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SPEAKER

Learning from Actor Network Theory: Bridging the gap between research in science and research by design

Abstract

This paper explores how an alternative understanding of the development of scientific knowledge through the work of Bruno Latour can help to bridge the gap between knowledge produced through practice-based research and conventional research outputs.

The paper reviews the history of the debate of what constitutes practice-based research outputs drawing from the work of Frayling (1993) and Archer (1995). An understanding of practice-based research is developed that goes beyond a simplistic view of a building or artefact as a research output or “mute object” (Till 2012).

This is considered in the context of the work of Bruno Latour (1987, 2005) and others who have tried to show how the construction of scientific facts is produced as a function of both the ‘objects’ and ‘social’ context of science.

Through reviewing practice-based research submissions from RAE 2008 the paper explores how we may re-conceive both the normative models of research outputs (peer reviewed academic papers) and the products of architecture practice (buildings and artefacts) and conceive them both as part of the same network of knowledge production. This is then discussed in the practical context of a practice-based

research project into low energy housing.

In doing so the paper suggest this new understanding will elevate the importance of rigorous practice-based research while overcoming the challenges faced in conventional research in the constant desire to show impact from research projects.

Introduction

The debate regarding what constitutes research in the field of the Architecture is contentious particularly since the introduction of the evaluation frameworks such as the Research Evaluation Framework (REF) in the UK or the Excellence in Research for Australia (ERA). This has resulted in the focusing of funding for research being connected to the quality of research outputs.

In Architecture, similar to other art and design disciplines, it has therefore become necessary to be able to evaluate a practice-based output in the form of a building in the same way you would evaluate a research publication and therefore understand how it constitutes research and how to measure quality.

Through a review of submissions to the 2008 Research Assessment Exercise this paper suggests that although submissions of buildings are possible there is a tendency in the submissions for academics to reference practice based metrics for deciding quality (architectural awards) or academic metrics (evidence of peer review publication). This has resulted in both a limited understanding of quality and a particular type of research that simplifies the nature of practice based design enquiry in connection with buildings.

The paper reviews the work of Latour to suggest an alternative model that looks to understand the activities of researchers and practitioners as the same. Through looking at a particular case study the paper suggests we should focus some of our collaborative research efforts on uncovering the connections between academia and practice as a way of providing new research methods and a better understanding of impact and quality.

Current practice in submitting buildings as research outputs

In setting the context for this paper it is important to look at current practice in the submission and evaluation of buildings as research outputs. This paper will focus on the UK 2014 Research Evaluation Framework where there is guidance on how to

submit a building as a research output (HEFCE 2011) and in doing so it is hoped that some general conclusions may be drawn as to how academics are justifying the quality of buildings as submissions. These submissions are called practice-led outputs and the panel C submission guidance specifically allows:

“a wide range of research output including, but not limited to...physical artefacts such as buildings, devices, images, installations, materials, products and processes, prototypes.” (HEFCE 2011)

This is not the first time that this is possible and in the 2008 Research Assessment Exercise (RAE 2008) a wide range of Universities submitted practice based outputs including buildings. From a review of the top 4 Architecture submissions in the RAE 2008 it is clear that practice based submissions were common even among the top ranked institutions.

Practice led research is allowed as long as it meets the REF definition of research:

“For the purposes of the REF, research is defined as a process of investigation leading to new insights, effectively shared.” (HEFCE 2011, p.48)

However it is not immediately apparent when a building is a research output and how quality is objectively measured. Although it is not possible to see the full submission, on reviewing the RAE 2008 summaries (HEFCE 2008c) it is evident that there is little consistency with regard to the description of research questions, methods and means of dissemination.

It is also not clear how practice based submissions are assessed in terms of their quality, although they are not supposed to be prejudiced and are measured against the same criteria (HEFCE 2011). Anecdotally this seems to be true as there does not seem to be a correlation with regard to overall ranking of the institution (i.e. the quality of the outputs) and the amount of practice led submissions that were made, although there are large differences between individual institutions. For example University College London had a large number of practice led outputs whereas Cambridge did not and they are both highly ranked.

Defining practice led research in Architecture

Before interrogating the submissions further it is important to define what practice led research is in Architecture in the context of a building. Architecture, Design and Art situate learning and scholarship in a professional setting and view practice as one of the logical locations for the undertaking of enquiry and research.

