Constructing Green: The Social Structures of Sustainability

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Building Expertise: Renovation as Professional Innovation

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[−] Abstract and Keywords

This chapter begins with a review of some recent literature on innovation in the residential sector. The chapter takes up the challenge of discerning which institutions can successfully intervene in the total sociotechnical system of the built environment to steer it toward sustainable performance. In doing so, it moves from discussions of what needs to be done to reduce carbon emissions in the existing housing stock, and draws attention to who will do it and how. Specifically, it focuses on the role of so-called “intermediaries,”, their expertise, and their ability to enhance (or inhibit) the implementation of sustainable strategies in existing residential buildings.

Keywords: innovation, residential sector, sociotechnical system, built environment, intermediaries, expertise, residential buildings

Introduction

The built environment must undergo dramatic changes to meet climate change targets. The World Business Council for Sustainable Development (WBCSD 2009) calls for a worldwide building sector energy reduction of 77 percent below projected 2050 levels. In Britain, the residential sector is the largest consumer of energy and the main emitter of $C0_2$. Although energy policy in the UK has emphasized energy efficiency in housing (e.g., DTI 2003; DEFRA 2007), the country now recognizes that more radical and transformative changes are needed, particularly for existing homes (DECC 2009). Killip (2008) estimates that transforming the entire UK housing stock by 2050 will require 500,000 refurbishments of older, inefficient properties every year. The sheer scale of these transformations requires radical changes in both technology and work practices.

The large technical potential for improvement in the housing sector has been demonstrated, requiring an integrated combination of ambitious demand reduction strategies (e.g., insulation, improved airtightness, more efficient appliances, behavior modifications) and low and zero carbon (LZC) technologies such as solar technologies and heat pumps (e.g., Boardman et al. 2005; Marchand et al. 2008). Research shows that to reach higher levels of carbon savings in refurbishment (e.g., 50 percent or more) it is not just one technology that needs to be implemented, but a suite of coordinated strategies that treats the dwelling, services it provides, and its occupants as an integrated system (Hermelink 2006; Roudil 2007). We call this the “house as a system” approach. The carbon savings from performing holistic retrofits, even without occupant participation, should not be underestimated. Ürge-Vorsatz, Petrichenko, and Butcher (2011) argue that there is a 79 percent difference between implementing a “state of the art” performance approach in new buildings and renovations **(p.36)** worldwide versus a “suboptimal” scenario based on piecemeal individual technologies.

Although optimizing the suite of available technical and social strategies for each existing dwelling will yield the best results in reducing carbon emissions, it is a tremendous challenge to assign this task to a fragmented construction industry. In both the UK and elsewhere, housing refurbishment is the preserve of small and medium-sized enterprises which include general builders, specialist subcontractors (e.g., roofing contractors), plumbers, heating engineers, electricians, architects, design engineers, project managers, building control inspectors and others. These groups are often considered “intermediaries” in the technology adoption process: they occupy an important position between technologies and end-users and as such are expected to provide low carbon refurbishment if their clients demand it. Yet we know that expertise matters, and it is not equally distributed. Quality design and highly skilled installation are essential to the success of low-carbon refurbishment projects, particularly in the areas of insulation, thermal bridging, and airtightness (Lowe and Bell 2000). If some intermediaries are more expert than others, then the supply of low carbon refurbishment is *not* perfectly responsive to the demand. Instead, intermediary groups have their own habits, practices, ways of thinking about problems, and ways of working that affect their ability to provide (and interest in promoting) low carbon refurbishment. How might the need for low carbon refurbishment change the roles of professions, and their interactions? How are existing professions developing to meet the challenge? Which professions will gain control over the new activities involved in low carbon refurbishment?

To address these critical questions, we take up the challenge of discerning which institutions can successfully intervene in the total socio-technical system of the built environment to steer it toward sustainable performance. In doing so, we move from discussions of *what* needs to be done to reduce carbon emissions in the existing housing stock, and draw attention to *who* will do it and *how*. Specifically, we focus on the role of so-called “intermediaries,” their expertise, and their ability to enhance (or inhibit) the implementation of sustainable strategies in existing residential buildings. This chapter begins with a review of some recent literature on innovation in the residential sector. Noting that literature on innovation in residential refurbishments is comparatively scarce, we argue that the understanding of this topic needs improvement, particularly with respect to the need for building expertise. To move toward filling this gap, this chapter suggests a socio-technical “system of professions” approach, **(p.37)** which addresses the role of experts and expertise in refurbishment. This discussion draws upon the intersection of two theoretical approaches: innovation in socio-technical systems (STSs) and the system of professions (Abbott 1988). The chapter concludes with a snapshot of the UK residential refurbishment industry, approaching existing practices through this theoretical lens. It considers one possible way for the current system of professions to evolve to incorporate low carbon refurbishment, focusing on what it would take to increase the skills and capabilities of small and medium builders in Britain.

