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Towards a new theory of construction innovation: a socio-material analysis of classification work

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ABSTRACT

There has been a longstanding concern among construction scholars and practitioners in classifying construction innovations, whether as “incremental” or “radical,” “technological” or “organizational,” “product” or “process”. In this paper we extend this interest in classification to examine what classification work accomplishes within construction innovation practices. Instead of addressing the validity of innovation categories as objective representations we explore how innovations are classified within everyday interactions that shape how they proliferate. Our approach is informed by socio-material theories of classification, communication and innovation, particularly those from Actor-Network Theory (ANT) and Ventriloquial Analysis (VA). Empirically, our approach is developed through an analysis of how a single innovation – a large format concrete block – was classified within a single warranty approval meeting as it entered the UK housing market. Our analysis explains how such classification work is dynamically constituted by formal and informal classificatory acts that involve displacements of human agency that shape how construction innovations proliferate. Classification work is thus shown to make a vital difference to how construction innovation is accomplished and can be understood.

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Introduction

Classification is an enduring feature of construction innovation, whether to explain how specific types of innovation (e.g. “incremental” or “radical,” “product” or “process,” “technical” or “organizational”) require particular development and implementation strategies (Tatum 1987, Slaughter, 1998, 2000, Blayse and Manley 2004, Larsson *et al.* 2006, Davidson 2013, Ercan 2019), to define what counts as “construction innovation” (Gambatese and Hallowell 2011, Clegg and Kreiner 2014, Bengtsson *et al.* 2018) or to explore the role of Standard Industrial Classifications (Slaughter 1993, Winch 2003, RICS 2007). That classification should be a matter of concern is hardly surprising because as Bowker and Star (1999) explain “To classify is human” (Bowker and Star 1999, p. 1). Our lives are enabled by what they call “classification work” (Bowker and Star 1999, p. 1) from informal “rules of thumb” that help us sort clean from dirty linen to standardised medical tests that classify those infected with a disease. However, as Bowker and Star (1999) explain, this

classification work is often unnoticed, existing as an invisible socio-material infrastructure that silently shapes our worlds. Indeed, it is often only when classification work fails – when we do not fit into binary gender categories, when a medical test result surprises us, when our national citizenship prevents us crossing a border – that we realise what classification work does. In this paper we argue that the invisibility and ineluctable force of classification work is deserving of more attention within scholarship on the management of construction innovations.

Our argument is partly inspired by earlier construction innovation research that has already started to explore classification work, notably around the impact of the classification of “construction” in Standard Industrial Classifications. This research identifies how such classifications hide construction innovation by prioritising lower innovation repair and maintenance work while disregarding more innovative design and architectural activities (RICS, 2007; Winch 2003). Such research offers an important redress to those who have criticised the sector on the basis of lower levels

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of innovation (e.g. Egan 1998, Farmer, 2016) to justify construction improvement recipes that may have limited value (Green 2011). In this paper we extend this earlier interest in Standard Industrial Classifications to explore the role of classifications within everyday interactions that constitute construction innovation practice. We contend that such classification work is more extensive and likely even less visible, but just as consequential in shaping the development and proliferation of specific construction innovations. The aim of our paper is to develop and then empirically mobilise a novel theoretical approach to explore what classification work does within construction innovation. Thus, our paper extends existing research concerned with abstractly classifying construction innovations to propose particular innovation strategies (Tatum 1987, Slaughter 1998, 2000, Blayse and Manley 2004, Larsson *et al.* 2006, Davidson 2013, Ercan 2019) to instead examine how construction innovations are classified, what those classifications accomplish, and how this knowledge can inform practice.

Following Bowker and Star (1999) our approach also mobilises a socio-materialist sensibility that conceptualises classification work as “*material*, as well as symbolic” (Bowker and Star 1999, p. 39; original emphasis). This approach suggests that construction innovation classification work cannot be reduced to mere cognitive-linguistic “properties of mind” (Bowker and Star 1999, p. 39). Instead, we understand processes of classification and their consequences as constituted through a material infrastructure of classification (e.g. material tests, written building codes, design plans) that have material effects on the development of an innovation. Thus, we conceptualise classification work and its consequences for construction innovation as a socio-material accomplishment. We develop our socio-material approach to classification work by drawing upon Actor-Network Theory (ANT) (Latour 2005, Law 2009, Sayes 2014), particularly studies of innovations (Callon 1986a, 1986b, Latour 1987), as well as ANT-informed ventriloquial analysis that examines how organisations are constituted by communications comprised of socio-material interactions (Cooren *et al.* 2008, Caronia and Cooren 2014, Nathues *et al.* 2020).