Practice led research is a loosely defined term across Architecture (Jenkins, Forsyth &

L. Smith 2005) and Art and Design (Durling 2000). The clearest definition is given in the EAAE research charter:

“any kind of inquiry in which (...) the architectural design process forms the pathway through which new insights, knowledge, practices or products come into being. It generates critical inquiry through design work.”

However the question of what constitutes research in a practice setting has drawn much debate and particularly on what types of practice based outputs should count as research outputs (Till et al. 2005).

In the UK this debate emerged over fifteen years ago initially through a series of articles and letters in the Architectural Research Quarterly which led to a focus by the Architecture profession and the RIBA to define the nature of research and practice led research in Architecture (Jenkins, Forsyth & H. Smith 2005; Macmillan 2010). The particular challenge was understanding the role of professional production, or the design and construction of a building and whether this constituted a research output and if this should be subjected to the same standards as all other research outputs (Jenkins, Forsyth & H. Smith 2005; Macmillan 2010).

The view that practice based research in Architecture should be subject to the same standards was not shared by all academics in Architecture. When the debate first emerged prior to the 2001 RAE there were some who argued Architecture should sit outside of standard conventions of research and that design was research in itself (King 1995a, 1995b, 1995c, 1995d, (Tabor 1995; Yeomans 1995)). This approach has now largely been dismissed and instead the challenge is to find ways of demonstrating how and when design is research (Till 2012; Macmillan 2010). This has been supported by a number of recent publications looking to define methods and practices in design research in Architecture (Fraser 2013).

Two frequently cited references for understanding what constitutes research in Art and Design which have been used to inform the debate in Architecture were Bruce Archer (1995) and Christopher Frayling (1993).

Both Archer (1995) and Frayling (1993) set out clearly the relationship between research in Art and Design and the physical sciences. In doing so they define three areas of research in Art and Design relative to normative academic research:

- Research into Art and Design (e.g. concerned with the historical, theoretical, perceptual research)
- Research through Art and Design (e.g. materials research, development work, action research associated with the production of an artefact or practice led research)
- Research for Art and Design (e.g. research into materials and processes for the purposes of development and production of an artefact).

Research into Art and Design is most frequently identified as part of academia and research through art and design (practice led research) and for art and design is most directly connected with practice (Frayling 1993).

Archer (1993) also suggests that the test for what constitutes research in the Arts (for all categories) should be the same as the physical sciences, namely that research is *'a systematic enquiry whose goal is communicable knowledge'* (Archer 1995).

Archer is the most explicit in noting the similarities between the two based on a critique by Karl Popper (Popper 1959) of the deductive model of scientific practice. This critique, which has been used by other authors (Brawne 1995), is used to suggest that practice based research is possible if it meets certain criteria. Archer suggests that when considering practice led research (research through art and design) the following tests should be applied:

- a. Was the practitioner activity an enquiry whose goal was knowledge?
- b. Was it systematically conducted?
- c. Were the data explicit?
- d. Was the record of the conduct of the activity 'transparent' and replicable?
- e. Were the data and the outcome validated in appropriate ways?

(adapted from Archer 1995)

From these tests and the definition of research there are two important consequences of this approach. Firstly that building can only be part of a research project if it has been conducted in a way that meets these tests and therefore not all buildings are part of research projects. Secondly, on its own, a building cannot communicate all of these criteria, therefore a building could be part of a research project but not a research output by itself. Till (2012) supports this view:

“Designing a building ...is not necessarily research. The building as building reduces architecture to mute objects. These in themselves are not sufficient as the stuff of research inquiry. In order to move things on, to add to the store of knowledge, we need to understand the process that led to the object and to interrogate the life of the object after its completion.”

(Till 2012, p.5)

So in the context of practice based research, research resides both within a building or artefact and the documentation that is able to explain the process of enquiry and justify the activity as research practice against a set of criteria such as the ones described by Archer (1995). What is necessary is to connect the evidence of the process of enquiry and / or its impact after completion with the building.

So buildings can be part of a practice led research project, however only when it meets the tests of what constitutes research and that there is evidence to support this. On its own it is not a research output. However, returning to the REF definition how do we know the research has been effectively shared and how can we measure the quality?

Measuring quality and dissemination

Conventional research outputs in the form of written publications are normally published in peer reviewed journals and disseminated globally. The determination of the quality of the output is a contested issue but can include the quality of the journal, its impact factor and number of citations of articles.