Background: Innovation in Housing

Recent work on innovation in construction suggests that influences on multiple levels affect the shape and nature of innovation. Koebel (2008) suggests that there are individual, firm, and industry characteristics of particular importance, including risks associated with innovation, the role of technology champions, and the degree of centralization in decision making between small custom builders and large production builders. With respect to green building, Hoffman and Henn (2008) agree that both individual and organizational factors inhibit innovation, and they add a third level—institutional barriers—which is broader and more pervasive than the structure of the industry itself. In Hoffman and Henn's framing, institutional barriers to green building include regulative, normative, and cognitive aspects of the larger social system in which building occurs. In particular, they assert that social and psychological barriers are in need of greater attention, for they believe that understanding and overcoming these barriers will lead to changes in social structures and in rewards and incentives.

Focusing particularly on passive housing designs, Gentry (2009) argues that it is the building process itself that needs to be changed. Whereas the process employed by large production builders leads to greater fragmentation in the construction of each house and a reduction in labor force skills, Gentry asserts that a design-build approach coupled with integrative design (where structure, systems, and aesthetics act as a team rather than a relay race) should be the way forward. One important aspect of Gentry's proposal is that it reconnects the homeowner with the builder, so that the homeowner (or occupant) becomes more actively engaged with the design and eventual operation of the home. Gentry is one of few authors who treats the resident as an integral part of the housing system.

(p.38) Taylor and Levitt (2004) also believe that the organizational process of building is important. They delineate the concepts of incremental and systemic innovations in the building industry, arguing on the one hand that incremental innovations happen in the building industry about as readily as they do in manufacturing industries. On the other hand, when it comes to systemic innovations, which require multiple companies to change in a coordinated fashion (e.g., supply chain management), the home building industry is a laggard adopter. Taylor and Levitt hypothesize that systemic innovations will increase when the home builders reduce the number of specialists they use on multiple projects and when the level of interdependence between specialist tasks is decreased. Taylor and Levitt are particularly interested in improving the overall economic efficiency of the industry; they do not mention energy efficiency as a goal of their work.

It is important to note that these studies are all about new housing. For many years, research and policy arenas have ignored renovation and retrofits. The implicit assumption is that because existing housing has already been built, the interesting organizational changes (e.g., integrated vs. sequential design) or radical technical approaches (e.g., passive solar strategies) are not applicable. This orientation, however, is changing in large part due to the carbon reduction agenda. Figure 2.1 shows the projected carbon emissions from the UK domestic sector to 2050 in a 75 percent reduction scenario. The largest block of emissions to be abated is from the existing housing stock. Even if all new homes were "zero carbon" by 2016 in keeping with UK government targets, carbon emissions from an untouched existing stock would swamp the new build improvements. From a demand perspective, 100 percent carbon-free new homes would *at best* leave current carbon emissions unchanged; only retrofitting the existing building stock can actually reduce current emissions.

The refurbishment industry grew substantially in recent years and is poised to grow even faster, in large part because of the emphasis on sustainable development, and due to economic conditions. In central Europe, Kohler and Hassler 2002, 226) claim that these trends have been operating for close to thirty years and believe that they will "oblige the building professions to shift their focus from new construction to maintenance and refurbishment of existing buildings." In the UK, a report commissioned by the Federation of Master Builders presents the poor performance of residences as a business opportunity (Killip 2008). The report claims that building firms, product manufacturers, and suppliers could tap into a new market worth between £3.5 and £6.5 billion ($5.5 to 10 billion) per year if the UK develops policies, skills programs, and financial incentives to upgrade the **(p.39)** existing housing stock to make it greener and more energy efficient. In addition, a refurbished housing stock would help reduce escalating household energy bills while making a real difference to climate change.

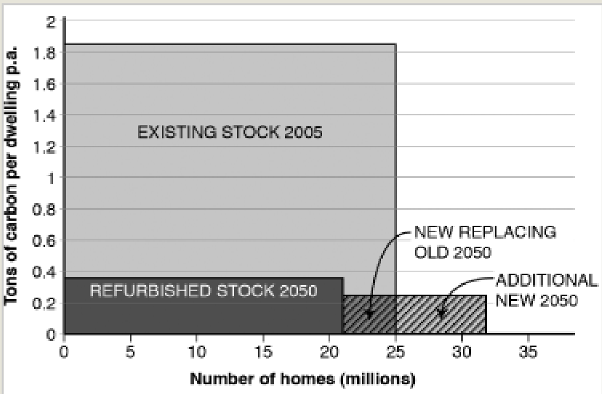

Figure 2.1 Carbon emissions from refurbished and new-build housing in the United Kingdom: 75 percent reduction scenario

Although the authors mentioned recognize the need for changes to the structure of professional practice, this recognition may be a minority view. Michael J. Kelly, chief scientific advisor to the UK Department for Communities and Local Government, recently wrote a commentary in the journal *Building Research & Information* on the importance of retrofitting the existing UK building stock. In this article (Kelly 2009, 198–199), he states that carbon emissions from existing buildings could be tackled in four ways, by

- reengineering the fabric of buildings

- improving the efficiency of appliances
- decarbonizing the sources of energy
- making changes in personal behavior

Kelly states that the first three approaches are “engineering related,” and the last one “is a matter of psychology and sociology.” In our experience, Kelly's conception of both the nature of the problem and his proposed solution set is fairly common, and carries within it two important **(p.40)** assumptions which often go unchallenged. The first is that the problem can in large part be solved by technology rather than people—an assumption based on a determinist view that technology and behavior are easily separable from each other. The second assumption is that social science is limited to investigating how individual people operate as consumers or citizens, not as artisans and professionals engaged in providing services. From this second assumption comes the expectation that social science applies only to changing homeowner behaviors. We challenge these assumptions and their implications in the following section.

