possible between the various consultant's applications leading to a "geometrically accurate" partial model containing rich information about "objects",

[26] Cooperative Research Centre for Construction Innovation (2007). Adopting BIM for Facilities Management : Solutions for Managing the Sydney Opera House. Brisbane, Cooperative Research Centre for Construction Innovation.

their properties and relationships (p17). It is clear that the extension of this approach more generally across the industry is being strongly advocated.

The benchmarking mentioned above has involved data gathering in collaboration with the facilities managers of twenty-two other iconic buildings around the world, such as Opera National de Paris, but also other uses like the "Turning Torso" apartment block in Malmo, Sweden and Portcullis House in Westminster. This displays an ambition to look worldwide for insights and information which is impressive, but the utility of the hard data revealed has been limited owing to the diversity of the sample. There is, however, unrealised potential to benchmark practices such as procurement and a framework has been established to make fuller use of the network that has been created.

Running throughout the publications is the potency of the SOH as a national icon such that it gains attention, gives credibility and carries a message that if it is good enough for SOH then others should seriously consider these issues. There is a synergy around the pride about SOH and the pride that Australia wants to be seen lead to be leading in this area. There is also no doubt that the innovations are being developed and tested in a hard headed commercial environment which again adds to the credibility and impact. This initiative stemmed from an action plan for the facilities management sector and has proved a vital way of achieving momentum. With such a visible project, no-one can afford to let it go wrong!

Possible lessons for the UK

In some ways this is a high risk approach to innovation. The project is very much under the spotlight, but as described above this gives the work done a potency and influence that probably could not have been achieved in any other way. The act that it is being reported here is indicative. The issues being addressed are notoriously tricky: gaining greater credibility, professionalism and linkage to business drivers for FM has been relevant for the UK for many years[27] and has gained urgency as the focus has moved onto value in use[28]; capturing the value of data throughout construction for the use phase is rarely achieved at great cost as information has to be recreated[29]; and, lastly, driving the sector to some common ICT exchange platform thus making feasible integrated data management for an industry predicated on temporary teams has long been a challenge. This last is something that researchers in Finland have been actively working towards for many years[30] and in Norway the defence industry is apparently demanding that all its consultants work on a common platform[31].

So, on these difficult issues this case shows the power of a client working with researchers in a concerted way to provide a high profile exemplar of what can be achieved such that the business of the client is enhanced.

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[27] Barrett, P.S. & Baldry, D. (2003). Facilities Management. 2nd Edition. Blackwell Publishing

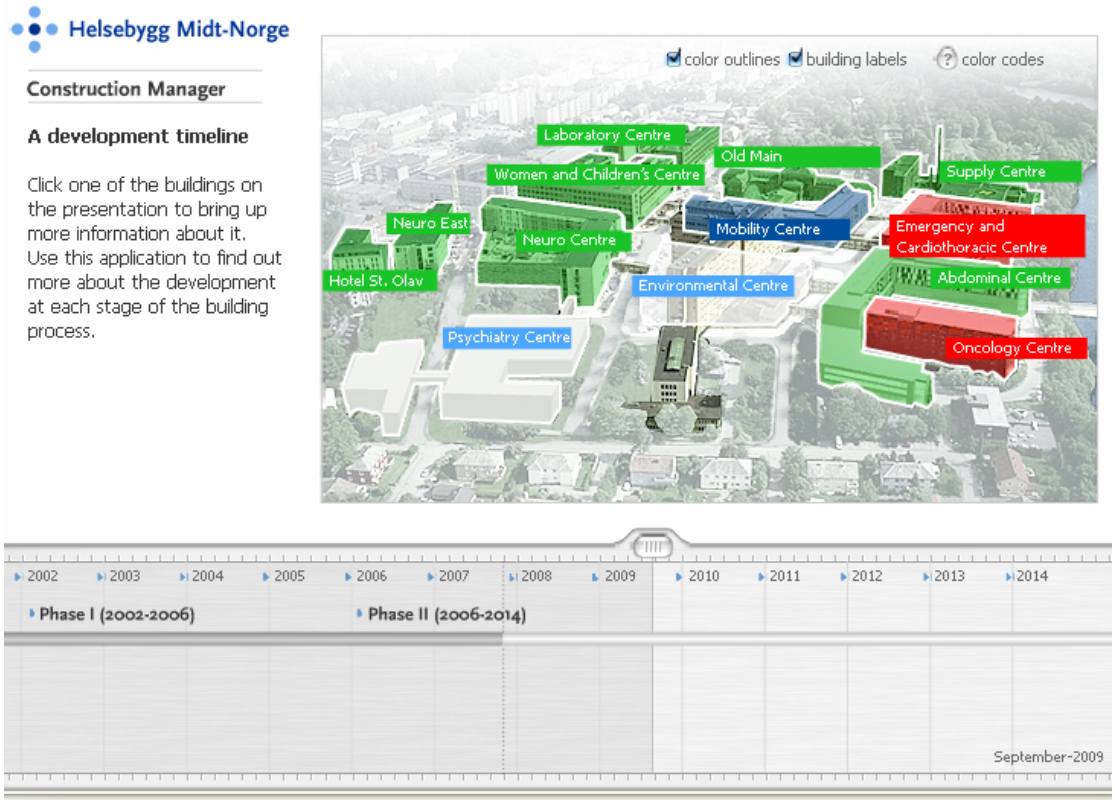
[28] Saxon R (2006). Be Valuable: A Guide to Constructing Excellence in the Built Environment. London, Constructing Excellence.
Barrett P (2007). Revaluing Construction. Oxford, Blackwell Publishing.

[29] Gallaher, M. P., O'Connor, A. C., Dettbarn, J. L. & Gilday, L. T. (2004) Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry. National Institute of Standards and Technology

[30] Information from Matti Kokkala of VTT and following report:
Uusikyla P, Valovirta V, et al. (2003). Towards a competitive cluster: an evaluation of real estate and construction technology programmes Helsinki, TEKES.

[31] Egil Skavang, Chief Executive of the Building Cost Programme, Norway

There are other examples of significant projects being used in this way, for example in Norway where the largest construction site outside of the oil and gas industries is for a new hospital, St Olav's in Trondheim[32]. Given the scale of the investment the approach to this project assumes a "heavy obligation" to innovate to create learning for the industry and to make the benefits created clear to the public. Thus a whole range of innovations in the organisation of the project have been implemented, including psychological profiling[33] as part of the partner selection criteria which had only 20% on price, and a careful elicitation and balancing of clinical / patient demands against practical engineering constraints. To meet the desire to communicate publicly the project has an very informative website www.helsebygg.com showing the scheme as it will unfold up to 2014 (see below), plus many details of the ideas and aspirations and how they are being implemented to provide innovative health care in advanced facilities. The web site has an English dimension in order that international connections can be forged with the notion that in this way learning from other's experience will be gained. Phase 1 of this project was delivered on time and £50M under budget. For the subsequent work the project has just been awarded a national design prize for the quality of its architecture and the environment created to help people get better.



[32] Information on this project was provided by Tom Rellsve of RIF in Oslo some years ago and more recently updated by Arve Olav Solumsmo of the developers Helsebygg Midt-Norge

[33] Dr Endre Sjovold provided more details of the group psychological profiling technique used called SPGR, which is derived from Bales work and subsequent development. For this project the emphasis was on the abilities of the teams assessed to respond to change and maintain an external focus. For some details of the SPGR tool see Sjovold E (2007). "Systemizing Person-Group Relations (SPGR): A Field Theory of Social Interaction." Small Group Research **38**(5).

