Article

Giving Meaning to the Concept of Sustainability in Architectural Design Practices: Setting Out the Analytical Framework of Translation

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Abstract: The question of how to give meaning to the concept of sustainability in architectural design practices is highly contested today. Although architects, engineers, clients, politicians, and others seem to agree that sustainability must be addressed, behind this apparent consensus many ambiguities, contradictions, and open questions emerge. Opinions largely vary on how to define the sustainability challenges that architectural design is to respond to, how to align the various stakeholders involved, which scales and elements to consider, and how to transform these questions into design strategies, spatial configurations, and materiality of buildings. These practices cannot be confined merely to technological problem-solving as they essentially mesh a range of cognitive, social, cultural, and material elements. This article draws on the interdisciplinary field of Science and Technology Studies (STS) to set out the transferable analytical framework of 'translation' through which to explain how the concept of sustainability is continuously transformed within contingent, complex, and dynamic architectural design practices as buildings materialize. The framework of translation is particularly well adapted to unpack claims, make them more accountable, and thereby support the larger project of sustainability.

Keywords: sustainability; sustainable architecture; sustainable buildings; sustainable design; translation; Michel Callon; complexity; controversy; implementation; Science and Technology Studies (STS)

1. Introduction

This article builds on a completed and award-winning PhD research project that adapted Michel Callon's concept of translation through an in-depth empirical case study to understand how the concept of sustainability is interpreted and implemented in architectural design practices [1,2]. This research project did not start with any interest in a particular building, but with the ambition to develop a better understanding of what architects, engineers, clients and others do with the concept of sustainability in their design studios, offices, and on site. The aim of this article is to set out the analytical framework of translation and show that this framework is particularly well adapted to explain how sustainability is given meaning within architectural design practices.

Callon's concept of translation has been used in several contexts (e.g., [3–7]), but never as a framework for exploring sustainability in architectural design practices, which is valuable to both research and practice. This framework is transferable: it may be used to reflect on architectural design processes completed (past) or to reframe and improve design processes in progress (future).

1.1. Buildings Play a Key Role in Pathways towards Sustainability

The impact of humans on the planet and the vital conditions of human existence can largely be observed through buildings and the associated practices of design, construction, operation, refurbishment, and demolition. The impact of building-related practices on the environment and the conditions of human life involves a complex dynamic that is multifaceted in scope and involves a far-reaching geography of resource extraction, material processing, and the environmental damage produced. For instance, it is argued that building construction consumes more materials and produces more waste than any other industrial sector [8] (p. 7). The International Energy Agency (IEA) suggests that globally the "buildings sector, which uses energy for heating, cooling, lighting, refrigeration and for powering electrical appliances, is currently the single largest final end-use consumer" [9] (p. 61) and the Intergovernmental Panel on Climate Change (IPCC) suggests that the building sector has a greater potential than other sectors to reduce greenhouse gas (GHG) emissions at the lowest cost [10] (p. 59). Further, it is emphasized that the design of buildings plays an important role in contributing to human well-being [11].

1.2. Controversy

More than three decades ago, the 'environmental crisis' began to occupy an important place in architectural debates and practices (cf. [12]), and since the late 1990s architects, engineers, clients, politicians, and others have increasingly addressed questions of sustainability. However, behind this apparent consensus many ambiguities, contradictions, and open questions emerge. Opinions largely vary on how to understand the problem of the environment 'out there', how to define the challenges of sustainability that architectural design is to respond to, how to align the various stakeholders involved, which scales and elements to take into account, and how to transform these questions into design strategies, spatial configurations, and materiality of buildings.

Since the stakeholders of architectural discourses and practices began to respond to the 'environmental crisis' and 'sustainability', a vast range of pluralistic approaches has developed, whose authors are responding to a broad variety of distinct challenges (Figure 1). For instance, some have promoted energy efficient high-tech, low-tech, or vernacular strategies; others have addressed health, well-being, and quality of life issues [13]; some took inspiration from the "analogy to natural forms" [14] (p. 576) or from processes in 'natural' systems [15] (p. 19); some emphasised "performance over appearance, and some appearance over performance" [16] (p. 4); and some developed 'intelligent' and 'responsive' materials, some renewable, recyclable, and biodegradable materials [17]; and some sensory perception [18]. Some addressed resilience and circular economy [19], some suggested not building at all and instead to promote virtualization. Some broached the issue of social justice and design, participatory processes, and affordable housing [20], and others ecological footprinting and consumerist lifestyles [21]. Other actors rely on universal best practice guidelines or building sustainability assessment methods. Some argue we need more technology, others think we need less; and some call for more archaic behavior or to challenge comfort levels.

1.3. Stepping Back: A More Careful Mode of Analysis Is Needed

The majority of debates and practices lack a rigorous approach to addressing the complexity, contestation, and controversy that is necessarily involved in sustainability and architecture. 'Sustainability' has become a well-established lens through which to conceptualize the environmental challenges in architectural design. Today, there is a significant commercial market in using building practices as a means to reduce environmental impact, but few engage critically with it. Through confident project descriptions and expansive claims, many conceal the contestation and uncertainty over pathways to less destructive futures. Sometimes attributes such as 'sustainable', 'environmental', 'energy efficient', etc. are deployed as if they would be identical. As a label, "'sustainability' [. . .] has come to stand for everything and nothing" [22] (p. 27). While acknowledging that these terms are difficult to frame,

I argue that it is important not to pretend that related meanings are clear, but instead to engage with and emphasize the controversies and interpretations over their meanings.

Figure 1. A broad variety of architectural responses to diverse interpretations of sustainability challenges (Collage, Torsten Schröder 2017).

A multiplicity of architectural practices in response to sustainability has emerged. These pluralistic practices can be characterized by "disagreement about design priorities, the role of technology, the importance of aesthetics, the relationship of natural and built environment and the degree of optimism and pessimism that the current state of sustainable architectural practice should invoke" [23] (p. 561). In order to comprehend how the diverse issues, aims, strategies, and actions emerge, we need to "encourage a deeper engagement with sustainable architecture, one that doesn't shy away from broader sociological or philosophical questions or merely indulge in the narrowly instrumental debates that characterise so much of the green architecture literature" [24] (p. 2).