A Socio-technical System of Professions Approach

In this section, we introduce a way of thinking about innovation in the refurbishment industry that is informed by theories of socio-technical systems together with the sociology of professions. Our aim is to reconnect the synaptic path that leads policymakers to think that technology is separate from people, and that people only live in houses rather than making their livelihood in them.

Technology Is Inseparable from People

Our first point is that technology and people are intertwined. The science and technology studies (STS) literature provides ample support for this perspective, offering an over-arching framework in which the “seamless web” of social and technological effects of change can be understood. This literature argues that technological change does not come about independently of behavioral change and the development of social norms; rather, the technical and the social coevolve and depend on each other in a complex socio-technical system (Hughes 1983; Bijker, Hughes, and Pinch 1987; Bijker and Law 1992). With regard to energy use in buildings, this means “relating the form, design and specification of more and less energy-efficient buildings to the social processes that underpin their development” (Guy and Shove 2000, 67). The social processes that have been studied in this field often focus on the behavior, habits, and motivations of the individuals who occupy homes (e.g., Wilson and Dowlatabadi 2007) and their interplay with technological attributes of devices within the home (e.g., Gram-Hanssen 2008).

Actor-network theory (ANT)—an approach that originated in the STS literature—further develops the relationship between technologies and their implementation. ANT sees the relationship between technology and people and ideas as a process of translation among multiple actors (both **(p.41)** human and nonhuman, including material objects and concepts), all of which can have influence on all of the others in a constant process of (re) creation of customs and norms (Callon 1986; Latour 2005). Three key concepts underpin this idea: first is the idea of “enrollment,” by which any actor (including nonhuman agents) successfully assigns a role to other actors in the socio-technical system in question. When all actors are successfully enrolled, the system is said to be “black boxed,” meaning that the emergent operation of the entire system is relatively stable. “Black boxing” is the second key concept, portraying habits and customs as just one set of possible outcomes from the processes of translation between actors. In ANT, stability emerges from interacting forces, meaning that new actors (such as a new regulation or profession) or changed objectives can make things unstable again. The third key concept is “dissidence,” where any actor (including nonhuman agents) fails to take on the assigned role, with potentially far-reaching consequences for the entire system (see Callon 1986).

Professionals Are People Too

If technologies are inseparable from people, which people matter most in the technology adoption process? In contrast to the research on individuals who use technologies, we concentrate on people who install technologies. Intermediary groups have been shown to have their own habits, practices, ways of thinking about problems, and ways of working that affect their ability to provide (and interest in promoting) energy efficient buildings (Janda 1998). Examples of how intermediaries affect the uptake of energy efficiency include the role of supply chains (Guy and Shove 2000), property agents (Schiellerup and Gwilliam 2009), builders (Killip 2008), heating engineers (Banks 2001), and architects and engineers (Janda 1999). In this section, we focus on two aspects of professionals who renovate homes: the shape and nature of their professional jurisdictions; and their competency in performing various tasks.

System of Professions Approach

A “system of professions” (Abbott 1988) approach fits within the general sociology of professions (Dubar and Tripier 2005). It is concerned with the ways in which different professional or occupational groups define their work and compete for authority, which is linked to their use and appropriation of knowledge. From a system of professions perspective, each work group is linked (neither permanently nor absolutely) to a set of socially accepted tasks considered to be its jurisdiction. Architects, for **(p.42)** instance, may see themselves (and be seen by others) as the profession with responsibility for creating quality of place and aesthetic values in the built environment; engineers are more concerned with the technical practicalities of making structures that are safe, healthy, and thermally comfortable. Professional groups compete and develop interdependently, based in part on their ability to perform (and defend) the tasks within their jurisdiction. Jurisdictions and professions change over time and are shaped by a number of social, economic, historical, and institutional factors (Abbott 1988; Bureau and Suquet 2009; Evetts 2006). Abbott focuses mainly on the meso or systems level, investigating relationships between professions, but he also looks at the levels below and above. At the micro level, he considers differentiation *within* professions related to work context, and at the macro level, he discusses the larger social forces that create the “system environment” in which the professions exist.

Abbott admits that his framework explains the shape of existing professional groups better than the development of new groups. However, he posits that growth in general knowledge can create a “new” socially legitimate set of problems and therefore an opportunity for new professional group(s). It is this underexplored element in Abbott's work that most intrigues us. Is growth in knowledge about climate change—its impacts, causes, and opportunities for mitigation—sufficient to challenge the current system of professions operating in the built environment today? Some industry and government organizations believe so. The WBCSD (2009) argues that a new “system integrator” profession is needed to develop the workforce capacity to save energy. The UK is training domestic energy assessors to draw up Energy Performance Certificates (Banks 2008), while the Australian government chose to support the development of a new profession of in-home energy advisors (Berry 2009). Each of these entities asserts that a new profession will help solve the “problem,” but each proposed professional solution is different.