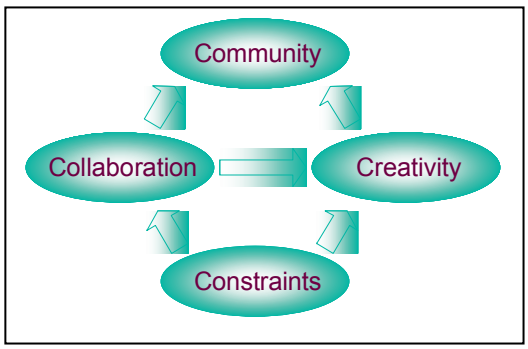
3.2 USA: Example of the 4Cs model of project excellence

Background and features of initiative

The 4Cs model emerged out of a synthesis of seventeen mini-cases elicited from workshops carried out in five countries[34]. Those participating totalled forty senior individuals representing a good cross-section of the interests around construction: 35% had a background as clients, 38% as consultants, a further 27 % came from contracting. The mini-cases were the result of individual responses to a question as to *the* construction project or activity that in their long experience best exemplified the creation of value, with the reasons for their choice.

These exemplary projects were typified by being subject to significant constraints, which drove those involved to collaborate strongly, spurring the team to innovative responses which not only triumphed against the demands of the project itself, but also impacted positively on the community around. Hence the 4Cs model as shown.

Within this framework some fuller case studies were built and that from the USA is given here[35] and an Australian case is given in the next section.



Hypertherm Inc. is based in Hanover, New Hampshire, USA. It is a medium-sized manufacturing facility employing 350 people and producing hi-tech metal-cutting equipment sold all over the world. In 1993 it expanded its manufacturing floor from 8,000 sf to 15,000 sf and added a 2-storey office structure comprising approximately 30,000 sf. The project was initiated in a conventional fashion, by hiring an architectural firm to provide a program (brief) and apply for zoning approval for expansion in its rural and natural setting (protecting wetlands, minimising tree cutting, protecting natural fauna etc). The inadequacy of the conventional briefing process for a complex change management problem led to innovative ways of making design and construction decisions and resulted in a building considered to be a major asset to the company. These are described below using the 4Cs structure.

Project *constrains* were in the form of limitations on form and extent of expansion imposed by the protected rural setting, a conventional budget, and the conventional approach taken by design and construction professionals to creating the new work environment for Hypertherm. The CEO rejected the brief submitted by the architects on the grounds that the rapid growth of his company required more than simple linear expansion of existing square footage; a larger organisation required a different structure to be successful. The construction company offered design services but discouraged innovation on the grounds that any unconventional aspect of the building would cause costs to rise.

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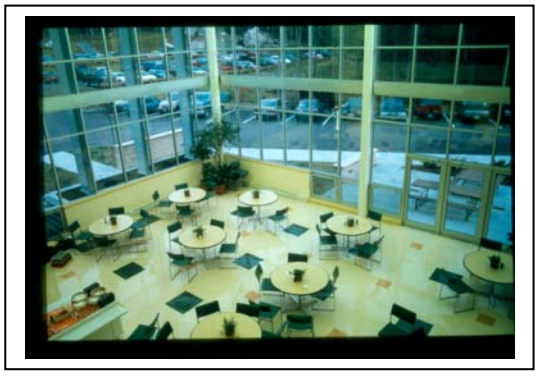
[34] Barrett, P.S. and L.C. Barrett (2006) "The 4Cs Model of Exemplary Construction Projects". *Engineering, Construction and Architectural Management*, Vol 13, No2, 201-215.

[35] Drawn from the above and based on material and discussions with Professor Jacqueline Vischer of Montreal University, who has provided an extended description in: Vischer, J.C., (2005) *Space Meets Status: Designing Workplace Performance*, Spon Press.

So, the architectural firm responsible for providing the initial brief was replaced by a small firm of work environment specialists which led to new forms of *collaboration*. The specialist's mandate was both to help the company determine its new form and structure, and also to facilitate the process of making key design decisions for their new work environment. The facilitators established a process whereby senior managers agreed on their definition of the new organisational structure and they helped them communicate this to employees. A secondary process, to involve employees directly in design decision-making regarding the design of their new work environment, was implemented to ensure buy-in from all levels of the company. The outcome of this extended briefing process was then communicated to the contractor, to ensure that detailed design and construction decisions continued to respect the client's new goals and values.

The abandonment of the conventional design and construction process offered a series of opportunities for *creative* problem-solving. Briefing, for example, had to be redefined, and a new process was implemented to involve users at all levels. At the same time, principal decision-makers (the CEO and the senior management team) engaged in defining the new organisational structure and in setting overarching goals and design principles that subsequent decisions had to respect. In this process, the brief became a vital tool for continuing to inform and guide design as the project evolved. Design development became an opportunity to involve more end users in the process, and gave them a say in the workspace they would eventually occupy. The process inspired a new and more creative relationship between the contractor and both the design team and the client. Through being involved in planning and managing change, the contractor participated in finding innovative solutions to technical problems that arose during construction, such as, for example, increasing ceiling height (distance between floors) in order to permit suspended indirect lighting in the office areas.



Hypertherm moved into the new building in 1996. As a result of their close involvement in all stages of the process, the firm's employees as a *community* took ownership of the new space and adapted smoothly to the new organisational structure and way of working. There was a feeling of being pioneers and successfully leading change, which led to a positive esprit de corps, in contrast with more usual employee reactions of fear of and resistance to change. The senior management team had opted to occupy the same open-plan workstations as employees, who then saw this as a commitment to the new work environment and to the egalitarian values it represented. In addition, Hypertherm employees proudly invited clients, vendors and new recruits to visit the building, considering that the new work environment was a major selling point for the company. This was positively viewed by the local *community*, for whom Hypertherm was a major employer, and also helped in recruiting new staff to this rather remote and rural part of the state. In the months after project completion, Hypertherm was voted the best place to work in New Hampshire.

Assessment of the approach

In this particular case it is apparent that the company's CEO was determined that the construction project should respond to directly to his business needs and become an intrinsic part of how the company was to achieve radical organisational change. This constraint or over-riding demand led to new forms of collaborative working through the involvement of work environment specialists. They played a creative role in objectively and independently revealing and arbitrating between the company's business needs and the built solutions and in the process engaged staff so that they had a strong feeling of ownership. The end results were positive in practical terms, but more importantly for the company it had been able to use the construction project to contribute significantly to the core operation of the company and the morale of its staff which often suffers during radical organisational change.

Looking more generally across all of the seventeen minicases and the three more detailed cases (only two of the latter are covered in this report) it has proved possible to credibly describe the key aspects of these projects that led to their success. The model seems to be robust across diverse sectors on hugely different scales. It has provided a relatively simple framework to help gain an understanding of, often, highly complex projects. However, it also became apparent that it is important to explicitly cover contextual issues, and especially, the measures of success that were especially relevant to each project. The model stresses connections between the parts as experienced in the real world and so provides some indications of bridges between these issues. For example, strong connections between procurement-driven enhancements in broadened collaboration and issues in the areas of briefing, design and sustainability, not to mention the satisfaction of those involved.