As described above it is not possible to understand a building as a research output in isolation but only as part of a wider process. Buildings that are part of practice-led research projects (unlike artwork, design objects, or music) cannot easily be directly shared with large numbers of people (through various digital media or physically transported) and the findings are disseminated through pictures and text in journals and magazines which may not include traditional academic journals. The quality of a building is also difficult to measure but in practice it is often associated with the winning of awards.

Therefore one way in which to understand if a practice-led research project has been effectively shared and is of high quality is to look at where it has been published and the awards it has won. It is not surprising to find the RAE 2008 submissions listing magazines and books that have published photographs and reviews of the building as evidence of dissemination and a list of awards it has won. However there is limited detail as to what these reports cover or the criteria against which the awards were judged. Architectural magazines are not part of a peer review process, there is no requirement for research findings to be published as part of the write up, and architectural awards relate to the quality of the building not the research behind it. Therefore a list of citations and awards won would be insufficient to justify the research being effectively shared or the quality of it. Certainly the assumption that a good building (award winning) implies a good research output is not true. As Till (2012) has noted a bad building may have good research findings and a good building may not. This was the case for a recent project by the Joseph Rowntree Foundation where the failure of a building resulted in findings that changed national policy (Wingfield et al. 2011).

In the worst cases in the RAE 2008 there is a focus simply on a list of publications in

magazines (architecture as 'mute object') or reports of the project in non-peer reviewed journals. However in other instances it is clear that the submissions reference peer reviewed journal articles or institutional reports that set out a range of particular findings connected with the building (see for example Wigglesworth's Mossbrook Special School Classroom for the Future and 9 Stock Orchard Street (HEFCE 2008a) and Short's SSEES building (HEFCE 2008b). In these instances reference to academic articles is used to provide robust evidence of findings associated with the research enquiry and its dissemination. However are these publications sufficient as a measure of quality or representative of the process of design enquiry? To understand this it is helpful to take a wider perspective on the activities of scientists in general.

Science and engineering practice

"no distinction [can] been made between what is called 'scientific' fact and what is called a 'technical' object or artefact. This division, although traditional and convenient, artificially cuts through the question of how to ally oneself to resist controversies." (Latour 1987, p.131)

The work of Bruno Latour has proved controversial in its re-framing of science, technology and society. He has argued that the division between the activities of scientists and engineers is artificial and results in an understanding of both that is limited in being able to account for the nature of technical and scientific progress and its relationship to society.

His re-framing draws together science, technology and society and as such offers a helpful reconsideration of the discussion of what constitutes research in architecture and how we may account for and describe practice based research.

I will outline the key aspects of Bruno Latour's work on science and technology studies drawing principally from his earlier texts, *Science in Action* (Latour 1987), *Aramis or the Love of Technology* (Latour 1996) and *Pandora's Hope* (Latour 1999) where his arguments are most clear and can be directly related to the discussions in *Architecture*.

What do scientists do?

Latour's starting point is to investigate how science moves from a position of uncertainty or controversy to an established fact where by the findings are no longer brought into question but are used as the starting point for further scientific

research.

He asserts scientists achieve this through the activity of “fact-writing”. Fact writing is the process by which, through the publication of articles, they are able to close down scientific controversies. This is achieved by building alliances from other academic papers that are able to support their particular findings and persuade others that what they are doing is correct.

As part of these publications graphs and other representations provide evidence of their arguments. These graphs are in turn produced by instruments or ‘inscription devices’ which translate an extracted and modified representation of nature into readable outputs that can be referenced and interpreted (as they cannot speak for themselves). Finally the scientists and devices sit within laboratories and institutions that support the scientists and attract and shape funding that is connected with the interests of government and other institutions. So the activity of ‘fact writing’ is principally about enrolling as many actors which include material actors (inscription devices, graphs, cultures) and immaterial actors (other scientists, institutions, funding bodies) to support your cause. In addition through this process of enrolment, actors goals are transformed which shift the direction of the research as it gains more allies. This transformation happens as individual controversies are resolved.

Therefore scientific controversies are resolved through the building and assembling of networks made from human and non-human actors (scientists, institutions, inscription devices etc.) The strength of these networks and their ability to enrol actors is what stabilises scientific controversies.