Seen from an ANT perspective, many actors will need to be enrolled in the carbon reduction challenge in order to successfully meet it. However, what if one profession is better prepared than another to meet this challenge? Is it possible to have the “wrong” set of actors enrolled in the system? Abbott's perspective allows us to consider what might happen if architects, engineers, builders, solar installers, or some new profession group “takes over” the carbon reduction challenge. It also invites us to consider whether this can be a shared responsibility among the existing professions, based on the established jurisdictions and black-boxed customs and practices of the construction industry in operation today.

(p.43) Competencies

The traditional focus of training has been on traditionally defined trades (plumbing, plastering, etc.). New LZC technologies and techniques challenge traditional trades to engage in a “multi-skilling” agenda. This agenda represents a shift of emphasis away from trades and specific technologies to an integrated “house as a system” refurbishment focus. A whole-home refurbishment requires multiple skills beyond substituting a more efficient item for a less efficient one. It requires technical understanding of building physics (e.g., how much heat goes out of the roof, wall, windows, and floors). It calls for the integration of demand reduction measures with energy supply technologies (e.g., calculating the heat load for a well-insulated property and sourcing a heating system to match). It involves aspects of project management (e.g., optimal ordering of works on site). Some of the more technical aspects of this work may be best addressed through the development of one or more packages for refurbishment (i.e., an all-inclusive design specification, which can be applied without understanding all of the reasons behind it). Having said that, there is a risk that packages may not work well in practice (or in certain situations), as the assumption that one size fits all is almost certain to be misplaced, given the variety and size of the housing stock. The low-carbon refurbishment agenda therefore presents a series of challenges for training, knowledge, and skills.

Professions + Competencies = ??

Figure 2.2 shows a general conceptual map of the fragmented construction industry, with professional roles arrayed along the horizontal dimension, and skills or competencies stacked along the vertical dimension.

This two-dimensional representation of the “problem space” of our research topic shows how professional jurisdictions are differentiated (or not) from one another in the current system. Notably, gaps appear at the intersections of the professions and competencies, indicating spaces and imperfections in the current system. To this system, we add low carbon refurbishment as a possible new profession or jurisdiction, or both. Existing professional roles (e.g., architect, structural engineer, general builder, roofer) may expand to encompass new competencies (e.g., energy assessment, installation of roof-mounted renewable energy systems, whole-home system integration). Competencies that are well established within one profession may need to be expanded to become the preserve of other roles, for which they have not traditionally been a concern; also, new roles and new competencies may be needed. **(p.44)**

So what does the current system of professions for housing refurbishment look like in Britain, and how might it change (or need to be changed) to mainstream low-carbon housing refurbishment? We explore this question in the following section.

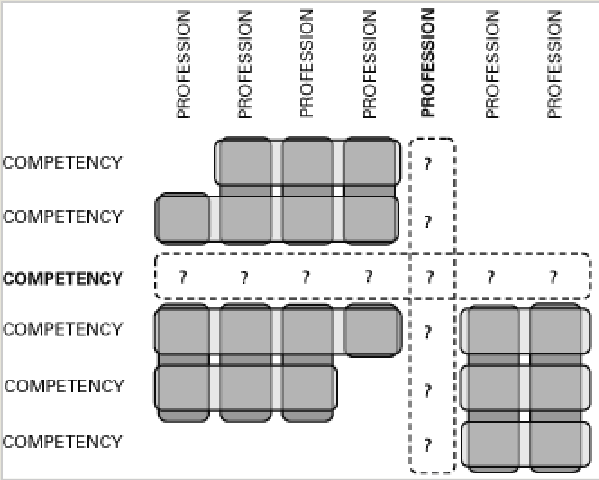

Figure 2.2 Roles and competencies for the integration of low-carbon refurbishment into a system of professions

Toward a UK Low-Carbon Refurbishment Industry

As figure 2.2 suggests, there are many possible configurations for a low-carbon refurbishment industry. Some have suggested that new entrants are needed. One oft-discussed option is for large corporations (e.g., the supermarket chain Tesco, or the home improvement chain B&Q) to lead the way forward by providing one-stop shopping for energy improvements. In this section we take up the question of mainstreaming low carbon refurbishment by developing the skills and capabilities of existing firms rather than new entrants. This section focuses on small and medium builders in Britain, considering their role as key to improving the sector. Whoever takes on the challenge has their work cut out for them.

(p.45) The State of the Shelf

Construction is a major employer in the UK economy, providing roughly 1.1 million jobs and generating £105 billion ($164 billion) of contractors' output in 2009, of which £39.8 billion ($62 billion) was spent on housing—38 percent of the total (Office for National Statistics 2010, table 2.4).

New construction is a different market from repair, maintenance, and improvement (RMI), just as construction work in housing is a different market from nonresidential work. Many individuals working within the industry move across these boundaries as their careers progress and as the availability of work and subcontractual arrangements shift in response to wider economic forces. Some firms specialize in one particular type of work, while others are generalists; some concentrate on residential work, some stick to commercial projects, and some do both. SMEs (small and medium-sized enterprises) are predominantly involved in RMI work, although some are developers of new housing, mainly on a small scale.

The breakdown of expenditure on housing in 2009 (as opposed to nonresidential buildings) shows that more money was spent in the private sector than the public sector (new-build and repair and maintenance), while the total output on housing repair and maintenance (in both public and private sectors) was £18.9 billion ($29.4 billion), exceeding the £14.6 billion ($22.7 billion) for new housing (see figure 2.3).

