Building and energy research and the new production of knowledge

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Abstract

In this short paper we explore the current state and future challenges of building and energy research as it presents itself from the perspective of the social study of science and research. We present briefly findings about major trends in knowledge production and discuss how these general descriptions may relate to practices within current building and energy research. We then search for signs of new forms of knowledge production in a little survey of self-descriptions of building and energy researchers. In the concluding section we present their own expectations of future challenges, their ideas about good science and their descriptions of what building and energy research is and should be and discuss these findings in relation to theories about which challenges knowledge production will face in the future.

Keywords

knowledge production, interdisciplinary collaboration, user-centred design, sustainability

Introduction

The recognition that the future of building and energy research is equally about the future of buildings and energy as it is about the future of research is the basis for the exploratory work presented here. While other contributions to this special issue focus on *buildings*, we approach the topic by exploring the present and future of *research* and *researchers* by letting them speak themselves. In the present paper we explore the split between traditional research approaches and new forms of knowledge production within building and energy research by referring to two sources, an empirical exploration of contemporary building and energy researcher's description of their field and recent theorising about new roles of science in society.

The motivating rationale behind this short paper is based upon the observations made in 2003 by one of the authors, who interviewed 14 architects and engineers working in a large Norwegian interdisciplinary building and energy research project called SmartBuild[2]. Dubbed a 'user-oriented' project aiming at the development of environmentally responsive, energy-efficient buildings, this project explicitly presented itself as an interdisciplinary crossover between application and basic research[3]. Not surprisingly, a topic brought up by every interviewee was the paramount importance of end-users and interdisciplinary collaboration for their research. However, as the analysis of the interviews revealed for approximately half of the interviewees, interdisciplinary work was actually a way of *not* dealing with end-users' demands. These demands, they argued, were the problem of their respective colleagues from other disciplines that work with users. This was in stark contrast to the other half of the interviewees that eloquently described how they genuinely enjoyed professional discussions between disciplines in addition to engaging issues involving end-users. These researchers, who promoted holistic views on building performance, also worked to develop additional working methods based on tight interdisciplinary collaboration, such as coordinated design and building processes (as described in Reed and Gordon 2000) and advanced integrated facades.

Thus, despite their opposing claims, the first group described in the previous paragraph remained firmly rooted in a traditional scientific mindset, based on clear divisions along disciplinary boundaries. The second group, however, represented something new, which according to leading observers of science and technology is in the process of becoming the pervasive mode of knowledge production. In the aftermath of Gibbons et al.'s book on 'the new production of knowledge' (1994), the idea that traditional research institutions reflect an aggregate of approaches in an ever more complex heterogeneous landscape of knowledge producers has become commonplace. To make their voices heard, researchers who study the relationship between science and society argue unanimously that knowledge producers increasingly have to engage in context- and problem driven research conducted in interdisciplinary teams in order to adequately address the complexity involved in issues related to the built environment.

Understanding a new production of knowledge

Traditionally, society is seen as an important *context* of science but not as part of its *content*. In the history of science such an understanding of scientific autonomy is usually connected with the normative structure of science described by the sociologist of science Robert K. Merton (1942). His four principles, known as CUDOS norms, Communalism of research findings, Universal validity of findings, Disinterestedness and Organised Scepticism, draw a strongly guarded line between universal science and partisan interests of parties that populate society. And that there should be a fundamental division between basic science which is located 'outside' society and a science which is 'applied' and therefore operating within society, is also a basic tenet of post-WW2 war technology policy. So called 'science push' models of technological innovation, which are often traced back to Vannevar Bush's 'Endless frontier' (1945), see new technology to originate in universal principles found by science which then are applied to create the new technologies society may or may not need.

Since the 1960s these ideals and the corresponding practices of science, but also of engineering and architecture, have increasingly come under attack from various sides. Oftentimes romanticising pre-industrial forms of native and natural knowledge, modern science and technology, their principles and their protagonists were blamed for the unintended consequences of modernization (Beck et al. 1994). This criticism was pointed first and foremost at those seen as responsible for negative consequences of modern technology in conjunction with the kind of technocratic large scale planning which was characteristic for the 1950s and 60s. Correspondingly, in the field of technology policy a linear understanding of development such as the ‘science push’-model, was opposed by calls for a democratization of science, technology and planning.