I argue that it is important to shift attention to the ways in which sustainability becomes transformed and displaced (that is, translation) within specific practices targeted at materialization. Crucially, I understand 'sustainability' to be a concept that needs to be interpreted by giving meaning to it. Merely as a concept, sustainability cannot be built—it essentially requires translation into contextualized definitions, design targets, strategies, and more.

1.4. Article Overview

To better understand how sustainability is given meaning within architecture, this article first suggests taking a pragmatic approach by shifting attention from buildings themselves to the design practices that are making buildings. Second, it briefly discusses some key characteristics of the concept of sustainability to show it to be a specific form of problem solving in which controversies, conflicts of aims, and public deliberation are central. Third, drawing on Science and Technology Studies (STS) it introduces and outlines the analytical framework of translation and highlights why translation is particularly well adapted to explain how the concept of sustainability is continuously transformed

within contingent, complex, and dynamic architectural design practices as buildings materialize. The article concludes by highlighting three key contributions that the framework translation can make to advance the enactment of sustainability in design practices.

2. Materials and Methods

2.1. Framing Architectural Design Practices

When exploring a completed building all the struggles, negotiations, and compromises involved in bringing it into being remain hidden. Instead, I suggest attention should be shifted from buildings themselves to the practices that assemble buildings. Thus architecture should be explored as a "moving project", which emerges through "a series of transformations" [25] (p. 80). I suggest we should open the typically black-boxed design process and follow architects, engineers, and clients at work as they enter their several construction sites of facts, forms, strategies, and technologies. Architectural studios and engineering offices are laboratories in which architecture is part of a contingent and unpredictable process, gradually assembled through diverse experiments (Figure 2).
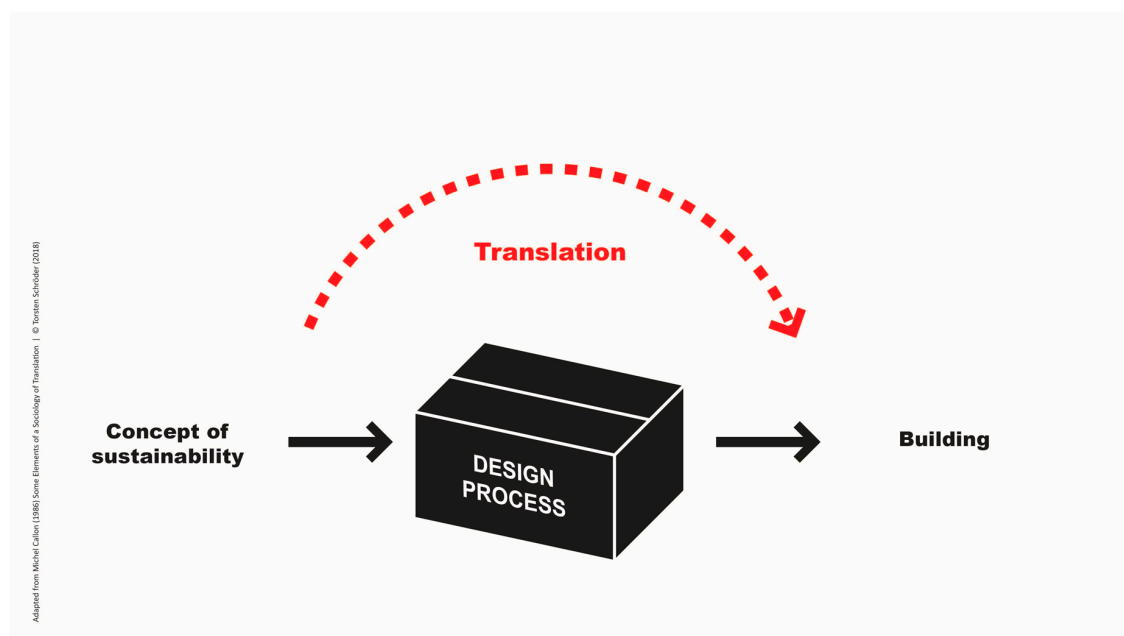
Figure 2. Applying the concept of translation makes it possible to open black-boxed design processes and understand how the concept of sustainability is continuously transformed within contingent, complex, and dynamic architectural design practices as buildings materialize (Diagram, Torsten Schröder 2018).

To develop an understanding of how the heterogeneous elements in architectural design practice are assembled, I suggest it is necessary to take a pragmatic approach and examine what architects, engineers, and the wider design collective actually do with the concept of sustainability in the daily context of their design studios and offices, and on site (cf. [24,26]). This makes it possible to question the claims surrounding a particular development and to show it to be the heterodox production of an assemblage of different forces.

In architectural design practices, heterogeneity, complexity, conflicts of aims, and controversies are normal. Architectural design practices are unpredictable, contingent, and messy. Multiple heterogeneous elements, entities, and human actors become associated: distinct vocational practitioners, conceptions, compromises and negotiations, specific sites, projected carbon emissions, computer models, simulations, tight budgets, design briefs, aesthetic preferences for the building to come, diagrams,

diverse materialities, low energy building systems, projected usage and occupation, tight development schedules, gross internal floor area, cubic meters of concrete, tonnes of structural steel, and many more.

It does not come as a surprise that architectural design involves heterogeneous elements, but it is a challenge to find frameworks that help one understand how they are assembled and co-shape each other. Architectural design practices can be explored through different theoretical perspectives that contain profound differences in how they conceptualize the relationships between practices, society, materiality, and agency.

Crucially, architectural design and sustainability are fields in which heterogeneity, complexity, conflicts of aims, and controversies are common. Before I outline the analytical frame of translation as a particularly well-adapted approach to critically explore the complex innovation practices of enacting sustainability in architectural design practices, I first briefly discuss some key characteristics of the concept of sustainability and show it to require a specific form of problem solving in which controversies, conflicts of aims, and public deliberation are central.