A major aspect within all of this is the role of constraints and the interesting question, in the project arena, as to when is a constraint a positive factor and not a restraining force? The answer would seem to be when it is stated explicitly, clearly and early on. Further, when it is demanding enough to define the project, prioritise and re-orientate behaviour around a super-ordinate goal and provide a clear measure of success. This is aided by a situation where other (less important) parameters are dealt with flexibly so that appropriate collaboration and creativity, both technical and organisational, is facilitated to meet the challenge. In this way the constraint has provided a clear space to work within and this certainty can clearly be stimulating provided sufficient flexibility with the remaining resources is available. This contrasts with most restraining forces that sap energy and hold back initiative and hamper creativity. Another pertinent aspect is the nature of the constraint itself. Far from being arbitrary, participants clearly understood and accepted the rationale for these constraints, whether social, time or environmental. Success with such a task is then explicit and the pride of the participants in these projects was clearly evident as they told their stories.

Possible lessons for the UK

The specific US case described here clearly illustrates the power of a determined client having the confidence and support to drive the business needs throughout the project and into the use of the facility so created. This is a shift in mindset from construction or even buildings as the focus, to these factors as means (amongst others) through which the client and their business / staff can achieve *their* ends. The role of

specialists in achieving this is interesting and indicates one approach to achieving a step change through the introduction of inclusive processes and measurement of the likely impacts on productivity and motivation of design choices.

The main message from the general case study synthesis revolves around the dynamic between the creation of major constraints for projects and their capacity to break the usual construction paradigm, so driving new forms of collaboration that release creativity, and ideally leading to community (users and broader) benefits. This will only happen if the focused drive so created is matched by a willingness to be flexible and risk-taking on the less important dimensions. The value of this flexibility is often not appreciated and a dysfunctional package of major demands and tight control results. Getting buy in and understanding of all involved is vital so that their collective problem-solving skills are continuously brought to bear.

3.3 Australia: Example of the 4Cs model of project excellence

Background and features of initiative

This case study has the same general provenance as that in section 3.2. However, the focus here is on William McCormack Place in Cairns[36]. This is a four–storey commercial building of 4,568 square metres developed in Cairns by Queensland Department of Public Works in order to provide sustainable office accommodation. A private sector construction manager, with an overall budget of $17.5m constructed the building.

The characteristics of the development is now set out within the 4Cs framework described in Section 3.3

The driving *constraint* for the project was provided by strict environmental sustainability targets under the Australian Building Greenhouse Rating Scheme, which demanded that the project had to meet at least a four star level. The rating that was achieved actually exceeded the five star level by 15%, equivalent to 317 tonnes of greenhouse gases saved. Such energy performance savings for the owner worked out at $6.75sq.m/annum as opposed to the projected $5 sq.m/ annum. The project had also to minimise environmental impact throughout its entire life cycle whilst still being a commercially viable unit that could flexibly accommodate a high churn rate of users. In terms of the actual construction work a requirement was made that particular attention should be paid to adverse environmental issues, pollution in terms of dust, mud, noise, and water run off.

In order to incorporate and deliver the environmental sustainability targets it was seen as essential to have honest, open business relationships and shared vision between the various stakeholders. The *collaborative* makeup of the project team reflected this objective. Overarching control of the project was in the hands of the facility management team that was to have responsibility for the management of the building

[36] This case is based on conversations and correspondence with Graham Messenger of Queensland Government, Department of Public Works

in the long term. Further, staff of the Environmental Protection Agency, as a major tenant, were also engaged in the design work. Local indigenous cultures were also involved in the project, with large-scale Aboriginal works promoting community ownership of the building.

The constraints set by the environmental targets stimulated *creative* responses in the design team. For example this can be seen in relation to the design and operation of the air conditioning unit. The inclusion of a thermal wheel enabled a 25% reduction in the size of the refrigeration plant and consequent energy savings. These innovative designs will result also in large life cycle costing savings in maintenance and capital replacement. The design of the external structure incorporated long lasting, low maintenance materials. Internally the fit out was also driven by the need to be ecologically sustainable in order to maximise the flexibility of the building throughout its lifespan. For example workstations were designed to use recycled components and mechanical fixing to facilitate dismantling. The design of the building as whole will enable the majority of its façade and internal components to be recycled. Resistance to budgetary pressures and an unwillingness to compromise on the environmental goals stimulated these project design solutions.

In line with the sustainability agenda the importance of economic sustainability in the local *community* was not overlooked. The project used local firms and materials and in addition many will be used in the day-to-day operation and maintenance of the property. The building also contributes to the social environment of the area, with landscape, planting and art works used creatively to make the building feel accessible, inclusive and inviting for the community.

Assessment of the approach

As already mentioned the final project exceeded the environmental impact targets that were set. Further it was completed on time, at $400,000 below the business plan budget. It was notable for putting the facilities managers in overall charge of the project and extensively engaging users and the community.

Possible lessons for the UK

It can be seen that the project set out to be, and to great extent appears to have achieved, a sustainable development approach: with a balance across environmental, economic and social issues. It is also evident that this was a result of the clear presence of the user perspective throughout the project. The innovations achieved were extensive covering process, organisational and technical domains, but all focused towards the projects clear environmental objective.

The other feature that is implicit in all of the 4Cs cases is how a focus on one driver can have very positive spill-over effects on other performance dimensions. So this project did meet environmental challenges, but also came in on time and below budget. The intense focus demands high levels of effective management and so good performance on a number of fronts can be achieved. This is an important refinement of the "focus plus flexibility" set out above, because it suggests that it can produce innovations leading to a wide range of benefits, no just in the focal area identified.

3.4 Singapore and Hong Kong: Incentivising quality in products and processes

Background and features of initiative

In response to concerns about poor quality of workmanship resulting from a shortage of skilled construction workers to cope with the building boom around that time the CONQUAS (construction quality assessment scheme) was launched in Singapore in 1989 by the Construction Industry Development Board[37][38]. The objectives of the scheme were to have a standard quality assessment for construction projects and to make that assessment objective by measuring construction works against workmanship standards and specification, whilst using a sampling approach to suitably represent the whole project[39] . In 1998 CONQUAS 21 was introduced for public projects; and similar schemes for private work and for civil engineering work were also launched.

The assessment in now CONQUAS consists of three main components: structural, architectural, and mechanical and electrical works, each of which is further subdivided in to different items for assessment and this assessment might be a site inspection, tests on the materials or on functional performance.

The minimum standards for these assessments were derived from consultations with major agencies operating within the public sector. The buildings within the assessment are categorised in five main bands with the weightings of the different components (structural, architectural, mechanical and electrical) varying between them (see Fig[40]).

Components	CAT A Commercial, Industrial, Institution & others	CAT B Commercial, Industrial, Institution & others	CAT B Private Housing	CAT C Public Housing	CAT D Landed Housing
Structural Works	25%	30%	25%	35%	30%
Architectural Works	55%	60%	65%	60%	65%
M&E Works	20%	10%	10%	5%	5%
CONQUAS Score	100%	100%	100%	100%	100%

The scheme provides an indicator of building quality and also gives a 0.2-5% tendering advantage in public building sector tenders to contractors if their average CONQUAS scores are above a given level.

[37] Information for this section was made available by Dr Florence Ling at the NUS

[38] Kam C and Tang S (1997). "Development and Implementation of Quality Assurance in Public Construction Works in Singapore and Hong Kong." International Journal of qaulity and reliability Management **14**(9): 909-928.