With social scientists and anthropologists entering the secluded laboratories of modern science (Latour & Woolgar 1986)[4] and producing outsider-accounts of scientific research as it was happening, a less normative and more descriptive appraisal of scientific practice took hold. These studies described in great detail how science was more closely bound to its societal contexts than Merton’s norms would allow. The ensuing ‘science wars’, which were triggered by the counterattack of the promoters of Mertonian science gained heat from a conflation of the older strand of modernisation critique with the newer efforts of describing scientific practices, a confusion which occurred on both sides of the confrontation.

With the dust settling from battles attacking and defending the purity of science, nowadays we hardly encounter anyone within social studies of science asking whether Mertonian norms should be valid or not. Instead, researchers explore how these norms are reinforced and which competing norms exist. That science is increasingly subject to extra-scientific demands is not any longer controversial. On the other hand, as the sociologist of science Merle Jacob (2005) points out, there is equally little doubt that science is a distinct activity which cannot be reduced to societal factors.

A common contemporary way of analysing the links between science and society distinguishes different kinds of science with varied degrees of societal involvement. In an early form, the theory of finalisation (Weingart 1997) claims that mature branches of science are less autonomous and more directed by non-scientific contexts of application. More influential in current discussions, Funtowicz and Ravetz (1993) see the advent of a special kind of science which they call post-normal science. They claim that under certain conditions, characterized by high decision stakes (high risk and urgency) and high uncertainty, a new kind of science which goes beyond professional consultancy and applied science has evolved, which manages to 'make ignorance usable'. What they call 'post-normal' science relies on an extended peer community which includes those affected or with special knowledge about the problem. Using the example of climate change induced sea-level rise they claim that this also changes the role of scientific values:

> Public agreement and participation, deriving essentially from value commitments, will be decisive for the assessment of risks and the setting of policy. Thus the traditional scientific inputs have become 'soft' in the context of the 'hard' value commitments that will determine the success of policies for mitigating the effects of a possible sea-level rise. (Funtowicz & Ravetz 1993, 195).

This description of new forms of valuating scientific outcomes is similar to what Gibbons et al. (1994) call 'social robustness' as dominant quality criterion within 'the new production of knowledge'. According to their diagnosis the whole of knowledge production has entered 'a new mode' and not only in specific research areas., and their mode-2description is probably the most influential, certainly the most comprehensive effort to describe current transformations of knowledge production to date(Hessels & van Lente 2008, 748). In addition to society and its values having a say in deciding what valid knowledge is, mode-2 theoreticians state that knowledge is increasingly produced 'in the context of its application'. This means that the context of scientific production 'talks back', and it no longer passively receives the outcomes of science but actively interves in its production. Reacting on criticisms of their first book (Gibbons et al. 1994), the authors contend that there may very well be different degrees of contextualisation of science (weak, strong and middle range). But the authors still claim that all forms of knowledge production are moving towards a new, less secluded mode (Nowotny et al. 2003). Consequentially, the authors mobilize a broad range of observations that knowledge production is becoming increasingly problem orientated, more interdisciplinary, flexible, reflexive and dynamic, user-oriented, more distributed in international networks, and less firmly institutionalised.

The main criticisms of this work in one way or another aim at the dualism created when a seemingly coherent new mode is contrasted with an older one (mode-2 vs. mode-1). This binary relation has been accused to do injustice to actual practices (Etzkowitz & Leydesdorff 2000, 116) and to create an unnecessary lock-in, instead of an opening to a broader variety of accepted forms of knowledge production (Rip 2000). As Hessels and van Lente (2008) show, despite these criticisms a large majority of publications discussing mode-2 do so in affirmative ways.

A new mode of building and energy research?

Engineering and architecture are young disciplines which have only a relatively short history of establishing boundaries around their specific expertise. Layton (1971), one of the pioneers of engineering studies and an engineer himself, was one of the first scholars who sought to purge engineering from the reputation of being 'just' application (e.g. of physics) by stressing the universal aspects of engineering. In the same way, architects have asserted to define their specific expertise distinguishing their knowledge from the provision of the purely practical solutions it offers to the human need of shelter for example referring to the much profounder spiritual need to shape our habitat and the aesthetic, emotional and symbolic meanings of architecture (Botta 1997, 10). In fact, whether architects should be educated at the polytechnics which were newly established to educate engineers was a much discussed topic around 1900 when architecture became part of national higher education systems with different outcomes[5].

But there are also strong tendencies which destabilise the disciplinary boundaries around engineering and architecture, as both have a long and successful history of mixing basic and applied research and of working in interdisciplinary teams. Both have a strong tradition of ad hoc specific problem solving (Gann 1997, 263; Slaughter 1993, 92). Despite the longstanding 'sibling rivalry' between architects and engineers (Saint 2007), the current renewed interest in sustainable performance criteria, holistic building design and construction methods is providing new opportunities to negotiate professional identities in practice (Abel 2004, Hardy 2008, Kieran and Timberlake 2004, Larsen and Tyas 2003, Lepik 2010).