2.2. Framing the Concept of Sustainability

In the late 1980s, the concept of sustainable development was largely brought to public attention through the Brundtland Report and this definition of the term has been cited many times: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [27]. Crucially, the Brundtland Report reframed environmental politics by arguing that environmental integrity could not be achieved except through strategies that as well addressed questions of human well-being. Hence, sustainability encompasses an interrelated concern of the diverse issues associated with protecting the environment: "promoting human welfare; satisfying basic needs [...] considering the fate of future generations; achieving equity between rich and poor; and participating on a broad basis in decision-making" [28].

At the beginning of the 1990s, sustainable development emerged as a popular approach within which to frame the challenge of environmental politics. It allows diverse stakeholders of different backgrounds to come together. The political scientist Maarten Hajer argued: "The paradox is that this coalition for sustainable development can only be kept together by virtue of its rather vague story-lines at the same time as it asks for radical social change" [12] (p. 14). Despite calls to "break out of past patterns" [27] sustainable development has, since its emergence, generally not brought about the fundamental organizational restructuring that it initially aimed for and that would appear to be necessary [29]. The concept's rather elusive nature has triggered further critical responses. One has simply been "to avoid defining it and instead to substitute a cluster of goals instead" [30] (p. 62). Since the Brundtland Report "multiple versions of sustainability" were brought forward and, especially in the 1990s, the "simplistic managerialism of many initiatives [...] left much to be desired" [31] (p. 39). Yet Hajer and Frank Fischer argue that "it would be wrong only to conceive of sustainable development as an evident non-starter" and, importantly, "it is not the metaphor of 'sustainable development' in itself that leads environmental politics astray. Rather, it is with the interpretation of its meaning" [29] (pp. 2–4).

Regarding interpretation and enactment, sustainability must be understood as a specific form of "problem framing that emphasises the interconnectedness of different problems and scales, as well as the long-term and indirect effects of actions that result from it". Problems cannot be addressed in a linear way or through rigid analysis. Seen this way, "sustainability cannot be translated into a blueprint or a defined end state". It "brings complexity and uncertainty to the fore" and "calls for new forms of problem handling". It "is more about the organisation of processes than about particular outcomes [and] the modes of problem treatment and the types of strategies that are applied to search for solutions" [32] (pp. 3–4). Melissa Leach, Ian Scoones, and Andy Stirling also draw attention to the ways in which sustainability is enacted. Their response to some who have suggested abandoning "the term sustainability 'altogether'" is to avoid treating "sustainability in a general, colloquial sense, implying the maintenance of (unspecified) features of systems over time" [31] (p. 5). Instead they

emphasize the importance of the concept of sustainability through re-casting it in a more explicit normative interpretation: "Sustainability refers to the explicit qualities of human well-being, social equity and environmental integrity, and the particular system qualities that can sustain these. All these goals of sustainability are context-specific and inevitably contested" [31] (p. 5). But they go a step further by arguing that "it is useful to distinguish between different normative views of sustainability, recognizing that there are multiple sustainabilities which decisively need be defined quite precisely for particular issues and groups" [31] (p. 42). Once sustainability is understood as a contested, discursive resource then it becomes crucial to recognize the importance of deliberation and negotiation "to specify clearly, for particular issues and settings, what is to be sustained for whom, and who will gain or lose in the process" [31] (p. 171). This facilitates argument about different forms of problem framing, different pathways to different futures.

Understanding sustainability as a normative, complex, contextualized, and contested resource is essential to develop a more reflective understanding of how design practices give meaning to sustainability. Architectural design practices must be seen as a sort of positioning in respect to sustainability: specific actors produce specific types of knowledge, emphasize certain issues and suppress others, focus attention, employ particular assumptions, negotiate choices, and privilege particular pathways.

3. Results

3.1. The Analytical Framework of Translation

Given this heterogeneity of different elements and forces, which co-shape how buildings are developing, this article draws on STS as a way of exploring how architecture is gradually constructed through particular design protagonists, design knowledge, methods, interests, tools, visual representations, and materialities. This way, I conceive architectural design practices as a series of heterogeneous assemblages and reject a mode of thinking that rests on separately layered realities (e.g., the social, the technical, or the material). Instead, I welcome and encompass the idea of heterogeneous characters and relational associations co-shaping each other. These elements are drawn together in design practice through many translations.

STS emerged as an interdisciplinary field in the 1970s and 1980s and can be described as the "study of science and technology in a social context". A central concern is that scientific knowledge and technology do not evolve in a vacuum, but take part in the social world, "being shaped by it, and simultaneously shaping it" [33] (p. 12). STS highlights how knowledge and things are constructed within specific contexts and could have been constructed in other ways. Today, STS is a flourishing interdisciplinary field dedicated to addressing the grand societal challenges of today [34].

With "some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay" the sociologist Michel Callon, in 1986, explored the formation of heterogeneous associations, controversies, and power relations [2]. His seminal text pointed towards a then newly emerging conception of the social, in which society, technology, and nature were considered uncertain and disputable. Callon's "sociology of translation" at once rejects social and technical determinism. His framework of translation has gained much attention in diverse socio-technical innovation practices. It has been used to study IT management [3], healthcare performance measurement systems [4], environmental policy-making [5], energy transitions [6], strategic landscape planning approaches [7], and many other subjects. In the social sciences, Callon's study is well-known and recognized to be one of the foundational texts that led to the articulation of actor–network–theory (ANT) [35] (p. 10). The concept of translation plays a central role in ANT [35] (pp. 106–108), [36] (pp. 132–133, 240–248), but it is Callon's study of the "sociology of translation" [2] that most comprehensively develops the principles, phases, and mechanisms of the translation framework. Callon's framework of translation has been used in diverse fields, but not yet in architectural design research and practice.

Callon developed the concept of translation especially to study how human actors and diverse entities enter complex and innovative practices, in which conflicting alliances are forged to create a joint action plan. The actors and elements are associated through many translations, in a fluctuating and unpredictable process involving many controversies and conflicts, drawing in more and more heterogeneous elements, in the quest to make the initial plan succeed [2]. Thus, translation provides a set of valuable principles, mechanisms, and vocabulary to better understand how the initial action plan is gradually enacted and implemented after going through complex practices. Callon's framework of translation builds on the following methodological principles [2] (pp. 197–201): it demands analytical openness and impartiality towards any unexpected actor, element, or scale that might become drawn into the process and thus co-shape it; in principle all claims, viewpoints, and relationships can be considered uncertain and disputable until they are settled; it requires the elimination and abandonment of all a priori distinctions between the social, natural, and technical; and the role and identity of actors and elements may fluctuate and change throughout the process.