[39] Building and Construction Authority Singapore (2000). CONQUAS 21: The BCA Construction Quality Assessment System, Building and Construction Authority, Singapore.
Ling F (2005). "Models for Predicting Quality of Building Projects." Engineering, Construction and Architectural Management **12**(1): 6-20. p9

[40] Op cit CONQUAS 21, p4

Assessment of the approach

In Singapore the incentive has proved successful in encouraging contractors towards higher quality standards. Since the launch of the scheme in 1989 more than 2,238 public and private building projects have been assessed and the industry average CONQUAS score has increased steadily from 67.9 to 80.6. Thus it has provided a tangible measure of build quality, whilst allowing some balancing of emphasis across different building types. Owing to its success a similar scheme called PASS was introduced in Hong Kong in 1990 and is extensively used.

Possible lessons for the UK

The focus on a significant factor, such as build quality, and measuring it so that it can be rewarded, is not something that has been systemised in the UK, where typically cost and time (both easily measurable) tend to take precedence. There have been some criticism of companies with high PASS scores doing poor work because it is only based on the previous six month's performance, so a full understanding of the schemes and careful thought would be needed as to how they would best be organised and incentivised in the UK context. However, this is an interesting example of tried and tested metrics related to the physical quality of the product of construction.

There is a potential further benefit in identifying key features to drive improvement in that it has been observed that this can lead to generalised improvements in performance. This is a feature that has been spotted by the Construction Industry Institute (CII) based in Austin Texas. They work actively with industry on, amongst many other things, targeted safety programs and one of the main benefits is efforts to address health and safety focused on hazardous situations "pay off by not only reducing injuries on the job site, but also contributing to an 'on time' and 'within budget' project delivery"[41] (pv). This is a perspective the UK Health and Safety Executive has also promoted. This sort of multiplier effect deserves careful attention and is raised in the 4Cs cases above too.

A final insight is provided from some work[42] in Australia on the impact of financial incentive mechanisms (FIMs) within large non-residential Government building projects. Through building a longitudinal view based on numerous interviews and other hard data, clear evidence was found that FIMs themselves did *not* have a major or necessarily positive impact, but that the following conditions surrounding the projects did: equitable risk allocation and management; scope for future project opportunities; harmonious project relationships; early contractor involvement in design stages; and, value driven tender selection process.

[41] Target Safety Research Team (2006). Targeted Safety Programmes. Research Summary. Austin Texas, Construction Industry Institute.

[42] Tim Rose has carried out a detailed analysis of four projects and kindly made his PhD data available. Rose T (2007). Effectiveness of Financial Incentive Mechanisms in Australian Government Large Non-Residential Building Projects. Faculty of the Built Environment. Brisbane, Queensland University of Technology.

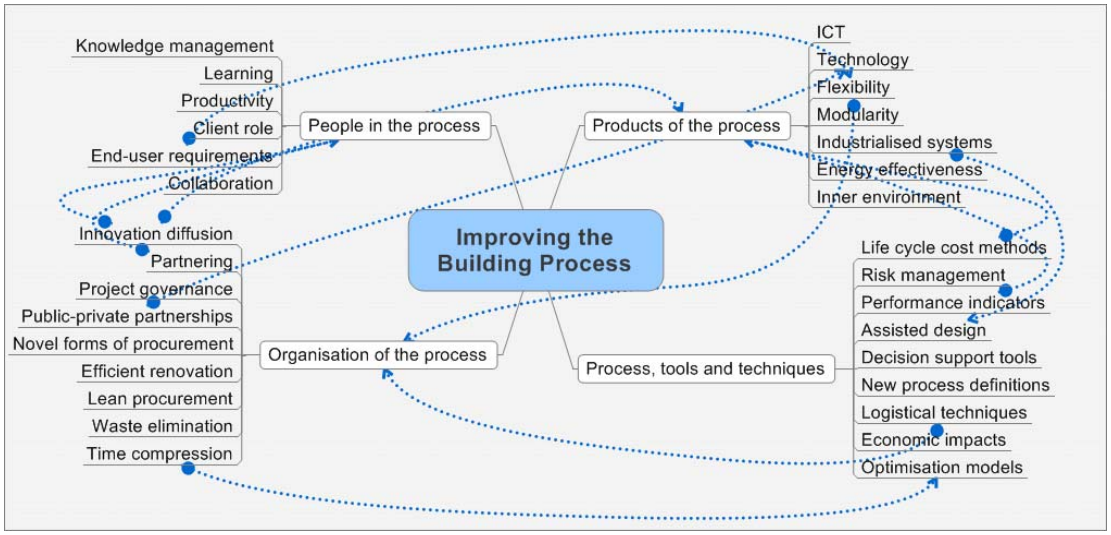
4 Industry level

4.1 Sweden: Competitive Building[43] initiative to drive industry innovation

Background and features of initiative

This is innovative collaborative approach to: stimulating innovation in the Swedish construction industry to achieve more efficient processes, enhancing its human capital to pursue future innovations and shifting the emphasis in the university sector to support process and managerial initiatives. The main source of this information has been assessment reports[44] from the programme management, supplemented by discussion with Professor Brian Atkin the Programme Director and informed by the author's direct experience as a member of the scientific council responsible for refereeing proposals.

The programme began in 1998 and is planned to run until at least 2008. The programme received funding of around 4M euros from the Swedish Foundation for Strategic Research and this was matched in kind by industry contributions. The core of the programme is a series of industry based research projects around which four partner universities and seventeen industrial organisations collaborate. The topics covered by the various projects are summarised in the figure below[45]. It can be seen that there is a wide spread of topics around four major themes, but all solidly related to the core issue of "improving the building process".



At the centre of the collaboration are so called "industry doctors", who are postgraduate researchers working on practical problems, but towards personal awards of licentiate degrees or PhDs.

[43] www.competitivebuilding.org

[44] Competitive Building (2004). Competitive Building 1998- 2004. Lund, Lund University.; Competitive Building (2005). Competitive Building 2005. Atkin B. Lund, Lund University.; Competitive Building (2006). Final Report of Phase II of the Competitive Building Programme. Lund, Lund University.

[45] Thanks to Brian Atkin for this figure.

The four universities; Lund, Chalmers, Lulea and the Royal Institute of Technology together are funded to support a "Research School for the Building Sector", which is organised by the Programme director. This provides workshops on topics such as: research methodologies, strategic perspectives on the building process and international real estate and construction. In addition study tours to Asia-Pacific, North America and Europe have been provided. This initiative is reaching the end of its funded life and it is intended that the partner universities will continue to support a primarily virtual network.

Assessment of the approach

The programme has created a shift in emphasis amongst university researchers towards process issues, whereas before technical research was dominant. Over thirty projects have been supported each of which has engaged industry partners in an issue of concern to them. Nine doctorates and 27 licentiate degrees have been awarded and the individuals concerned plus others, amounting to 300 attendees, have attended the doctoral school meetings and virtual networking facility. Over 250 papers have been produced together with a Best Practice article series, which hs proved very poplar with practitioners. There is a website that is supports the researchers buit also is industry-facing.

Assessments in 2000 and 2002 recommended greater internationalisation and deeper engagement with industry. The outward-looking international aspect has certainly been addressed and the Swedish initiative enhanced by linking to the Nordic Graduate School for the Construction Sector with eleven university members. The engagement with industry is harder to assess., but probably reflects the tension between immediate application and study towards academic awards. Having said that significant practical impacts have been achieved by the researchers within some of the companies and here there is evidence of these people working as human vectors for innovation in the sector, which was the longer term aim of the programme.