Our paper is organised around four sections. First, we review existing ANT studies of construction innovation to explain how classification work makes a difference to how construction innovations proliferate or not. However, owing largely to their longitudinal orientation these studies do not explore the empirical specificities of everyday classification work. Second,

we explain how by combining ANT approaches to innovation with ventriloquial approaches to communicative interactions such finer-grained insights can be generated. Third, we introduce our methodology and empirical context – the warranty approval process for a large format blockwork innovation in a UK volume housebuilding firm – to develop such an analysis. Fourth, we discuss our findings from our empirical case to elaborate how this innovation was variously classified in ways that shape its proliferation. We conclude by discussing how exploring the socio-materiality of informal classification work contributes to existing understandings of the proliferation of construction innovations and ANT studies of construction innovation.

Innovation as classification work: insights from ANT

Bowker and Star’s (1999) seminal treatise on classification work does not directly explore innovation. However, through a brief example of a CD player they do gesture at the significance of classification work within innovation: “Most of us have no notion of the decades of negotiation that inform agreement on, *inter alia*, standard disc size, speed, electronic setting, and amplification standards” (Bowker and Star 1999, p. 9). Here Bowker and Star (1999) evoke ANT’s relational model of innovation (Callon 1986a, 1986b, Latour 1987) to explain the role of classificatory standards in innovation. CD players can proliferate because the interests of human and non-human actors, from markets to suppliers to electromagnetism, have all been identified and enrolled around standardised (“black boxed”) technologies (Latour 1987, p. 3). If disc sizes or play speeds had not been standardised it would be impossible for the interests of global consumers, retailers, disc manufacturers and CD player producers to be aligned and for CD players to proliferate. Latour (2005) similarly explains how “most coordination among agents is achieved through the dissemination of quasi-standards” (p. 229). But there is a limitation when mobilising ANT to analyse classification work: “The actors being followed did not themselves see what was excluded: they constructed a world in which that exclusion could occur. Thus if we just follow the doctors who create the ICD [International Classification of Diseases] at the WHO [World Health Organisation] in Geneva, we will not see the variety of representation systems that other cultures have for classifying diseases of the body and spirit” (Bowker and Star 1999, p. 48; original emphasis). In other words, ANT is

better placed to follow the “top down” production of singular standards (Latour 1987) than explore how multiple, even contradictory, classificatory acts interact to shape the proliferation of innovations. The significance of this classification work and the analytical limitations of ANT to explore this work can be further explained with reference to ANT studies of construction innovation.

It is notable that the very first ANT construction innovation study concerned a problem of classification. Specifically, Harty (2008) draws on ANT to challenge categorizations of construction as “low tech, low innovation” (p. 1031) and instead conceptualises construction as a site of “relatively unbounded innovation” (Harty 2008, p. 1033) wherein heterogeneous actors (technologies, firms, human actors, projects) are enrolled and aligned in support of innovations while those innovations are adapted to sustain their enrolment. Harty (2008) also explicitly calls scholars to recognise the importance of classification work within these enrolment processes: “Who, or what, is being drawn into negotiations around the innovation process? Who and what is being excluded from them? And how are these inclusions and exclusions being undertaken?” (p. 1039). However, Harty’s (2008) ANT analysis lacks empirical detail on the role of classification within enrolment. Although he proposes that innovation categories such as “incremental” and “radical” may play a key role in understanding enrolment processes (Harty 2008, p. 1035) – for example by helping the ANT analyst understand why certain actors might be enrolled or not – little is said about what classification work occurred during actual enrolment negotiations and what it accomplished. This leaves some important questions unanswered because if enrolment and thus innovation is a socio-material process of including and excluding actors (Harty 2008) how do such classificatory processes operate? And what do they do?