As explained before, architectural design and sustainability are fields in which heterogeneity, complexity, conflicts, and controversies must be taken as normal. Many architectural debates and practices lack rigor and critical reflection on how sustainability is addressed in architectural design practices. To overcome this conceptual deficit, I draw on Callon to develop the framework of translation for architecture in the rest of this article, and suggest that this framework is particularly well adapted to explain how sustainability is given meaning within architectural design practices.

Callon describes the translation process through four specific phases (or moments) which in practice might overlap, and which mark a progression in the ongoing negotiations: 'problematization', 'interessement' (interposition), 'enrolment', and 'mobilization' [2] (pp. 203–219). Crucially, the translation process is hypothetical during these four phases, success is never assured and in the end of these phases translation might fail: design teams might fall apart, buildings might not get built or buildings in operation might not perform as predicted during the design development. In an idealized way, in Figure 3 I demonstrate how Callon's four phases of translation relate to the typical architectural design stages.
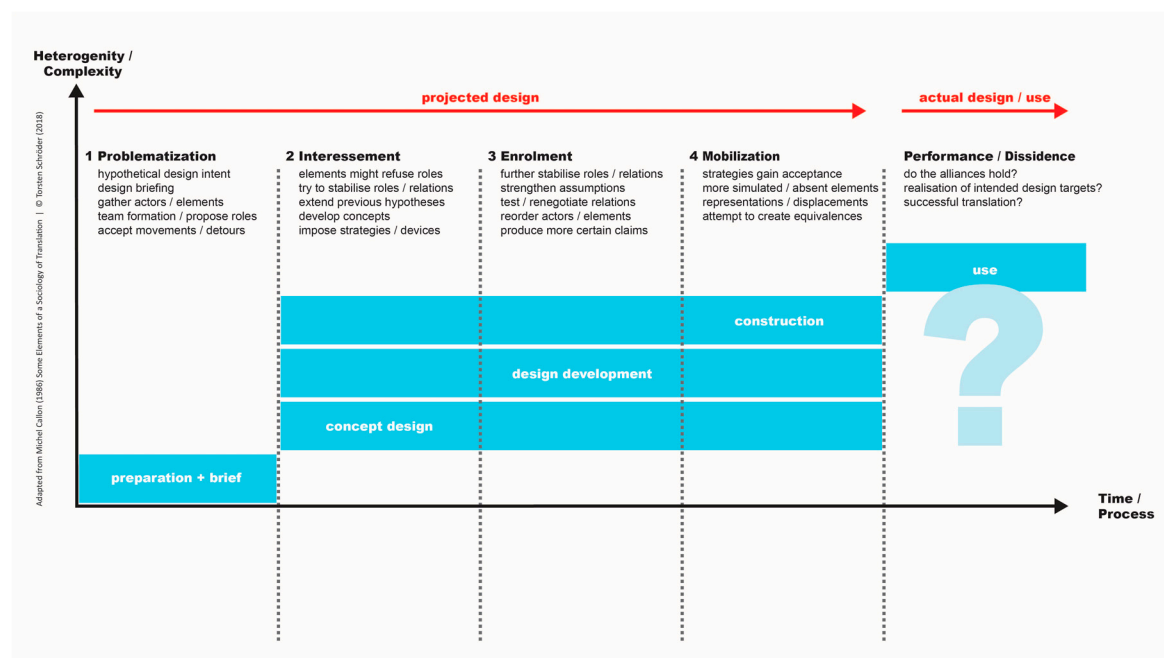
Figure 3. The analytical framework of translation adapted to architectural design processes. The diagram shows in idealized form how Callon's four phases of translation relate to the typical architectural design stages (Diagram, Torsten Schröder 2018).

The first phase, 'problematization', correlates with the design stage of preparation and brief. In this phase a group of design protagonists—for instance clients, architects, engineers—defines the building project's objectives and the design briefing (the joint action plan). A crucial question is which challenges of sustainability they recognize and how in response to these accepted challenges they construct specific particular sustainability design goals and design targets are constructed to instruct and in order to align the design team when creating buildings. Typically, the client has the power to give directions and define sustainability design goals and targets. The client could challenge the other team members—for instance architects, engineers, and developers—to interpret the concept of sustainability themselves and to develop a tailored strategy, vision, or indicators of what sustainability could mean for a specific project since all the "goals of sustainability are context-specific and inevitably contested. This makes it essential to recognize the roles of public deliberation and negotiation" [31] (p. 5). But the design team members could also challenge the sustainability agenda setting of the client and attempt to expand it. In order to progress, the design team then depends on other actors and elements, for instance specialist consultants and specific information, and seeks to assign roles to them and form relationships with them in the joint mission to achieve and enact the design briefing. Particular movements and detours must be accepted to avoid obstacles and problems, for instance a limited budget or the request for a 'symbolic' building. Thereby the initial design objectives, roles, and responsibilities become transformed.

Callon's next phases of 'interessement', 'enrolment', and 'mobilization' cannot simply be correlated with the next architectural design stages of concept design, design development, and construction, since interessement, enrolment, and mobilization constitute a reciprocal process that occurs across and repeatedly within the stages of concept design, design development, and construction.

In the second phase, 'interessement', the design team members seek to stabilize the proposed roles, entities and relationships of the initial plan (this might occur in the stage of concept design, but might also occur during design development and construction). The team gathers further design knowledge and associates more and more elements with the design process. For instance, the team might carry out site analyses or adopt specific best practice design guidelines. By negotiating envisaged relationships team members develop and interpose several strategies and devices, for instance models, calculations, performance simulations, and proposed technologies, to enable them and material entities to identify with their roles. With these strategies and devices, designers extend and materialize previous hypotheses. Actors and elements might refuse the transaction by redefining their identity, goals, motivations, or interests in another manner.