Additionally research findings are only a partial representation of nature. The construction of scientific facts relies on the extraction of data from nature and at each step the data is simplified and reduced, the findings from science are not nature and never can be found in nature. Therefore appealing to the truth of nature in order to resolve a controversy is not possible as nature is only represented in a reduced and amplified form (Latour 1999). When the findings of research are taken into practice they are necessarily modified as they are re-situated in a new network.

What do engineers do?

In contrary he discusses the making of machines. This is made most explicit in *Aramis* or the *Love of Technology* (Latour 1996). Here the question is how to enrol a series of actors (human and non-human) in the making of a machine moving from a disorderly set of allies to something that works without understanding its internal operations.

In the same way the production of scientific facts can be un-peeled to reveal the

institutions, devices and scientists behind them, this can be done for machines. They move from their inception by individuals, to projects which begin to enrol further actors (engineers, institutions, other technologies) which come together and re-shape the trajectory of the project. As new alliances are formed between actors and controversies settled their goals also get translated until ultimately the machine is constructed.

As with the scientific facts the ultimate outcome is a working machine (or stabilised entity) that is then transported to other sites where its inner workings are not brought into question. Latour refers to this situation as a 'black-box' and applies equally to scientific facts as it does to machines.

However neither scientific facts or machines are 'black-boxes'. As soon as you do not maintain a machine it breaks down into its many parts or as soon as the assumptions of a scientific fact are brought into question the whole context of the debate re-emerges. Neither are therefore 'black-boxes' only temporary stable situations reliant on actors to either maintain the machine or re-assert the 'facts'.

In summary Latour does not see a difference between science and technology "the problem of the builder of "fact" is the same as the builder of "objects": how to convince others, how to control their behaviour, how to gather sufficient resources in one place, how to have their claim or the object spread out in time and space" (Latour 1987, p.131). The only subtle difference "is when new and unexpected allies are recruited" (Latour 1987, p.131). visible in laboratories or when "all gathered resources are made to act as one unbreakable whole" (Latour 1987, p.131) visible in the making of machines.

To overcome the current paradigm that tries to separate the work of scientists from those of engineers and from both of these from society he suggests that we should examine and un-cover these networks to understand how and where these 'objects' and 'facts' emerge.

Accounting for buildings

"In order to move things on, to add to the store of knowledge, we need to understand the process that led to the object and to interrogate the life of the object after its completion." (Till 2012, p.5)

Reflecting back on Till's quote above it is exactly this process of enquiry that is been advocated by Latour. In the submissions to RAE 2008 we can see that even when buildings are supported by academic papers reporting findings from the project they

do not reveal the process of enquiry that led to the object in the way Latour or Till describe. Rather, I would suggest, they reinforce the division between practice and research by looking only partially at the outcomes of the project.

In order to overcome this division we can look again to Latour. Actor-network Theory (ANT) (Latour 1999) provides a theory and methodology which was originally developed out of Science and Technology Studies as a method to study science and technology. It can be applied to the design and construction process and has been widely applied to engineering practices and more recently the design of buildings (Yaneva 2008; Yaneva 2009). Importantly ANT views buildings as socio-technical objects (Latour & Yaneva 2008).

Using ANT means not describing buildings as technical artifacts but rather revealing how the cultures and practices of building construction shape and are shaped by the technological objects through the design and construction process.

This network of human and non-human actors stabilizes around particular controversies where a group of actors (human and non-human) form to discuss and resolve a disagreement. Importantly it is both the non-human and human actors who have agency. An ANT account of a building therefore describes what both human and non-human actors do over time.

Energy as an example

“If you show me a serum for diphtheria, I'll understand how far you drifted from the original research programme that aimed at making vaccines and I'll tell you who are the physicians who will get interested” (Latour 1987, p.136)

The challenges we face today are exactly the issue of how we shift from research to practice and back again and how design enquiry as a tool can support this. The challenge is to understand this interface and the design and construction of buildings offers a unique opportunity to this. Rather than separating research as Archer and Frayling did into ‘through’ art and design and ‘into’ art and design, to understand them as part of the same network. In doing so would result in two outcomes. Firstly instead of trying to understand the quality of a building as a result of how it has influenced people through the publication of articles or the winning of awards to instead study how through the design and making of the building the actors were reshaped and then went onto reshape future contexts. The second consequence would be the ability to see how, in detail, the process of design shaped the nature of enquiry. It is this second point I will discuss in more detail.