It could easily be argued that architects known for ground breaking projects are able to do so because of access to the best available engineering collaborators, as well as, to greater financial resources or cost per square meter for construction and design budgets.

Inversely, it could also be claimed that in projects with smaller budgets and ambitions, the specialized roles of team members dominate, reinforcing professional boundary conditions, where architects address non-technical issues and engineers address technical ones. This is obviously not true in every case, although it is not to say that financial resources and accepted professional norms do not affect outcomes. Of course, they do. However, frequently in practice many actors coordinate in the field to joint problem solve innovatively.

According to the mode-2 hypothesis, boundaries between disciplines, but also boundaries between applied science and basic science become systematically blurred. The question now is how well building and energy *research* and *researchers* are prepared to meet these challenges. Based on what was said so far we can imagine two possible outcomes: Either building and energy researchers continue to guard their specific expertise, possibly intensifying their efforts as they experience that their knowledge is devalued in favour of alternative skills more in demand within interdisciplinary work. Or they connect to traditions and trends within their disciplines which open for integrated and user-oriented approaches. In the latter case, it would be interesting to see whether building and energy research has to offer lessons to other disciplines which according to mode-2 research are undergoing similar developments.

To explore whether and to which degree building and energy researchers embrace mode-2 knowledge production we have circulated a questionnaire among active European contributors to the field. If the mode-2 hypothesis is correct, existing disciplines are losing importance. Therefore, we could not refer to traditional disciplines or other institutional structures and had to leave the presupposed underlying population of the study weakly defined (as self-assigned building and energy researcher). Since we cannot know anything about the exact size of the population our sample is drawn from, the following exploration could not strive for statistical representativeness. Still, as we will show in the next section, our respondents present a coherent image of the current state of building and energy research and its relation to the mode-2 hypothesis.

Letting the building and energy researchers speak themselves

In June 2011 150 targeted participants were solicited via email to complete an online questionnaire consisting of 28 questions. The addresses were which were selected according to two criteria: Approximately one third were institutional addresses (such as info@...) with the expectation that the respective institutional contacts would use their local knowledge to distribute the email to appropriate individuals. Another two thirds of the addresses s consisted of persons actively contributing to the field, among them the Northern and Central European contributors to the five last volumes of the academic journals Building Research and Information and Energy and Buildings. These emails resulted in 42 responses which is an acceptable response rate of 28 percent. Of these responses only 24 have answered more than 25 percent of the questions and were included in the analysis. Two comments given by respondents suggest that this relatively high degree of drop-outs is related to unclear signals about the desired addressees given in the initial use of the word institution.

The self-selection (respondents were encouraged to forward the questionnaire to people they knew are contributors to the field) of this study has resulted in a sample consisting of respondents mainly employed at universities (82 %[6]). Almost 40 percent of the respondents were trained as architects and more than half were either additionally or exclusively trained as engineers (62%). In their day to day work they did research (89%), teaching (56%), and consultancy (29%).

State of the art in building energy research

Asked for the current state of building and energy research the description as applied research gathered the strongest support together with the statement that it is dealing with climate change (with a mean of 4.0 on a scale from 1 to 5, N= 24). While this sends a clear message pointing into the direction of postnormal science and mode-2 research, there were opposing trends as well. The descriptions as dealing with high financial risks and flexible were those with the lowest acceptance (2.6 and 2.9 respectively, N=24). Thus, high risk, the defining criterion of postnormal science, was not seen as important for building energy research.

In the next question we used the same statements turning them into normative prescriptions exchanging currently is with should be. Here interdisciplinary research scored highest (mean 4.8, N= 24). The next highest ranking values were assigned to international networking (4.6, N=24), dealing with climate change (4.5, N=24), applied research (4.5, N= 24), and reflection on methods (4.4, N=23). The only result not fitting this perfect list of characteristics valued high in mode-2 research was that being based on scientific principles actually ranked second highest (4.6, N=24). This is consistent with a general scepticism against involving research in financial risk (3.3, N=23) or dependence from industry support (3.0, N=24), which are among the lowest ranked items.

Comparing the respondents' description of the current state of building energy research and their normative prescriptions, we were able to find areas where the respondents were particularly unsatisfied with the current state of affairs. The three topics where the respondents showed the largest difference between their answers to these two questions were in regard to the statement reflecting on its methods, aware of end-users' demands and wishes, and involved in societal discussions. This means that they saw the largest need to improve in tenets central to mode-2 research: reflexivity, user-orientation and societal involvement.