In the third phase, 'enrolment', the design protagonists seek to further stabilize relationships to enable them to succeed. The aim is to transform hypothetical assumptions into more certain arrangements. Design options are developed, and envisaged relationships, design strategies, and building technologies are tested, renegotiated, and reordered to make them perform as predicted. This is a conflictual process. It is crucial to trace how controversies occur and how agreement over often conflicting responsibilities between distinct vocational design team members is achieved.

In the fourth phase, 'mobilization', proposed design strategies and building technologies gain wider acceptance and the associations increasingly include absent (simulated) entities, for instance actual devices are simulated, the environmental performance of the facade is modelled through specific physical elements (solar irradiance, daylight gains, and heat losses) and the behavior of (future) occupants is projected. It is crucial to find out how representative particular assumptions and predictions are. Many absent (simulated) entities become associated in the construction of design strategies and technological pathways and the design protagonists must determine whether they will perform (and be accepted) as predicted.

To study how sustainability is interpreted and then continuously transformed as buildings are realized it is less Callon's above mentioned phases themselves that provide key insights into the translation process but rather the activities that occur within and across these phases.

Therefore, I explain the specific and insightful mechanisms that are central to Callon's phases of translation in Figure 4.
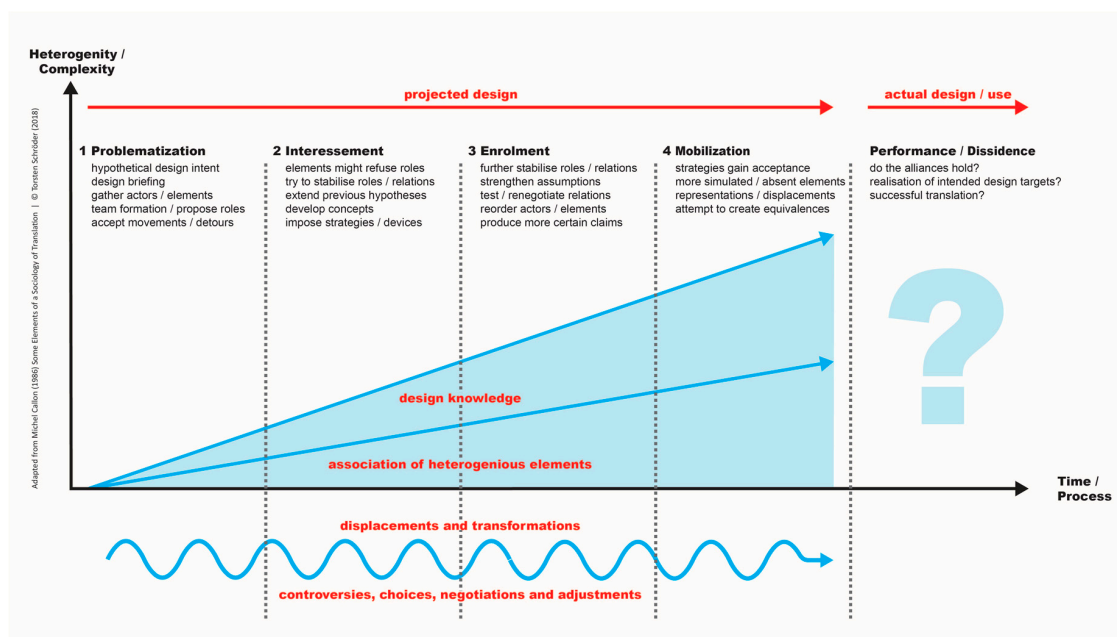
Figure 4. The analytical framework of translation adapted to architectural design processes. Translation foregrounds the inseparable mechanisms of design knowledge production first; second, the construction of heterogeneous relationships; third, displacements and transformations; and fourth, controversies, choices, negotiations and adjustments, which are central in bringing buildings into being (Diagram, Torsten Schröder 2018).

3.2. The Mechanisms and Elements of Translation

In architectural design practices translation is a fluctuating and unpredictable process, through which heterogeneous entities (e.g., architects, interpretations, arguments, world views, materialities) become associated and forged into a conflictual, unpredictable alliance. In translation, the persistence of transformation and displacement (a flow of many translations) that occur in architectural design practices is emphasized. Displacements occur at every stage. Some are more important than others. Proceeding from the initial problem and plan towards architectural materialization necessarily depends on the simultaneous production of design knowledge and the additional association of heterogeneous entities. Crucially, this process is not neutral, but performed by two inseparable mechanisms: on the one hand, various sorts of displacements and transformations; on the other hand, the controversies, choices, negotiations, and adjustments that accompany them (Figure 4). During this process the initial problem and action plan, the role of actors, the properties of entities and their relationships are reciprocally shaped, modified, and re-ordered.

I briefly discuss and highlight three crucial mechanisms of enacting sustainability in architectural design practices, which are foregrounded by the analytical frame of translation, and relate them to example case studies. First, the framework draws attention to key strategic transformations and displacements. Transformations occur at every stage when buildings are made, but some play a more strategic role than others. In many cases the 'problematization' phase is crucial. During this initial phase the design briefing is developed as a key device to guide and align the diverse stakeholders of the design team in the design-to-construction process. The design briefing typically defines the sustainability design targets that the project in question has to aim for. In many cases, in this phase the importance of sustainability is recognized but the concept of sustainability with its broad scope of associated challenges becomes abandoned by translating it into a request for a specific