(p.46) Construction is multifaceted, ranging from major infrastructure projects, such as the 2012 Olympics, right through to decorating and handyman services in people's homes. The industry is made up of over 194,000 firms: a large number of small businesses, particularly microbusinesses. Firms with one to three employees make up 70 percent of the total number of firms in the industry. Only 35 percent of the total workforce is employed in firms with more than eighty employees (Office for National Statistics 2010, table 3.4).

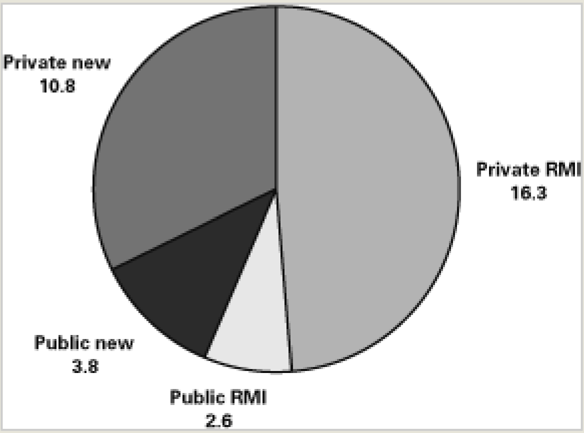

Figure 2.3 Contractors' output in housing in Great Britain, £ Billions (2009)

Innovation in the UK Construction Industry

Sir John Egan's *Rethinking Construction* report (Egan 1998) first set out a clear agenda for improvements to business processes and efficiency in the UK construction sector. This report was followed by a second review, *Accelerating Change*, which described the sector as “a series of sequential and largely separate operations undertaken by individual designers, constructors and suppliers who have no stake in the long term success of the product and no commitment to it” (Egan 2002, 13). A more recent review concluded that progress on the Egan agenda has shown some signs of improvement since 2002, but that these have tended to be “skin-deep” (Wolstenholme et al. 2009). The reality of mainstream practice is that it is dominated by fragmented roles, adversarial rather than collaborative relationships among different professions, wasteful and inefficient management processes, and poor client satisfaction.

Nonetheless, Harris and others (2006) show that innovation does occur in this sector, but that it is hidden from view because of the widespread belief that innovation signifies new technology, and that it can therefore best be measured using conventional metrics that apply to product innovations: research and design spending and patent applications. Instead, Harris and others argue that new regulation and client demand drive innovation in construction, and that it is project based and collaborative. New products are clearly relevant, but so are innovations in practices (ways of doing) and processes (ways of organizing). The metrics that could be used to report on practice and process innovations are not immediately obvious but, given the policy context of an 80 percent reduction in carbon dioxide emissions, they need ultimately to relate to building performance.

The importance and prominence of sustainability issues in construction are much lower on the ground than among policymakers and strategists. Two of the top ten skills issues for Construction Industry Training Board/ConstructionSkills are “making sustainability a reality in construction” **(p.47)** and “improving the skills base and competence through client-led demand, enhancing industry's responsiveness to technical change and productivity improvement” (CITB-ConstructionSkills 2008). In the SME sector working on housing refurbishment, there is a long way to go before these aims are met. In a survey of 152 members of three trade federations in Scotland, on average only 10 percent had received any form of training on sustainable development while only 6 percent reported ever having lost business for environmental or social reasons (Brannigan and Tantram 2008). On this evidence, few clients make sustainability a primary objective of the work that they commission. At the same time, 50 percent of all respondents to the Scottish survey believed that the pressure to be more environmentally responsible would grow over the next one to two years, and over 80 percent thought this pressure would definitely increase within five years. The pressure is largely perceived as being policy driven, rather than driven by demand in the market for refurbishment work.

A Socio-technical System of Professions Approach to Building

The usual policy approach to retrofits is to give rebates or assistance for individual qualifying measures, such as cavity wall insulation. The remaining potential for uptake of these measures is still significant—for example, roughly ten million cavity-walled homes do not have their cavity walls insulated (CIGA 2008). At the same time, an acknowledgment is needed that this policy approach is both time limited and insufficient to meet carbon dioxide reduction targets. In the short term this means carrying on with existing measures, while simultaneously preparing for a shift of emphasis in the next few years. Going beyond the existing program requires a new approach, which makes low carbon refurbishment a mainstream “normal” decision for people. Key to managing this transition is to engage more fully with the construction industry, specifically the firms—usually SMEs—that are already involved in housing repair, maintenance, and improvement works. If the opportunities for low carbon refurbishment are to be exploited fully, this kind of renovation needs to be on offer every time a building tradesperson is asked to quote for work. In effect, from an ANT perspective, firms across the entire construction industry need to “enroll” in the low-carbon refurbishment idea, such that this form of refurbishment becomes black boxed. For SME building tradespeople to deliver low carbon refurbishments on a large scale, the sector's capacity to do this kind of work needs to be developed—almost from scratch. In the following sections, we concentrate on three aspects essential to this development: increasing the buildability of innovations, increasing **(p.48)** integrated practice and multi-skilling, and developing regional innovation networks.