To illustrate one way we may begin to uncover this divide is to look at the issue of energy use in new housing. Research on energy consumption in new housing both internationally and in the UK is identifying a gap in performance between the technical potential of achieving these energy savings and the performance of new housing in use (Lowe et al. 2007; Miles-Shenton et al. 2012; Wingfield et al. 2011; Isaacs et al. 2010; Stevenson & Leaman 2010; Stevenson & Rijal 2010; Williamson et al. 2010). This relates both to individual technologies as well as the design of whole houses. Many of the research findings for the causes of this gap focus on technical fixes to existing technologies and designs or how to overcome non-technical barriers (social and organisational) to increase adoption and technological efficacy.

The error here, in my view, is not that there are either social or technical problems that need to be understood, but the very conception of a divide between the social and technical, or the translation of energy models from science to practice. The process of design of a building, and therefore the energy performance of a building, is shaped by interactions between clients, design teams, contractors, sub-contractors drawings, models, building components and various regulations from the beginning of the design process to the building completion that are situated in very local contexts. The technology of a building and the building performance is as much a function of the properties of the materials as it is the legal contracts and budgets that constrain the design process. Therefore the very deployment of technology and removal non-technical barriers cannot be conceived of as part of one or another domain. What is needed is a study of these socio-technical networks in order to understand how they contribute to the gap in performance.

From an ANT perspective energy use in buildings is distributed between human and non-human actors. Energy efficiency in housing is not (and never has been) a stabilized object, rather it is fluid and shaped by controversies over matters of concern (Latour 2005). In housing this could be where the contractor, designer, prefabricated insulated panel, cost plan, regulations and energy model come together to try and deliver the best thermal performance for a wall.

Providing an ANT account of energy in a building would mean not only understanding the relationships between non-human actors that together are represented in energy models but also to account for the cultures and practices that shape the energy performance through time.

This type of account of energy in a building would not treat the outcomes of energy models as a matter of fact and that the technical potential could be realized through appropriate deployment in a particular context.

This approach is illustrated in research undertaken on the Temple Avenue Project (TAP) in York (Bradbury 2014). These houses are prototypes that were constructed between July and December 2009 as part of a larger project for 540 new homes called Derwenthorpe for the Joseph Rowntree Foundation. The two prototype houses (see figure 1) preceded the main development and were based on two house designs that were included as part of it. They were of similar design with the only major difference being the location of the south facing winter garden on either the front or rear elevation due to different locations on the site. The objective of the prototype project was to reduce the fabric energy performance gap from as designed to as built and a team of academics collaborated with the team to achieve this. The energy performances of these houses were mapped using ANT as a methodology through the design and construction of the project.



FIG. 1. Temple Avenue prototype houses in York (Bradbury 2014)

Specifically the controversies that shaped the decisions that effected energy efficiency were mapped and the performance of the designs were modeled. Following Latour, in order to identify the causes of changes to energy performance the method was to “just look at the controversies and tell what you see” (Venturini 2010). This was done by following the actors to identify when and why the energy performance changed and by triangulating information from interviews, emails, drawings, specifications, programmes, cost plans, energy models, contracts and other key documents. Additionally a construction and post completion survey and report that identified key construction defects and causes of the performance gap (Miles-Shenton et al. 2012) was also referred to.

In order to represent how the predicted performance changed through the design process, the evolving Architects specifications and drawings were used as a data source to develop energy models and these were correlated with the controversies that shaped the decisions. This mapping can be seen in figure 2.