building sustainability assessment method rating—for instance, a Building Research Establishment Environmental Assessment Method (BREEAM) or a Leadership in Energy and Environmental Design (LEED) rating. For example, such a key strategic transformation occurred in the design development process for the new headquarters of the Greater London Authority (GLA), London City Hall (London, UK). The GLA headquarters was created between 1998 and 2002 by the Government Office for London, Minister for London Nick Raynsford, More London Developers, Foster + Partners Architects, Arup, Turner & Townsend Project Management, and many more. As the quasi client, minister Raynsford had the power to define the sustainability agenda. Ambitiously he proclaimed that the GLA headquarters was set "to be a statement about the new authority, including its commitment to environmentally progressive objectives, the principles of sustainability" [37]. Instead, of inviting an exploration of what sustainability could mean for the GLA headquarters design practices, Raynsford abandoned the concept by translating it into the request for a BREEAM rating of at least "very good" in the design briefing [38]. BREEAM was thus chosen as the key entrusted device to the guide the transformation of sustainability into the design architectural practices. General assessment systems like BREEAM "compress the meaning of sustainability to a relatively narrow band of pre-defined issues" [39] (p. 22). Committing to the concept of sustainability in a contextualized design practice is clearly not equivalent to committing to a specific sustainability assessment system rating. Choosing a building sustainability assessment method rating—deployed as a central sustainability design target—seems to contribute to a partial de-politicization of design practices. For example, when stakeholders of a design team think they can meet their sustainability objectives by applying for a BREEAM or LEED rating, a much wider scope of problems becomes dissociated through narrow framing. Furthermore, 'real world' problems are displaced and dissociated from design practices through a system of awarding credits and points. Thus, for instance, the key challenge of climate change as a threat in which "[n]aked survival" is at stake [21] (p. 590) loses its importance and urgency when transformed into several interchangeable BREEAM assessment credits. The design team should debate in detail how to translate the concept of sustainability into design practices for a specific project and recognize that it is a controversial issue to tackle. An important question becomes deciding who has the power to give directions and define sustainability design targets. Those in power could challenge those bidding to work on a specific design—developers, architects, and engineers—to interpret and give meaning to the concept of sustainability and to develop a tailored strategy, vision, or indicators of what sustainability could mean for a specific project. Those in power could ask these bidders to specify in their designs what has to be sustained for whom, and who would gain or lose in the process?

Second, the translation framework is valuable when analyzing the ways in which design strategies are constructed between distinct vocational design actors, for instance architects and engineers. In design practices the alliance of architects and engineers conflicts: often there is no consensus over the role of building form, facade strategies, glazing ratios, and many other matters in their joint approach. Such a conflict occurred in the design development process for the new headquarters building for PricewaterhouseCoopers (PwC) called 7 More London Riverside (London, UK), which was designed between 2005 and 2011 by PwC, Foster + Partners Architects, Roger Preston & Partners (RPP), Building Design Partnership (BDP), Arup and many more. PwC declared their then new flagship building to be the "greenest building in the capital" [40]. The architects and building services engineers of RPP clashed over the design of the façade—especially about the ratio of the glazing in the building envelope. One of the engineering directors of RPP declared that Foster + Partners "loved the big glass boxes" and "they were one of the last architects to accept that they need solidity within their facades" to reduce solar gains and thus have a low energy cooling system perform well [41]. The architects mainly framed the facade design through the overall building appearance and the views of the River Thames visible through the floor-to-ceiling glazing. By contrast the RPP engineers focused more on the environmental performance of building services. In the finished design, the architects succeeded in stabilizing and implementing their desire for the facade's 'glass boxes'. The building was given

the BREEAM rating "outstanding", but this was achieved largely because it used a biofuel-driven tri-generation engine—a combined cooling, heat, and power plant (CCHP)—rather than because of the facade design. The CCHP was a controversial choice for various reasons and was described by an engineer from another engineering firm as "tri-generation. [It] is effectively an incredibly inefficient process [...] it's [a] kind of sacrilege" [42]. The translation framework is particularly useful to explain how these conflicts between distinct design actors occur and can eventually be negotiated and reconciled. Translation demonstrates the differences between the ontological perspectives of architects and engineers in understanding the (world of) design. While they are part of the same design project, it may seem as if there are two different designs being developed: different perspectives, expertise, and responsibilities clash. Which of these partial worlds are more desirable and less destructive than others? Since different partial perspectives cannot always be reconciled, it is necessary to pay careful attention to the trade-offs and consequences involved in negotiation.

A third key design activity is the attempt to establish supposed equivalences between projected and actual design. Often, the performance targets created for new buildings are not met. The translation framework highlights for design research and practice how supposed equivalences are put in place between the projected and actual design. Translation foregrounds the hypothetical dimension of the shared design proposals—design strategies may fail. These supposed equivalences are often established by designers using powerful visual representations (diagrams) when making decisions about design practices as they seek to render their chosen design strategies more plausible by suppressing the hypothetical dimension of their activities. These representations are crucial visual devices, which designers use when attempting to render design strategies more credible and stabilize them. For example, such a supposed equivalence between projected and actual design was established in the design development process of the Greater London Authority (GLA), London City Hall (see case example above). The design team deployed several diagrams, for instance the 'Energy Story' diagram, to explain how the projected energy performance of the facade design is framed, developed, and simulated. The key elements of this diagram captured during the design process were building form, building orientation, shading devices, openable windows, solar gains, heat losses, and passive cooling system with chilled ceilings [43]. In actual operation, the energy consumption of the GLA headquarters was more than double (about 135%) than had been predicted [44]. A couple of factors contributed to this failure. An important one was that the design team developed a very compact building form. In consequence the floor plans were rather deep, the building interior did not receive much daylight and a huge amount of electricity for lighting was required in actual operation. The use of electrical lighting as a decisive constituent of energy performance was not considered during the design phase. The design team had constructed the facade design and facade performance through a set of manageable design elements but had missed a crucial element, which was not integrated into the 'Energy Story' diagram that appeared to be very convincing during the design phase of the project.

4. Discussion

This analytical framework of translation is particularly well adapted to help analyze the complex and conflictual processes that are central to design practices: the expansion through simultaneous association of new entities, construction of additional relationships, and production of design knowledge, which are a precondition for developing the initial problem and action plan. The notion of translation foregrounds the conflicts between diverging perspectives, objectives, and strategies of different practitioners, and the performance of technical devices and materials. Translation highlights how controversies occur and how they end. The many struggles and displacements constantly reorder the practice of architectural design. The concept of translation offers a better understanding of the establishment and evolution of power relationships. Power relationships occur in various circumstances, for instance, through the way in which roles and elements are defined and associated, and those occupying the roles are simultaneously obliged to comply with the design alliance's objectives. Power relations are also demonstrated by the way in which controversies are

resolved, when entities are aligned through strategies and devices, when some entities are controlled by others, and through the ways in which some entities are allowed to represent absent entities. Furthermore, in translation the important role of visual representation in design practices to align the various practitioners is emphasized. Diagrams, drawings, and computer visualizations connect the imagined and material. They are central means of organizing the design-to-production process [45]. Translation undermines the very idea that there might be such a thing as faithful representation or faithful translation. All representations betray their objects. Representations act as intermediaries and equivalences to render displacements easier, as if the projected design (the world in the design studio) would be the same as the actual design (the world of use an operation).