As the formal scheme comes to an end there is a question as to how effective a purely virtual network will be – only time will tell, but it is hard to substitute for "human glue" between the researchers.

Possible lessons for the UK

This concerted effort to support the industry in becoming less technically obsessed and more orientated towards process and clients' needs is a good example of how to fashion something that is both industry led but more than the sum of its parts. The emphasis on developing human capital is excellent, especially in its international orientation and represents a long term investment that should pay dividends. For the UK similar funded collaboration across universities around a postgraduate programme would be a possibility and the principles could possibly be applied to a "programme" of KTPs with shared training and support.

The existence of the Three Pillars initiative being led by Malcolm Dodds of Constructing Excellence is relevant here. This already has many industry players highly motivated around the core client-orientated themes of post-occupancy evaluation, briefing and evidence-based design. What they lack is research resource to provide reflection and analysis to match their innovation and aspiration.

The active effort to gain an international perspective evident in the CB initiative also typified the initial stages of the major Dutch construction industry review, PSIBouw[46], which has been developing over the last three years. This was initiated by Dr George Ang[47] of the Dutch Government Building Agency and exploited study tours involving a mix of international experts and senior industry / academic actors from construction in the Netherlands. This revealed a range of issues to take into account, including the necessarily long term nature of reform processes, together with the need to refresh the initiatives across political cycles. It has of course subsequently moved to an operational phase and is rather early to assess success, but it is clear that those leading the change had the wisdom to realise that others elsewhere have been addressing similar issues and there were lessons to be learnt, albeit they need interpretation into the local situation.

4.2 Australia: Innovation through SMEs

Background and features of initiative

The Australian Construction CRC for construction innovation has been deeply involved in engaging with and encouraging small construction companies to innovate[48]. A major stimulus for this has been a report commissioned by the Australian Department of Industry, Tourism and Resources, which has highlighted the important role of "incremental innovation"[49]. The report entitled "Embracing Change" aimed to "fill the gaps in our knowledge of how Australian firms innovate in ways that are not generally related to R+D" (p5). It was based on case studies of 30 companies, which it was known had innovated it terms of either their: procedures, personnel practices, processes, or structures. In fact it was found that in the past two years most of the companies had actually introduced innovations in at least three of the four above areas, emphasising the systemic nature of successful innovation. The firms were diverse in all respects and about a half were service firms. The studies revealed that despite their innovative nature these firms were rarely in the position to patent their inventions / processes. Further, only a (manufacturing) minority had received government assistance in the form of grants, mainly because "the type of innovation in which they were involved could not be defined as formal R+D" (pp6-7) and that innovation support programmes "were divorced from the realities of doing business" (p8). The service sector firms studied were found to "continuously revise their knowledge base as a result of on-going contacts with clients" (p8). This chimes with research in the UK[50] that found that small companies in construction are tightly aligned to satisfying client needs and that this is the major driver of incremental, project-based innovation with formal encoding of the learning across projects as a significant challenge, hence an emphasis on tacit knowledge and teams. For these small companies and for larger companies the existence or otherwise of a conducive

[46] www.psibouw.nl/generiek_pagina.asp?L=2&id=5156

[47] Dr Ang has contributed a chapter about this process:
Ang G (2007). Competing Revaluing Construction Paradigms in Practice. Revaluing Construction. Barrett P. Oxford, Blackwell Publishing**:** 83-104. (Chapter 11)

[48] Dr Karen Manley of the CRC has kindly provided access to the information mentioned here and provided an overview perspective

[49] Thorburn L and Langdale J (2003). Embracing Change: Case Studies on how Australian Firms Use Incremental Innovation to Support Growth, Department of Industry Tourism and Resources.

[50] Barrett, P.S., Martin Sexton, (2006), "Innovation in Small Project-Based Construction Firms", *British Journal of Management*, Vol 17, No 4, 331-46.

business environment is key to whether longer term company innovations will happen. This involves issues such as stability, confidence, profitability and absorptive capacity.[51]

Through the BRITE project the Construction CRC has actively worked on encouraging incremental innovation covering the above four areas. This draws from construction industry case studies[52] of contractors to illustrate in practical ways approaches and tools for others in the industry to achieve innovative performance. This includes benchmarking information and numerous suggestions to stimulate incremental innovation, including advice on how to access Government support, but also other aspects of the innovation ecosystem such as networking via industry associations.

The case studies demonstrate that incremental innovation is driven by market-pull factors, often involving non-technological activity, such as linkages with global experts; relationships with manufacturers and clients; or building trust between project stakeholders. This is in contrast to radical innovation, which tends to be driven by technological-push factors. The distinction underlies the relative importance of organisational skills, compared to technical skills, for the majority of innovation undertaken in the Australian building and construction industry. The case studies also illustrate the long-term benefits flowing from formalised research and development (R&D) programs. More significant however, is the evidence that non-R&D innovation activity can also provide considerable benefits. This finding is in keeping with growing evidence nationally and internationally, and across industries, that R&D and non-R&D innovation activities are equally important in improving business performance. However, the case studies suggest that for the building and construction industry to improve the R&D side of their performance, there needs to be a rethinking of the Commonwealth Government's R&D tax concession, which currently favours the manufacturing industry.

BRITE works intensively with Australia's construction industry associations, particularly the Civil Contractor's Federation and the Master Builder's Association. BRITE also has close relationships with key government clients, particularly, Qld Dept of Main Roads and Qld Dept of Public Works. Relationships with construction firms are also extensive, with BRITE managing a National Database of Innovative Contractors, containing nearly 100 registrations. Ongoing relationships are also maintained with SMEs, such as AirConserve, Quickcell Technologies and McNab Constructions, and large firms such as ARUP, John Holland and FRH Group.

Assessment of the approach

The aim of the BRITE project is to grow a more vigorous innovation culture throughout the construction sector, especially amongst SMEs. The publications produced are of a very high standard and are presented in a way that is clearly calculated to be attractive and accessible to industry. This is enhanced by explicitly

[51] Barrett, P. & Sexton, M.G. (1998) Integrating to Innovate, the Construction Industry Council. DETR / CIC: London.

[52] Cooperative Research Centre for Construction Innovation (2007). Being the Best. Talking with Highly Innovative Contractors. Brisbane, Cooperative Research Centre for Construction Innovation. Cooperative Research Centre for Construction Innovation (2007). BRITE Innovation Gallery 2007. Brisbane, The Cooperative Research Centre for Construction Innovation.

showing how businesses can reap substantial benefits from adopting and extending innovation developed by others; a process known as adoptive or incremental innovation.

There has been strong demand for these industry-orientated industry publications and extensive media coverage. More tangibly, over 28,000 copies of BRITE industry reports have been diffused to stakeholders within the national construction industry, including site workers, SME managers, industry association representatives, event attendees, public-sector client managers, and media editors. Since 2003, 200 articles have been published in over 46 different industry publications, including Business Review Weekly, concerning the case studies and associated activities of the BRITE Project.

Latest figures from the Australian Bureau of Statistics show that Australia's construction innovation rate grew 4% between 2002-2004. It is likely that BRITE's case studies are a contributing factor behind this growth. An external review of BRITE's impact was conducted by the STEM Group, with their 2006 report showing that 65% of respondents to their survey felt that BRITE case studies have had a positive impact on overall industry attitudes to innovation in Australia, while 90% of respondents felt innovation adoption rates would increase over time because of the BRITE case studies.