Increasing Buildability

The work to build capacity in the sector needs to take account of established custom and practice—or the endeavor will result in rejection by most practitioners. This would be called “dissidence” in ANT. This insight is captured in the idea of “buildability,” a term intended to capture the reality of how builders operate and the fact that whenever refurbishment is carried out, the contractors have to be confident of their ability to do the work and achieve satisfactory results, both for themselves and for their clients.

The term “buildability” typically applies in the field of construction project management with a focus on the ease of construction, the robustness and quality of what gets built, and a reduced risk of error, delay, or cost overrun. The Construction Industry Research and Information Association defines it as “the extent to which the design of the building facilitates ease of construction, subject to the overall requirements for the completed building” (CIRIA 1983, 26).

Crowther 2002, 2) highlights the importance of the conditional clause in the CIRIA definition and argues that “overall project goals may actually restrict the buildability of the project, such that heuristic principles of buildability may not necessarily be appropriate in all cases.” In other words, some building projects may be inherently more complicated and carry greater risks for the project manager than other projects.

“Buildability” has come to the fore in recent times as a term used by members of the construction industry to provide a “reality check” to the pursuit of ever tighter energy and carbon dioxide emissions standards for new buildings. An industry task group used buildability to establish a kind of checklist for proposed zero carbon standards for new housing: “Does the specification require overly complicated construction processes? What are the implications for site management and build processes? Will the supply chain be able to deliver circa 200,000 units p.a. to this standard?” (Zero Carbon Hub 2009). These concerns are real enough but they are couched in the language of current incumbents, rather than innovators. What is seen as an “overly complicated” construction process by an incumbent may be something to which others can adapt more readily (see also chapter 6, this volume); site management and build processes may need to change, but that may be because existing techniques, materials, and practices are unsuited to the new standards. Buildability can be **(p.49)** seen as an expression of the dilemma of the diffusion of innovation: how can the new and unfamiliar be reconciled to the expectations of the existing mainstream?

If a low-carbon refurbishment strategy can be devised in such a way that it takes account of the need for buildability, then the strategy has the greatest chance of acceptance by the SME construction sector. Without it, it is likely to be ignored or subverted on the ground. Key elements of the buildability idea are that building work needs to comprise products and methods that must be all of the following: practical, replicable, affordable, reliable, sellable, available, guaranteeable, and profitable (Killip 2008, 23–24). Where new products are needed to help meet the low-carbon refurbishment agenda, the key stakeholders (in addition to the SME building tradespeople) are the manufacturers and suppliers. Where new supply chains need to be developed, the key to success is a strong long-term policy commitment from government. This will stimulate investment and strategic business developments, both among existing players in the market and among potential new market entrants.

Increasing Capacity for Integration

The skill sets of traditionally defined tradespeople (e.g., plasterers, electricians, etc.) will need to be expanded so that they understand enough of the low-carbon refurbishment agenda to play their part effectively. This is likely to include a better understanding of how the interaction of different trades on site can lead to loss of overall building performance (e.g., air-tightness can be compromised if wet plaster stops at the height of skirting boards instead of reaching floor level; the performance of vapor barriers and insulation materials can be compromised by inaccurate installation and subsequent drilling of holes for pipes, ducts, wires and recessed light fittings). In relation to the installation of low and zero carbon technologies (LZCs), the relevant sector skills council has identified these new technologies as key to the future of mechanical and electrical building services (National Energy Foundation 2007). This council began a process of setting national occupational standards for training on the installation of LZCs, starting with a review of the short courses and other forms of training that have emerged during the early period of market development. This work confirms a widely held observation that innovation in skills training does not start with vocational qualifications, but with short courses. Developing short courses into vocational qualifications is an important part of mainstreaming the capacity to deliver new services. Existing national occupational standards may have to be amended (leading to **(p.50)** changes in related vocational qualifications). It is also likely that one or more new sets of occupational standards and vocational qualifications will be needed. Without a perceived need from the industry leaders who guide the development of new skills, none of this work on mainstreaming skills for low carbon refurbishment will come about.

Developing Regional Innovation Networks

Some of the system required to deliver low carbon retrofits already exists and operates at a national scale (e.g., building codes, building energy labeling), while other elements that do not yet exist also imply national-level implementation (e.g., financial incentives or fiscal reform). At the same time there are several reasons for thinking that a regional focus is needed to foster some of the innovation implicit in the low-carbon refurbishment agenda. These mixed scale issues suggest the need for a nationally defined strategy implemented in a series of devolved regional networks. Some of the regional characteristics are summarized as follows.

• Devolved administrations. Both Wales and Scotland have taken different paths to England in terms of the zero carbon new-build agenda, while Scotland's Building Regulations are also significantly divergent. As refurbishment moves up the political agenda, it seems reasonable to assume that the devolved governments will want to define their own strategies for the existing housing stock as well.

• Housing stock variations. Locally and regionally, UK housing has quite different characteristics—from Scottish tenements to back-to-back terraces in northern English cities; from rural houses made of traditional materials (e.g., Devon cob) to inner-city high-rise flats. While some dwelling types are common and ubiquitous, there is also geographical diversity. Tackling these issues at the level of a devolved administration or an English region would allow for more detailed work on the predominant types in that particular part of the country.

• Climate and climate change impacts. Heating demand is typically higher in colder Scottish winters than in Cornwall, while the changing climate may lead to a significant increase in demand for summer cooling in London and the southeast, but not elsewhere.