Quality criteria

In the next two questions we asked the respondents about how the recognition of quality in building energy research *is* currently determined and how it *should* be determined.

Traditional quality criteria like scientific quality and peer review scored high both in description (3.8, N=22 and 3.7, N=23) and norm (4.9, N=22 and 4.1, N=22). But among the four highest ranking criteria were as well non-traditional qualities like relevance for environmental problems (is: 3.6, N=22 and should: 4.6, N=22) and the effects of research (is: 3.6, N=22 and should: 4.4, N=22).

On the other end of the scale, aesthetics scored very low both as current and desirable criterion (2.4, N=22 and 3.2, N=22). In the normative dimension it was only surpassed by lobby interests, which scored medium in the respondents' description of the current state.

Interdisciplinary collaboration

The high valuation of interdisciplinary collaboration, which we saw in the previous sections, is reflected in the respondents' actual practice. All but one respondent said that they have been involved in interdisciplinary work with collaborators from in average five different disciplines. The topics for this collaboration were extremely diverse. Indoor environmental quality (IEQ) was the only one which was mentioned more than once (4 mentions). In two cases the collaboration's goal was an evaluation of different aspects of existing buildings.

The future

We also included an open question about the respondents' expectations about focus areas within building energy research in the immediate future (until 2020) and in the long term (2020-50). In the following we list mentioned topics which we found more than two times ordered ascending by frequency.

A common combination of short and long term prognoses which was given here assumed a perfection of passive measures soon and the development of active systems including renewable energy production in the long term. A second group of topics which was mentioned was different forms of integration: between disciplines, on the system level (e.g. integration of water recycling, transport and telecommunication) or varying scales. Connected to the scale aspect we saw a frequent long term expectation that building energy research would move on from the building level to district, urban, regional, national or even European levels. Refurbishment was equally often mentioned as a short and long term focus area.

Conclusions

The respondents' descriptions of building and energy research as applied science which deals with climate change and which should be interdisciplinary and internationally networked complies well with basic descriptions of the new production of knowledge which was put forward as mode-2 hypothesis. As we have seen there are indications that the respondents are not seeing their activities as post-normal science as the low scores for 'high risk' suggest. More importantly, however, there are findings which are more in line with traditional Mertonian CUDOS norms than with mode-2 or any other assumption about a new production of knowledge. The respondents' are overall positive towards traditional quality criteria for good science such as 'scientific principles' and 'peer review'. Moreover, they reject unanimously financial dependence on the building industry. That these statements exist alongside a clear commitment to quality criteria controlled by extra-scientific parties, such as users and the environmental impacts of the research, shows that the respondents are only ready to sacrifice scientific independence to *certain* parties. Distinguishing not only between science and non-science – as necessary when following Mertonian norms – but now also between different non-scientific parties poses new challenges to research: Who is the 'user' of the research who is allowed to set the agenda (Shove & Rip 2000)? And who is speaking for the environment and therefore allowed to interfere with science?

A second set of future challenges for building and energy research follows from the respondents' own expectations about future research topics. As we have seen they were related to the integration of more functions into the individual building, functional integration, and the integration of the building into larger technical systems. With buildings becoming more and more complex internally and at the same time more and more connected to other technological systems, the need for integration of different kinds of expertise will only increase. In this respect the respondents' call for methodological reflection is an adequate answer to the methodological challenges awaiting building and energy research.

If we accept that the mode-2 hypothesis describes a secular trend within all kinds of knowledge production, the challenges for building and energy research which are connected to defining the relation to various extra-scientific factors (users, industry, and environment) and ever tighter integration of expertise will not go away soon. There is reason to believe that contemporary building and energy research is well prepared to participate in this 'new production of knowledge': Drawing on a broad range of disciplines and being at its core problem driven it is increasingly addressing contextual factors.

The further development of interdisciplinary and context sensitive approaches which includes the management of uncertainties introduced by contextual factors is one of the most important challenges building energy research faces in the next decade. If it embraces this role it will be able to inspire a whole new set of research initiatives also outside the building sector.

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[3] See the project's self-description at http://www.ntnu.edu/energy/smartbuild

[4] For ethnographies engaging with engineering and architectural practice see Latour (1996) and Yaneva (2009) respectively.

[5] For a comparison across national education systems, see Stevens 1998: 168-87; an in-depth account of the Norwegian side of the story was written by Berre 2001

[6] Multiple responses were possible.