Possible lessons for the UK

The BRITE case studies have been explicitly modelled on the Egan Demonstration Projects in the UK. They probably show many parallels with the work of Constructing Excellence. What is interesting about their work is the clear identification of the full range of innovative activities that can be included and here a clear Australian Government steer is important. The identification and promotion of the value of incremental innovation, involving aspects such as innovation in procedures, personnel practices, processes, and structures, opens up the field for many industry layers who would otherwise feel excluded from innovation only defined to include that which is R+D-driven. This shift in worldview is implicit in taking a services perspective seriously and has significant implications for the measurement and support of innovation at a national level.

Picking up on this last point, the nature of the work done by the sector has particular characteristics, but also its composition is notable with small companies massively predominating. TEKES, the research and innovation funding body in Finland, has had for some time a big technology programme focused on the "real estate and construction" sector (a choice of grouping influenced by a service standpoint). In a recent review[53] entitled "Towards a Competitive Cluster" it stated: "the role of TEKES has been more integrative in this cluster than in other industries, which is due to the special characteristics of the cluster" (p39). So not only is the type of innovation different from the "traditional science" model, but the nature of the support has to be different to be affective too. A specific example of TEKES commitment is the VERA project with 43M Euros funding, 20M from TEKES and, quite unexpectedly the balance from industry. The push here is to develop the

[53] Uusikyla P, Valovirta V, et al. (2003). Towards a competitive cluster: an evaluation of real estate and construction technology programmes Helsinki, TEKES.

technologies to facilitate information flows during the entire lifecycle of the building. Good progress has been made as set out in the above review, for instance on the use of IFCs. The work has included actions to overcome adoption barriers and this is proving of benefit to the Finnish industry internally, but is also likely to be an export strength (p19).

The gap between incremental and systemic innovation in construction has been studied by Stanford University and VTT in Finland[54] and the predominance of the former noted, reinforcing the importance of positively grasping this aspect so that the general performance of the industry can be enhanced in lots of small ways by many, many small players. They also highlight the need for very comprehensive approaches to achieve radical innovation that effectively change the market, even if pursued by very large players. The case study about CORAS in the NESTA "Hidden Innovation" report illustrates this too.

It is also notable that the Australian BRITE scheme engages widely with industry associations. These are reference points and meaningful networks for many small companies. Such engagement is something that could perhaps happen more strongly in the UK. For example, in Norway the professional institutions have agreed together on a balanced "code of ethics" for the industry – see table below.

Legality	Fair competition
Environment	Cooperation and mutual respect (Samspill)
Profit for all	Balanced contracts
Satisfying client's requirements	Conflicts of interest avoided
Justice and respect for employees	Discrimination avoided

Although the impacts of this are not yet known the institutions have worked hard to promote the code[55] so endeavouring to improve the climate for productive and creative co-working. On a more general note, there would seem to be a clear opportunity for UK professional organisations to be encouraged and supported to play a more prominent role in the EC's FP7 research and innovation programme, which has a significant focus on SMEs and SME *associations.*[56]

Creating a positive innovation climate for the many small companies in the industry is not easy, but there are some additional examples from a number of countries. For example in Norway[57] there is a tax deduction system for industrial R&D that encourages cooperation between the industry and the research institutes. This is considered to be a supplement to the more traditional ways of R&D funding, especially addressing the more close-to-market projects. So far the Norwegian experience has been good, especially because this has resulted in a lot more companies (especially SMEs) getting involved in R&D than what would otherwise have been the case. So, for companies carrying out systematic R&D activities, SkatteFUNN[58] is often a natural first step. All companies are entitled to take part in

[54] Based on a presentation by Tapio Koivu of VTT and private correspondence. The publication of these results has yet to happen
[55] Feedback from Siri Legernes at RIF in Norway.
[56] EC (2007) Research for SMEs and research for SME associations at a glance: The FP7 funding model, European Commission, Brussels
[57] Based on information provided by Svein Willy Danielsen of SINTEF
[58] Website (in Norwegian): www.skattefunn.no

this scheme, which offers tax deductions of up to 20 per cent for a company's expenses in connection with R&D activities for approved projects. "User- driven innovation" projects implemented by a company itself are eligible for a tax reduction of up to NOK 800,000. Long term research projects can be supported for "research driven innovation" if they are implemented in cooperation with an approved research institute and can receive a maximum reduction of NOK 1.6 million. The Research Council of Norway offers the opportunity of partial financing of research and development projects

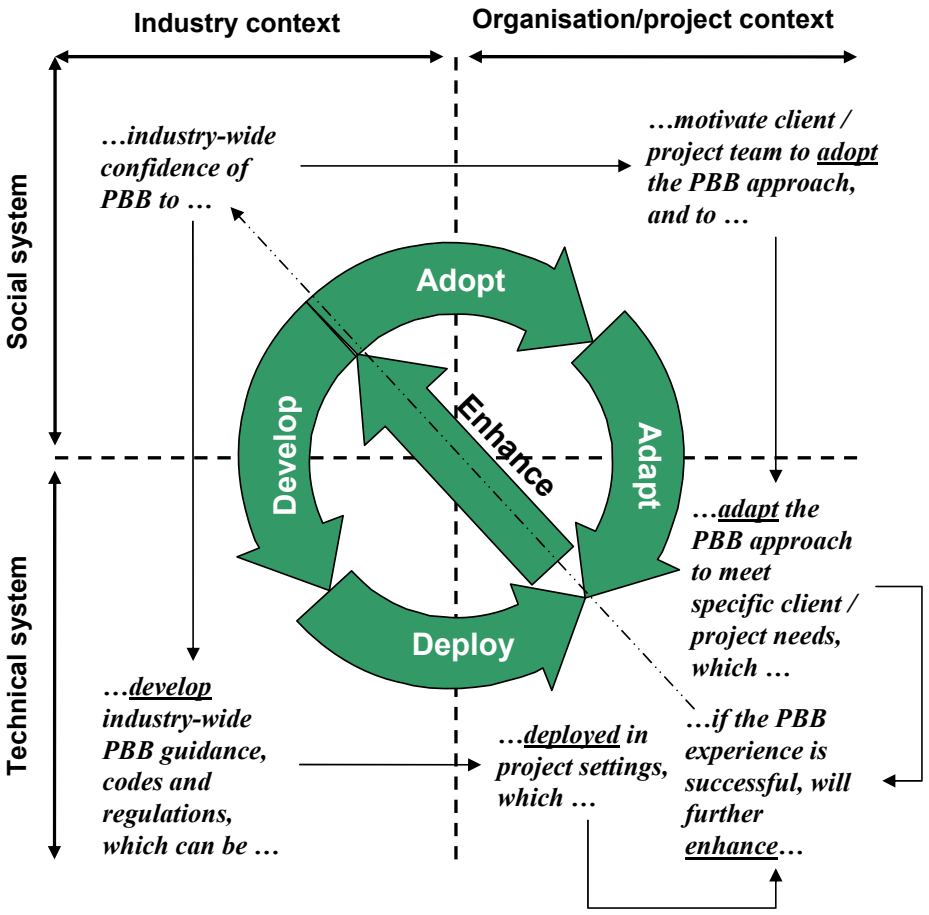
On a broader front, in Norway again, government legislation is being used to make it mandatory to consider life-cycle costing in the design of new public buildings. A similar requirement to consider "partnering" has been legislated for in Denmark since January 2004. These actions are designed to change expectations and perceptions. They do not prescribe the outcome, but aim to influence the process so that it is, respectively, more holistic by including explicit consideration of the use phase, and more open to cooperative ways of working.