Through translation, it is possible to understand how an ambitious sustainability agenda is interpreted and enacted. Thinking about the answers to a few simple questions helps one understand the processes of translation in architectural design practices: how (and by whom) is the initial problem and action plan formulated? How are sustainability challenges constructed as an issue for design? How are these challenges transformed into targets and goals to instruct and align the architects, engineers and developers in making their design proposals? How are design concepts, design strategies, and building technologies constructed and materialized? Which additional elements are required to expand initial hypotheses (e.g., actors, entities, strategies, devices, detours, and problems)? How are they negotiated and adjusted? How are they reciprocally displaced and transformed? How are design strategies stabilized? And, finally, how far have sustainability design targets been met in practice?

This article has highlighted the important role that buildings play in pathways towards sustainability. While there seems to be a wide consensus among architects, engineers, clients, politicians, and others that sustainability must be addressed, I have explained that behind this apparent consensus many ambiguities, contradictions, and open questions emerge. Opinions largely vary on how to define the challenges of sustainability that architectural design is to respond to, on how to align the various stakeholders involved, which scales and elements to consider, and how to transform these questions into design strategies, spatial configurations, and materialization. Both in architecture and in sustainability complexity, conflicts of aims and controversies must be taken as the normal state of affairs. The aim of this article has been to set out the transferable analytical framework of translation to explain how the concept of sustainability is given meaning in architecture. The transferable analytical framework of 'translation' draws on the interdisciplinary field of STS to explain how the concept of sustainability is continuously transformed within contingent, complex, and dynamic architectural design practices as buildings materialize. Translation provides a set of valuable principles, mechanisms, and vocabulary to navigate and better understand these messy worlds. The framework of translation is particularly well adapted to unpack claims regarding sustainability ambitions, to make them more accountable, and thereby support the larger project of sustainability. This analytical framework is transferable: it can be used by looking back to enhance the understanding of sustainability in completed design practices (past), or looking forward to reframe and thus improve design practices in progress (future). The concept of translation is particularly useful when analyzing the inseparable mechanisms of the production of design knowledge, the construction of heterogeneous relationships, diverse displacements and transformations, and negotiations and adjustments [2] (pp. 203, 224), which are central in bringing buildings into being.

5. Conclusions

In conclusion, this article offers the opportunity to make a unique contribution to design research and practice by setting out the transferable analytical framework of translation through which to explain how the concept of sustainability is continuously transformed within contingent, complex, and dynamic architectural design practices as buildings materialize.

Many clients, architects, and others promote their architectural projects in a rhetoric of consensus, predictability, and feasibility. Controversy, contingency, and competing knowledge claims are rendered

inexistent. Those using the adjective 'sustainable' in connection with a newly created building seek to assign it a particular status quo, a form of black-boxing: sustainability 'achieved' and 'materialized'. I argue that architectural practitioners should actively engage in debates on how and how far sustainability can be translated into particular design tasks and settings. I suggest that it is necessary to step back, eliminate the adjective 'sustainable' when describing practices and artefacts, and instead think about how to give the concept meaning—about how it is enacted—in design practice. To face the controversies over how to address sustainability seems a more promising approach than to pretend that there is no divergent opinion about it. In doing so, I see the concept of translation as a useful tool to address particular claims, to make them more accountable, thereby supporting the larger project of sustainability, whose advocates sometimes seem to suffer from a certain fatigue as practices that attempt to incorporate the concept fail to bring about the necessary reordering in their processes.

References

1. Schroeder, T. Translating the Concept of Sustainability into Architectural Design Practices: London's City Hall as an Exemplar. Ph.D. Thesis, London School of Economics and Political Science, London, UK, 2014. [CrossRef]

2. Callon, M. 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?* Law, J., Ed.; Routledge & Kegan Paul: London, UK, 1986; pp. 196–223.

3. Doorewaard, H.; Van Bijsterveld, M. The Osmosis of Ideas: An Analysis of the Integrated Approach to IT Management from a Translation Theory Perspective. *Organization* **2001**, *8*, 55–76. [CrossRef]

4. Leotta, A.; Ruggeri, D. Performance measurement system innovations in hospitals as translation processes. *Account. Audit. Account. J.* **2017**, *30*, 955–978. [CrossRef]

5. Beveridge, R.; Guy, S. Governing through Translations: Intermediaries and the Mediation of the EU's Urban Waste Water Directive. *J. Environ. Policy Plan.* **2009**, *11*, 69–85. [CrossRef]

6. Scotti, I.; Minervini, D. Performative connections: Translating sustainable energy transition by local communities. *Innovation* **2017**, *30*, 350–364. [CrossRef]

7. Tietjen, A.; Jørgensen, G. Translating a wicked problem: A strategic planning approach to rural shrinkage in Denmark. *Landsc. Urban Plan.* **2016**, *154*, 29–43. [CrossRef]

8. Hegger, M. Vorwort. In *Energie Atlas Nachhaltige Architektur*; Hegger, M., Fuchs, M., Stark, T., Zeumer, M., Eds.; Birkhäuser: Basel, Switzerland, 2008; pp. 6–7.

9. International Energy Agency (IEA). *World Energy Outlook 2012*; OECD Publishing: Paris, France, 2012.

10. Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2007: Synthesis Report*; Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; IPCC: Geneva, Switzerland, 2007.

11. Dianne, S.; Priya, M.; Marina, L. Interior Architecture as an agent of wellbeing. *J. Home Econ. Inst. Aust.* **2012**, *19*, 2–9.

12. Hajer, M.A. *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*; Clarendon Press: Oxford, UK, 1995.

13. Guy, S.; Farmer, G. Reinterpreting Sustainable Architecture: The Place of Technology. *J. Architect. Educ.* **2001**, *54*, 140–148. [CrossRef]

14. Ingersoll, R. The Ecology Question and Architecture. In *The SAGE Handbook of Architectural Theory*; Crysler, C.G., Cairns, S., Heynen, H., Eds.; SAGE Publications: Los Angeles, CA, USA; London, UK; New Delhi, India; Singapore; Washington, DC, USA, 2012; pp. 573–589.