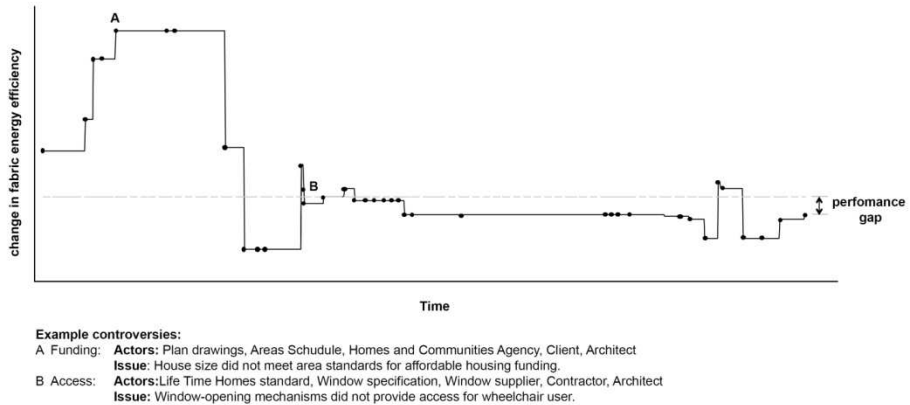


FIG. 2. Change in fabric energy performance through design process and illustration of controversies that had an impact. (simplified and adapted from Bradbury 2014)

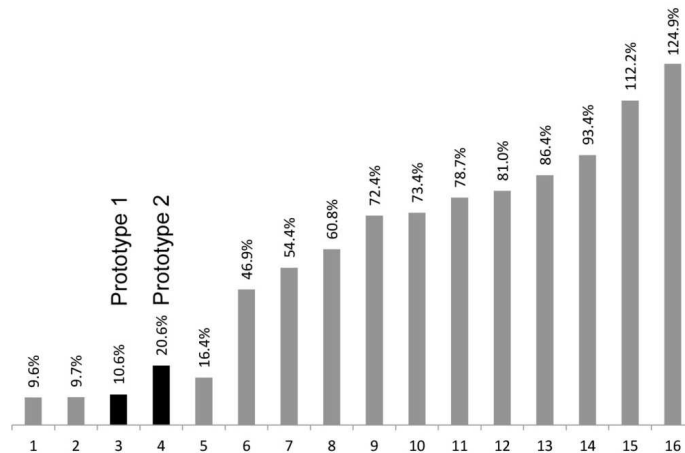


FIG.3. Graph showing percentage difference between completed and as designed fabric energy performance of the two houses compared to all houses tested in UK (adapted from Miles-Shenton et al. 2012)

The representation of energy performance in figure 2 can be seen in stark contrast to the graph that was produced to show the percentage gap in performance from the model predictions to the tested building from the energy assessors (fig. 3). Where as the first figure reveals energy *translated* through the design process and in the context of the controversies that led to the gap in performance the other suggests energy should be a stable or a 'black box' issue. The first contextualises, describes and gives value to the process of design where as the second assumes that there has been a failure of design or construction process and the results are transferable. Indeed the first representation even draws into question the notion of what a performance gap is when it is clear that energy is never stable long enough to set the points to measure the difference between. These findings rather than reporting on the success of the project in achieving a very small gap in performance (which indeed it did) or the awards it won (which are numerous) re-focus on how the design enquiry led to the outcome.

Conclusion

"If you take any black box and make a freeze frame of it, you may consider the system of alliances it knits together in two different ways: first, by looking at who it is designed to enrol; second, by considering what it is tied to so to make the enrolment inescapable. We may on the one hand draw its **sociogram**, and on the other its **technogram**." (Latour 1987, p.138)

It is clear that in defining what practice based research is in the context of buildings there is a need to build strong alliances between research and practice as others have noted (Till 2012; Borden 2008). Without this it is not possible to communicate the substance of the research project that is embedded in the design and construction of a building.

Evidence of this collaboration is present in many of the submissions to RAE 2008. However even when this is done the substance of this research needs to support and give value to the process of design, the collaboration in of itself is not enough. Therefore despite evidence of research papers that show findings from buildings that are practice led research projects, it is not clear that these are exposing the process of design as research practice. This is because there is a tendency fall back on the divisions between the academic and practitioner that are explicit in the way in which practice led research is defined. It is then no surprise to see submissions looking to

measures of quality drawn from awards and peer review publications.

Latour offers a way of drawing practice and research together by understanding the process of design enquiry as equal to research enquiry and that for both we need to draw the 'sociogram' and 'technogram'. Once we describe the networks through the controversies and actors as was illustrated in the example the division between the social and technical, researchers and designers disappear and instead the process of design is revealed. It is then clear how the process of enquiry led to the outcome, how agency and context shaped decisions. For some this may not be enough as it is not transferable, replicable and there are no clear answers. Certainly it is controversial not least for scientists in questioning their practice. However I believe if we can start to reveal how the process of design works, we may, at least in part, to be seen not in opposition to the process of research but as part of the same system of progress.

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