Subsequent ANT construction innovation research has similarly gestured towards the role of classification work within enrolment processes. Lovell (2009) for example draws on ANT to explore the production of low-carbon homes. Citing an interviewee who draws a distinction between “wacky” and “serious” innovations, Lovell (2009, p. 500) explains how the material act of building helps categorise an innovation as serious, enabling its proponents to enrol more actors. Adopting ANT to study Building Information Modelling (BIM), Linderoth (2010) and Lindblad (2019) respectively suggest how actors are classified on the basis of whether they are “indispensable” or “vital” to be

enrolled in support of BIM project. However, little is explained about how these classification processes unfold. A more developed analysis of classification can be found in Tryggestad et al.’s (2010) ANT analysis of the construction of an innovative high-rise tower. Future residents were enrolled in the project as they were categorised as “co-designers” not mere “users” of the project. However, the inability of structural engineers to enrol a non-human actor – a strong offshore wind – in support of the structural stability of tower’s complex design, eventually forced design changes that prevented mass customisation and required a re-classification of the customers as “users” (Tryggestad et al. 2010). The role of classification work in enrolment is also briefly mentioned in London and Pablo’s (2017) ANT study of innovation and collaboration. Here an innovative floor cassette system is classified by a housebuilding firm as both “radical” to excite and enrol the general public and media in the innovation, and then as “incremental” to enrol cautious industry partners (London and Pablo 2017, p. 566).

Summarising, ANT studies of construction innovation suggest that classification work can shape; (i) what actors are included in processes of enrolment (Harty 2008, Linderoth 2010, Lindblad 2019), (ii) what innovation classifications can enrol what actors (Harty 2008, Tryggestad et al. 2010, London and Pablo 2017) and (iii) how non-human actors can support and disrupt human enrolment tactics (Lovell 2009, Tryggestad et al. 2010). However, the longitudinal orientation of these studies means there is a lack of empirical detail about how such classifications are mobilised within specific interactions and how different classificatory acts interact with each other and the materialities of innovations. Exploring these concerns is important to understand how ANT studies of construction can move beyond developing broad theoretical suggestions around the role of classifications, to understand how specific classificatory acts have specific effects on the proliferation of innovations. In the next section we will develop our approach to generating such insights by combining early ANT concepts, such as enrolment (Callon 1986a, Callon 1986b, Latour 1987) with ventriloquial analysis (Cooren et al. 2008, Caronia and Cooren 2014, Nathues et al. 2020).

Innovation classification as interaction: enrolment and ventriloquism

Within ANT enrolment refers to a group of processes wherein “trials of strength and tricks” (Callon 1986a, p. 206) are employed to align the “interests,” “wishes,”

“desires,” “motives” and “identities” (Callon and Law 1982, p. 623) of actors in support of an innovation, whether a technology or scientific paper. Latour (1987, p. 108–121) lists various tactics that enable enrolment, from “piggy backing” on an actor’s enrolment in existing “black boxed” innovations, cutting off actors’ interests from competing innovations, offering short cuts to the pursuit of pre-existing interests, or even inventing new interests. ANT can also register how existing standards and classifications are evoked to enrol other actors in support of new innovations (e.g. the use of the “QWERTY” keyboard from mechanical typewriters in personal computers). What ANT lacks is a way to analyse; (i) what these classifications accomplish within lived interactions, (ii) how they are mediated by non-human actors, and (iii) how multiple classifications interact with each other to allow innovations to proliferate. We propose ANT-informed ventriloquial analysis approaches to explore these concerns (Cooren *et al.* 2008, Caronia and Cooren 2014, Nathues *et al.* 2020).