• Business networks. Most SME construction firms work at a local level, but federations and business-to-business networks typically operate at the slightly larger scale of English regions, nations (Scotland and Wales), and the province of Northern Ireland.

(p.51) • Regional/devolved development agencies. There is considerable potential for new jobs and new economic development, much of which could benefit from financial assistance and other development services that are available at a regional level.

• Training centers. ConstructionSkills (the agency charged with skills development for the construction industry in England) and the further education (vocational training) college network can be usefully integrated into a regional structure. The involvement of these institutions is key in light of the far-reaching implications that low carbon refurbishment has for skills. Developing the low-carbon refurbishment agenda will require coordination of information, opportunities for networking, and knowledge transfer activities. All of these can usefully take place at a regional level and, in many instances, there are existing partnerships or stakeholder networks in which the low-carbon refurbishment agenda could be accommodated, making good use of existing structures.

Conclusions and Next Steps

This chapter set out some of the issues around low carbon refurbishment and proposed some ideas and recommendations for government bodies and other stakeholders to consider. Much more work clearly is needed to bring about the transformation of the UK housing stock to meet low carbon standards. This amounts to a completely new service provided by the SME construction industry, potentially adding £3.5 to £6.5 billion ($5.5 to 10 billion) to the existing market for housing repair, maintenance, and improvement. A new kind of service is needed, combining new and traditional skilled trades in ways that result in low carbon refurbishment. Many vocational qualifications will need to be amended so that awareness of energy and carbon issues within the SME construction industry is significantly improved and practices changed to meet these new requirements. To increase the chance of success, refurbishment initiatives need to take into account the ways in which building tradespeople operate, making the objectives of policy practically deliverable.

To make these changes, we emphasize the importance of rethinking the ways in which practitioners, policymakers, and academics think, learn, and teach about the built environment. Making significant changes in the built environment is not a matter of reengineering a technical system on paper, it is about reshaping a socio-technical system by redefining established skills, work practices, and professions on the ground.

(p.52) Although low carbon refurbishment is not currently the norm, we are interested in exploring the ways in which built environment professionals see gaps, opportunities, and challenges for integrating low carbon refurbishment in their work. Work on this topic is ongoing. Nösperger, Killip, and Janda (2011) recently introduced a comparative study of Britain and France that takes a socio-technical system of professions approach to the topic. Because we are interested in whether a new profession might arise, forthcoming work in this vein will focus particularly on the work practices of innovators as providing a key to understanding the social construction of new competencies or roles, or both, that may alter the current system of professions. This focus on innovation will be set against a backdrop of more general work practices and policy context.

References

Bibliography references:

Abbott, Andrew. 1988. *The system of professions*. Chicago: University of Chicago Press.

Banks, Nick. 2001. Socio-technical networks and the sad case of the condensing boiler. In *Energy efficiency in household appliances and lighting*, ed. Paolo Bertoldi, Andrea Ricci, and Anibal de Almeida, 141–155. Berlin: Springer.

Banks, Nick. 2008. Implementation of energy performance certificates in the domestic sector. UKERC/WP/DR/2008/001. Working Paper. UKERC: Oxford.

Berry, Stephen. 2009. Overview of the green loans programme. Presentation at Oxford University. August 31.

Bijker, Wiebe E., Thomas P. Hughes, and Trevor Pinch, eds. 1987. *The social construction of technological systems: New directions in the sociology and history of technology*. Cambridge, MA: MIT Press.

Bijker, Wiebe E., and John Law, eds. 1992. *Shaping technology/building society: Studies in sociotechnical change*. Cambridge, MA: MIT Press.

Boardman, Brenda, Sarah Darby, Gavin Killip, Mark Hinnells, Christian N. Jardine, Jane Palmer, and Graham Sinden. 2005. 40% House. Oxford: Environmental Change Institute. .

Brannigan, Jimmy, and Joss Tantram. 2008. *Building future skills*. Scotland: ConstructionSkills.

Bureau, Sylvain, and Jean-Baptiste Suquet. 2009. A professionalization framework to understand the structuring of work. *European Management Journal* 27 (6): 467–475.

Callon, Michel. 1986. Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In *Power, action and belief: A new sociology of knowledge?* ed. John Law, 196–233. London: Routledge.

CIGA. 2008. The benefits of insulation. Leighton: Cavity Insulation Guarantee Agency. .

CIRIA. 1983. *Buildability: An assessment*. London: Construction Industry Research and Information Association.

CITB-ConstructionSkills. 2008. *Annual review and accounts 2007. HC 387*. London: Construction Industry Training Board-ConstructionSkills.

Crowther, Philip. 2002. Design for buildability and the deconstruction consequences. CIB Publication 272. Karlsruhe: Chartered Institute of Building. .

DECC. 2009. Heat and energy saving strategy consultation document. London: Department of Energy and Climate Change. .

DEFRA. 2007. UK energy efficiency action plan. London: Department for Environment Food and Rural Affairs. .

DTI. 2003. Our energy future—creating a low-carbon economy. Energy white paper. London: Department of Trade and Industry. .

Dubar, Claude, and Pierre Tripier. 2005. *Sociologie des professions*. 2nd ed. Paris: Armand Colin.

Egan, John. 1998. *Rethinking construction*. London: Department of Trade and Industry. .