15. Ursprung, P. Nature and Architecture. In *Natural Meatphor*; Sauter, F., Mateo, J.L., Eds.; Actar/ETH: Zürich, Switzerland, 2007; pp. 10–21.

16. Hagan, S. *Taking Shape: A New Contract between Architecture and Nature*; Architectural Press: Oxford, UK, 2007.

17. McDonough, W.; Braungart, M. *Cradle to Cradle: Remaking the Way We Make Things*, 1st ed.; North Point Press: New York, NY, USA, 2002.

18. Sattrup, P.A. Philippe Rahm Architects—Interview with Philippe Rahm. In *Frontiers of Archiecture II: Green Architecture for the Future*; Holm, M.J., Kjeldsen, K., Eds.; Louisiana Museum of Modern Art: Humlebæk, Denmark, 2009; pp. 88–93.

19. Cheshire, D. *Building Revolutions: Applying the Circular Economy to the Built Environment*; RIBA: London, UK, 2016.

20. Bell, B.; Wakeford, K. *Expanding Architecture: Design as Activism*; Distributed Art Publishers: New York, NY, USA; Thames & Hudson [Distributor]: London, UK, 2008.

21. Droege, P. Beyond Sustainability: Architecture in the Renewable City. In *The SAGE Handbook of Architectural Theory*; Crysler, C.G., Cairns, S., Heynen, H., Eds.; SAGE Publications: Los Angeles, CA, USA; London, UK; New Delhi, India; Singapore; Washington, DC, USA, 2012; pp. 590–601.

22. Crysler, C.G.; Cairns, S.; Heynen, H. *Introduction 2: Reading the Handbook The SAGE Handbook of Architectural Theory*; SAGE Publications: Los Angeles, CA, USA; London, UK; New Delhi, India; Singapore; Washington, DC, USA, 2012; pp. 23–37.

23. Guy, S. Introduction: Whither 'Earthly' Architectures: Constructing Sustainability. In *The SAGE Handbook of Architectural Theory*; Crysler, C.G., Cairns, S., Heynen, H., Eds.; SAGE Publications: Los Angeles, CA, USA; London, UK; New Delhi, India; Singapore; Washington, DC, USA, 2012; pp. 554–572.

24. Guy, S.; Moore, S.A. *Sustainable Architectures: Cultures and Natures in Europe and North America*, 1st ed.; Spon Press: New York, NY, USA; London, UK, 2005.

25. Latour, B.; Yaneva, A. *Give Me a Gun and I Will Make All Buildings Move: An ANT's View of Architecture Explorations in Architecture: Teaching, Design, Research*; Birkhäuser: Basel, Switzerland, 2008; pp. 80–89.

26. Yaneva, A. *The Making of a Building: A Pragmatist Approach to Architecture*; Peter Lang: Bern, Switzerland, 2009.

27. Brundtland, G.H. Our Common Future: Report of the World Commission on Environment and Development. Available online: http://www.un-documents.net/our-common-future.pdf (accessed on 12 July 2012).

28. Lafferty, W.M.; Meadowcroft, J.R. *Implementing Sustainable Development: Strategies and Initiatives in High Consumption Societies*; Oxford University Press: Oxford, UK, 2000.

29. Hajer, M.A.; Fischer, F. *Living with Nature: Environmental Politics as Cultural Discourse*; Oxford University Press: Oxford, UK, 1999.

30. Giddens, A. *Politics of Climate Change*; Polity: Cambridge, UK, 2009.

31. Leach, M.; Scoones, I.; Stirling, A. *Dynamic Sustainabilities: Technology, Environment, Social Justice*; Earthscan: London, UK, 2010.

32. Voβ, J.-P.; Bauknecht, D.; Kemp, R. *Reflexive Governance for Sustainable Development*; Edward Elgar: Cheltenham, UK; Northampton, MA, USA, 2006.

33. Law, J. *After Method: Mess in Social Science Research*; Routledge: London, UK, 2004; p. 12.

34. Felt, U.; Fouché, R.; Miller, C.A.; Smith-Doerr, L. (Eds.) *The Handbook of Science and Technology Studies*, 4th ed.; MIT Press: Cambridge, MA, USA, 2017.

35. Latour, B. *Reassembling the Social: An Introduction to Actor-Network-Theory*; Oxford University Press: Oxford, UK; New York, NY, USA, 2005.

36. Farías, I.; Bender, T. *Urban Assemblages: How Actor-Network Theory Changes Urban Studies*; Routledge: Abingdon, UK; New York, NY, USA, 2010.

37. Interview Raynsford, N. Minister for London [interview by T. Schröder] London. Unpublished work. 8 September 2010.

38. Turner & Townsend Project Management. 980804 Greater London Authority: Preliminary Summary of Authority's Requirements. Unpublished work. 1998.

39. Farmer, G.; Guy, S. Hybrid environments: The spaces of sustainable design. In *Sustainable Architectures: Cultures and Natures in Europe and North America*, 1st ed.; Guy, S., Moore, S.A., Eds.; Spon Press: New York, NY, USA; London, UK, 2005; pp. 15–30.

40. PricewaterhouseCoopers. Corporate Sustainability Lessons Learned. 7 More London: A Catalyst for Behaviour Change. Available online: http://www.pwc.co.uk/corporate-sustainability/downloads.jhtml (accessed 21 November 2011).

41. Interview (2011). Roger Preston & Partners Director of Environmental Engineering [interview by T.Schröder] London. Unpublished work. 29 September 2011.

42. Interview (2011). Arup Engineering Project Manager [interview by T.Schröder] London. Unpublished work. 8 August 2011.
43. Foster + Partners. Greater London Authority Headquarters, Planning Application Drawings. Unpublished work. 7 July 1999.
44. Greater London Authority (GLA). Detailed Statistics Facilities Management December 2011. Unpublished work. 2012.
45. Henderson, K. *On Line and on Paper: Visual Representations, Visual Culture, and Computer Graphics in Design*; MIT Press: Cambridge, MA, USA; London, UK, 1999.