Taking a different perspective the EU PeBBu (performance-based building network) brought together many actors from across Europe to assess and promote the concept of creating and using regulations that have been framed in terms of ends not means. Ideally this should allow the client's / user's needs to drive the whole process. The argument is that a performance based building approach (PBB) should create the flexibility for innovation to occur, albeit in practice this carries a risk of mistakes being made as novel solutions are tried (as happened with damp-proofing of housing in New Zealand), and it has to shift the industry's rational, and often efficient, response to use standard "deem to satisfy" solutions. The part of the project specifically focused on innovation found it had to clarify two views: "PBB as the innovation" and "PBB as a source of construction innovation". That is, there were two schools of thought on the relationship between performance-based building and innovation. The 'content' school championed the view that performance-based building is the innovation in itself. In contrast, the 'contextual' school advocated that performance-based building provides the enabling environment to stimulate a raft of innovation activity which may include prescriptive, as well as performance-based elements. Ultimately it was agreed that these two schools are not in conflict; and there is significant value in recognising and integrating them to form an evolutionary approach which promotes continuous development and use. A framework was thus developed[59] that conceptualises the performance-based approach as an evolutionary cycle of innovation across industry and project contexts, and between social and technical systems.

The model (see Fig below) operates as follows. First, it is accepted that PBB does not function independently, but that in order for it to be adopted and used, PBB must be part of a larger configuration of mutually attuned elements such as infrastructure, knowledge, skills, organisation, regulatory standards and cultural norms, through which the PBB approach can be handled productively by a range of actors. PBB, therefore, must be embedded within the industry context at a social system level to a

[59] Sexton, M. and Barrett, P., (2005), "Performance-based building: Balancing client and industry needs", *Building Research and Information*, 33: 2: 142-148.

degree where there is sufficient *confidence* in PBB as an approach to be considered as one of a portfolio of viable options which can be *adopted* by organisations in project contexts, and which the industry wide knowledge (in the form of 'good practice', codes and regulations) can be *developed* at a technical system level.



To the extent that there is success at the project level this will feed back to enhance confidence. This is clearly a dynamic model and to succeed calls for action on several interactive fronts. The critical need to respond to or establish market pull is emphasised by the experience in Denmark on Project Hus, a very large, long term initiative to promote industrialised house building through demonstration projects – which to a great extent halted as soon as the funded scheme came to and end[60].

There is in all this discussion of regulations an issue of principle which is the need to move beyond demanding minimum thresholds for individual dimensions such as: air quality, or accessibility, etc and to also support and encourage the creation of excellent spaces based on holistic human-centred advice.

[60] Based on a visit in 2005 and discussion more recently with Kim Hagboulle of SBi in Copenhagen

5 Summary and Conclusions

The first section of this report presented Gronroos' services model that stresses the perceptual, interactive nature of services delivery, with *how* things are done being as important as what is actually done. The various case studies drawn from several countries raise a range of issues concerning services-driven innovation in construction, as it relates more broadly to the built environment and its contribution to organisations and individuals in society. In drawing out insights for the UK it has to be acknowledged that many of the countries have much smaller populations (eg Finland and Norway) and appear to find it easier to create a consensus, and this may in part be compounded by differences in national characteristics, such as the desire to act collaboratively. That said the implications of the cases generally suggest aspects that are systemically desirable, albeit practically feasible approaches would have to be devised to fit the UK situation.

The table below summarises the implications running from the case study examples in two columns – one around the notion of factors relevant to measuring a conducive innovation environment; and the second suggesting factors that could inform the measurement of the outcomes of services innovation in construction / the built environment. These columns parallel the distinction in traditional innovation metrics between, say, IT usage and patents. The figure at the start of this report suggests the potency of a systemic approach to innovation, thus it should not be thought any of the possibilities implicit in the table should be discounted, however, in the first column a subjective assessment by the author as to the key levers that could be driven by Government is reflected in the yellow highlighting.

Level	Innovation environment	Innovation outcomes
Client / user	The multi-disciplinary (scientific and sociological) evidence base to support the creation and delivery of human-centred built environments (see sections 2.1 and 2.2)	Measurable improvements in human health and performance (see section 2.1 and 2.2)
	Design guidance driven by user needs, possible emphasising naturalness and individualisation (2.1, 2.2)	Tangible evidence-based driven enhancements in the built environments provided (2.1, 2.2)
	Customer engagement to understand their reactions to spaces and tune the provision made (2.3, 2.4)	New offerings to customers or constant adaptation of existing provision (2.3 and 2.4)
	Capturing, experimenting with and then optimising standard offerings for specific sub-sectors. Constantly refreshing this cycle[61] (2.3, 2.4)	Efficient and effective delivery of appropriate built environments offerings to customers (2.3, 2.4)
	Creation and promulgation of models of building functionality and serviceability (2.3)	Active use of models of building functionality and serviceability throughout to keep overall priorities in balance (2.3)
	The existence of a powerful client (demand –side) voice at a national level (2.5)	Direct impact on legislation and, through education / purchasing power, on industry practice (2.5)
Project	The use of iconic projects to move the "state of the art" around building for client / user benefit forward - including real time publicising of the actions / achievements (3.1)	Adoption more generally in the industry of the models so demonstrated, such as uptake of building information models (perhaps based on IFCs) and psychological profiling of teams (3.1)

[61] This is a key opportunity for large clients including many public sector bodies, but also general studies could be carried out for given sub-sectors so that others with smaller volumes of work could benefit.

	The use of case studies to illustrate the close interaction between a client's business and the contribution of construction (2.3, 2.4, 3.2, 3.3)	Innovative practices fully orientating the construction activity around the development of the client's business needs (2.3, 2.4, 3.2, 3.3)
	Guidance on the role of primary constraints as drivers, linked to flexibility in achieving the goal set – all as illustrated by the 4Cs Model (3.2, 3.3)	Practical developments in contracts and practices, such as partnering / alliancing, to facilitate this tight / loose arrangement (3.2, 3.3)
	Developed schemes to assess quality etc in rigorous, practical ways and link this to incentives for good performance (3.4)	Use of implemented schemes, primarily by clients with a flow of work to let and evidence from the metric produced of rising performance (3.4)
	The evidence base to demonstrate the spill-over effects from an emphasis on key project parameters, such as H+S (3.3, 3.4, 4.2)	Motivation for industry players to invest around managing key demands with concomitant improvements in performance on these and generally (3.3, 3.4, 4.2)
Industry	Holistic human-centred design guidance / regulation that supports excellence as well as minimum standards (2.1, 2.2, 2.3, 2.4, 4.2)	Evidence of the impacts of excellent design in, say, students' learning, patients' recovery and workers' productivity, etc (2.1, 2.2, 2.3, 2.4)
	Common, but flexible ICT platform to support information flows for the whole life cycle of a building (3.1, 4.2)	Take up of ICT platform and development of innovative business models / practices as a result – including measured efficiencies and delivering full value to the FM phase of the building[62] (3.1)
	Strategically linked educational initiatives involving multiple players to create the internationally-informed human capital required to innovate in a services context (4.1)	Well qualified personnel in client organisations and the industry linked via vibrant communities of practice, ideally with an international dimension (4.1)
	Accepted national metrics for incremental service innovation involving dimensions, such as: procedures, personnel practices, processes, and structures – plus wide publicity of illustrative cases for industry (4.2)	Surveys demonstrating increased incremental innovation with evidence of benefits flowing to customers and the firms themselves – this could link with economic measures such as GVA (4.2)
	Excellent environment through an appropriate combination of Government support for incremental innovation in terms of tax relief, research funding, regulation around the scope and nature of project consideration (WLC, partnering, etc) and with a focus on performance (4.2)	As above[63]
	Full engagement of professional and institutions trade associations around innovation agenda (4.2)	As above plus increased engagement in R+D programmes of their members (4.2)
	High profile, on-going change programme covering a cycle of social / technical x industry / organisation / project (4.2)	Explicit engagement of major bodies and significant numbers of players in the industry around a consensus agenda (potential to build on international Revaluing Construction initiative – see below) (4.2)