Egan, John. 2002. *Accelerating change*. London: Strategic Forum for Construction. .

Evetts, Julia. 2006. Short note: The sociology of professional groups: New directions. *Current Sociology* 54 (1): 133–143.

Gentry, Thomas A. 2009. Passive low energy housing: Paradox of behaviors. In *Proceedings of International Conference on Passive and Low Energy Architecture (PLEA)*, 45–50. Québec: Les Presses de l'Université Laval.

Gram-Hanssen, Kirsten. 2008. Consuming technologies—developing routines. *Journal of Cleaner Production* 16 (11): 1181–1189.

Guy, Simon, and Elizabeth Shove. 2000. *A sociology of energy, buildings, and the environment*. London: Routledge.

Harris, Michael, Paul Nightingale, Virginia Acha, Mike Hobday, Pari Patel, Alister Scott, Mike Hopkins, and Caitriona McLeish. 2006. The innovation gap: Why policy needs to reflect the reality of innovation in the UK. London: National Endowment for Science Technology and the Arts. .

Hermelink, Andreas. 2006. A retrofit for sustainability: Meeting occupants' needs within environmental limits. In *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*. Washington, DC: American Council for an Energy-Efficient Economy. .

Hoffman, Andrew J., and Rebecca Henn. 2008. Overcoming the social and psychological barriers to green building. *Organization & Environment* 21 (4): 390–419.

Hughes, Thomas P. 1983. *Networks of power: Electrification in Western society, 1880–1930*. Baltimore: John Hopkins University Press.

Janda, Kathryn B. 1998. Building change: Effects of professional culture and organizational context on energy efficiency adoption in buildings. PhD diss., Energy and Resources Group, University of California, Berkeley.

Janda, Kathryn B. 1999. Re-inscribing design work: Architects, engineers, and efficiency advocates. In *ECEEE Summer Study Proceedings*. European Council for an Energy-Efficient Economy. .

Kelly, Michael J. 2009. Retrofitting the existing UK building stock. *Building Research and Information* 37 (2): 196–200.

Killip, Gavin. 2008. *Building a greener Britain: Transforming the UK's existing housing stock. A report for the Federation of Master Builders*. Oxford: Environmental Change Institute.

Koebel, C. Theodore. 2008. Innovation in homebuilding and the future of housing. *Journal of the American Planning Association. American Planning Association* 74 (1): 45–58.

Kohler, Niklaus, and Uta Hassler. 2002. The building stock as a research object. *Building Research and Information* 30 (4): 226–236.

Latour, Bruno. 2005. *Reassembling the social: An introduction to Actor-Network Theory*. Oxford: Oxford University Press.

Lowe, Robert, and Malcolm Bell. 2000. Building regulation and sustainable housing. Part 2: Technical issues. *Structural Survey* 18 (2): 77–88.

Marchand, Christophe, Marie-Hélène Laurent, Rouzbeh Rezakhanlou, and Yves Bamberger. 2008. Le bâtiment sans énergie fossile? Les bâtiments pourront-ils se passer des énergies fossiles en France à l'horizon 2050? *Futuribles* 343:79–100.

National Energy Foundation. 2007. Identification of renewable energy training provision, qualification accreditation. Milton Keynes, UK: SummitSkills. .

Nösperger, Stanislas, Gavin Killip, and Kathryn B. Janda. 2011. Building expertise: A system of professions approach to low-carbon refurbishment in the UK and France. In *ECEEE Summer Study Proceedings*. European Council for an Energy-Efficient Economy. .

Office for National Statistics. 2010. Construction statistics annual. London: Office of Public Sector Information. .

Roudil, Nadine. 2007. Artisans et énergies renouvelables: une chaîne d'acteurs au cœur d'une situation d'innovation. *Les Annales de la recherche urbaine* 103:101–111.

Schiellerup, Pernille, and Julie Gwilliam. 2009. Social production of desirable space: An exploration of the practice and role of property agents in the UK commercial property market. *Environment and Planning. C, Government & Policy* 27 (5): 801–814.

Taylor, John E., and Raymond E. Levitt. 2004. Inter-organizational knowledge flow and innovation diffusion in project-based industries. CIFE Working Paper #089. Center for Integrated Facility Engineering, Stanford University. .

Ürge-Vorsatz, Diana, Ksenia Petrichenko, and Andrew C. Butcher. 2011. How far can buildings take us in solving climate change? A novel approach to building energy and related emission forecasting. In *ECEEE Summer Study Proceedings*. European Council for an Energy-Efficient Economy. .

WBCSD. 2009. Energy efficiency in buildings: Transforming the market. World Business Council for Sustainable Development. .

Wilson, Charlie, and Hadi Dowlatabadi. 2007. Models of decision making and residential energy use. *Annual Review of Environment and Resources* 32:169–203.

Wolstenholme, Andrew, Simon Austin, Malcolm Bairstow, Adrian Blumenthal, John Lorimer, Steve McGuckin, Sandi Rhys Jones, et al. 2009. Never waste a good crisis: A review of progress since *Rethinking construction* and thoughts for our future. London: Constructing Excellence. .

Zero Carbon Hub. 2009. Defining a fabric energy efficiency standard for zero carbon homes—task group recommendations. .