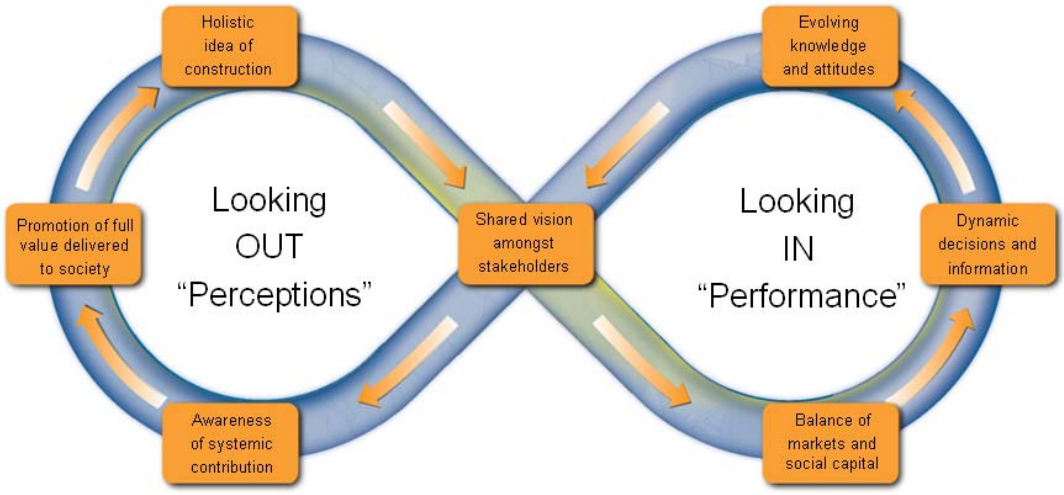
Picking up on the last line of the above table there is value in having a holistic and progressive improvement model for the sector. Building on the UK "Rethinking" initiative, but also flexing it to stress value to all stakeholders, the CIB has successfully promoted an international initiative on the theme of "Revaluing

[62] A methodology for this measurement is given in:
Gallaher, M. P., O'Connor, A. C., Dettbarn, J. L. & Gilday, L. T. (2004) "Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry." National Institute of Standards and Technology.

[63] A measure of the value that can be released by achieving good levels of trust (8-20% of contract value) has been estimated by:
Zaghloul, R. & Hartman, F. (2003) "Construction contracts: the cost of mistrust." *International Journal of Project Management* 21:419-424.

Construction" over the last five years or so. Details of this are available at www.cibworld.nl/revaluingconstruction and a benchmark statement has recently been published.[64] This model is summarised in diagrammatic form in the figure below. It clearly covers much of the ground set out above, but links them in a way that has been well received by industry and others, forming the basis for the opening keynote and the summary discussion at the end of a recent RC2007 international conference in Copenhagen / Malmo.

The top-left box in the figure will be mentioned first to stress the importance of the basic conception taken of the notion of construction. It is pivotal to Revaluing Construction that a broad, holistic idea is adopted, otherwise the potential of the industry to maximise its contribution to buildings in use will be compromised. From this robust basis the creation of a shared vision amongst stakeholders (at the centre of the figure) can be addressed that emphasises maximising the value jointly created and equitably distributing the resulting rewards. This political consensus creating process is primarily located at a national policy level involving major stakeholders. It is here that the vision for Revaluing Construction is created, maintained and promulgated, including its practical implications. Within this conducive policy context, a key operational area where significant change is needed is in the balance of weighting between market forces and social capital, particularly in relation to procurement. When appropriately addressed, to provide a higher level of stability and trust there appears to be significant willingness to handle information and decisions more coherently and dynamically throughout the whole building life-cycle. This then has the potential to release considerable latent gains in value. Taken together these actions will mean that some clients and some projects will deliver much higher levels of value. However, to make the improvements take hold across the industry in the longer term it is essential that the knowledge and attitudes of those involved evolve strongly. This will then reinforce isolated good practice so that it becomes normal practice. The three boxes on the right-hand half of the figure, together with their interactive connection to the central vision, provide a clear focus on how the industry can move to improve its performance by "looking in" at the practices, relationships and techniques that it employs.



[64] Barrett P (2007). Revaluing Construction. Oxford, Blackwell Publishing.

In itself this will deliver great benefits. However, it will be relatively fragile and in a sense will not seriously shift the limited and often negative perception of construction within society. For the role of construction to be significantly Revalued the industry needs to "look outwards" and work to raise awareness of the systemic contribution that construction makes. This is indicated in the bottom left-hand box in the figure and involves accounting for the multiple value streams running from construction, some for very many years beyond the building event itself. Given the generally negative standing of the industry, the final step is to pick up on the rich and positive messages contained in the contributions identified and to actively promote the full value delivered to society by construction. Success on this front will then bring us back to the box that started this description, by reinforcing the holistic idea of construction making it more than a compelling theoretical idea, but a powerful policy and social conception as well.

The "infinity" model stresses the two complementary halves of the Revaluing Construction agenda. The industry looking in at itself to perform better, but also looking out at how it is perceived within society. This linkage of the normal "looking in" factors with "looking out" considerations has proved a useful marriage between existing initiatives and the type of more service orientated issues raised in this report. Thus, the seven action areas and their connections are proposed as a coherent set of priority areas that taken together provide a dynamic improvement process for the industry as a whole. The "infinity" model illustrates and symbolises the on-going, reinforcing nature of the path set out.

Linking in with this international initiative that has good momentum (with over 300 requests for pages per day on the website) would seem to make good sense to give shape to the UK efforts in this emerging area.

Appendix: Individuals consulted

Name	Organisation	Country
Dr George Ang	Ex Dutch Government Building Agency	The Netherlands
Prof Brian Atkin	CB programme	Sweden / UK
Dr Henrik Bang	DACC	Denmark
Frédéric Bougrain	CSTB	France
Svein Willy Danielsen	Sintef	Norway
Malcolm Dodds	CE	UK
Kim Hagboulle	SBi	Denmark
Tapio Koivu	VTT	Finland
Dr Matti Kokkala	VTT	Finland
Dr Florence Ling	NUS	Singapore
Dr Karen Manley	CRC	Australia
Graham Messenger	Queensland Government, Department of Public Works	Australia
Tom Rellsve	RIF	Norway
Tim Rose	CRC	Australia
Neil Sachdev,	Sainsbury's	UK
Dr Peter Scuderi,	CRC	Australia
Dr Endre Sjovold	Academic / consultant	Norway
Egil Skavang,	Building Cost Programme	Norway
Arve Olav Solumsmo	Helsebygg Midt-Norge	Norway
Steve Thomas	CII	USA
Prof Jacqueline Vischer	Montreal University	Canada
Prof John Zeisel	Hearthstone Alzheimer Care	USA