Ventriloquial analysis approaches have been developed to analyse how organisations are constituted by communication that involves more than simply human to human interactions (Caronia and Cooren 2014, Clifton and de la Broise 2020, Nathues *et al.* 2020). Ventriloquial Analysis (VA) recognises how “Humans and things mutually engage in this process whereby they make their counterpart speak, act, move or even exist” (Caronia and Cooren 2014, p. 46). Following ANT’s relational ontology (Latour 2005), this process always cuts two ways between humans and non-humans. First, within the course of our interactions humans often speak on behalf of (or “ventriloquise”) not just other humans but also the material world (e.g. technologies, buildings, cars, plants) and even “not-yet-existing beings” (e.g. dreams, ideas, futures) (Nathues *et al.* 2020, p. 4). VA thus aligns with the flat ontology of ANT by refusing to make an *a priori* distinctions between a micro-actor within an interaction (e.g. meeting participants) and macro-actors outside the meeting (e.g. globalization) (Latour 2005). However, this “speaking-on-behalf” always involves a certain level of attachment to those things. That is, we must get to know those actors to speak confidently for them and this attachment implies these actors also make a difference to what we say and what we can do. Thus, second, VA proposes the actors we ventriloquise, including non-humans, can also ventriloquise us. As Caronia and Cooren (2014) explain, “things also lead people to say what they say” (p. 47) exactly because we are attached or committed to them. This

does not mean human interactions are causally determined by non-humans but merely that there is a passive element to human communication wherein non-human agencies also influence us. But this influence is not limited to action or inaction. Rather non-humans can influence humans in a myriad of ways: “things might authorise, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid, and so on” (Latour 2005, p. 72). VA extends this general ANT principle to suggest we are susceptible to such influences within an interaction because we are already attached to them.

VA also helps explain why innovation classifications are more than mere linguistic utterances and cognitive constructs. For example, if in a meeting a construction manager classifies an innovation as “radical” or “incremental” she is looking to speak on behalf of heterogeneous actors (e.g. suppliers, clients, technologies, business processes) in order to accomplish a certain ordering of the world. This ventriloquial act possesses an intention: to enrol other actors in support of not just that classification but the associated innovation. And moreover, VA also suggests that the more actors (human and non-human) we can confidently ventriloquise during an interaction, the more authoritative we are within that interaction. Caronia and Cooren (2014) explain that success in speaking on behalf of other actors is reliant on the extent to which “we (learned and know how to) make it speak” such that “We make it speak either when we verbally or kinetically make some of its aspects salient to others” (p. 46). Thus, this process of ventriloquising an innovation through a classification to enrol actors is bidirectional – it contains an active and passive element. On the one hand, our hypothetical project manager is actively enabling the innovation to speak through the classification. On the other hand, the material existence of the innovation led the project manager to speak through the classification (Nathues *et al.* 2020). What is more, human actors may sometimes intentionally position themselves as more or less active. For example, a project manager might passively draw on a classification of an innovation to explain its proliferation (“all our competitors are using this radical innovation so we just have to use it now”) or they may actively draw on a classification to advance its proliferation (“this is a really radical innovation and it will really help us”). But, like ANT, VA suggests agency is never reducible to human intent. If a particular component or person we may like to enrol in support of our classification of an innovation (e.g. a meeting participant or a technical standard) resists our speaking

on their behalf, that actor may instead ventriloquise us – forcing us to speak on its part, challenging our classification. Thus, the enrolment process and the proliferation of that innovation may be disrupted or cease. In the next section we will explain how VA informs our analysis of the role of classifications with construction innovations.

Methodology and context

VA is influenced by ANT's sensibility to disclose how heterogenous actors generate their worlds through interactions (Law and Singleton 2013), whether in workplace encounters like meetings or social talk (Cooren and Fairhurst 2004, Cooren *et al.* 2008, Caronia and Cooren 2014, Clifton and de la Broise 2020). The crucial difference between VA and ANT is that the analytical focus is extended to include lived interactions. As we have suggested this does not mean that VA adopts a "micro level" focus as it can also explore how "macro level" actors (e.g. global standards, distant artefacts and people) are ventriloquised within interactions, but it does mean that it can register interactional actors and practices that might be unamenable to classic ANT. This is because, unlike ANT, VA facilitates a closer-grained exploration of classification work occurring within natural occurring interactions between humans and non-humans rather than reconstructing and abstracting away from such interactions through second-hand accounts found in documents (as in Callon 1986a, 1986b, Latour 1987, Tryggestad *et al.* 2010, London and Pablo 2017) interviews (Lovell 2009, Tryggestad *et al.* 2010, London and Pablo 2017) or more longitudinal ethnographies (Harty 2008, Linderoth 2010, Lindblad 2019). VA also entails analysing the meanings and patterning of verbal exchanges between human actors as they employ different tactics to enrol heterogeneous actors in support of their innovation classifications, enabling that innovation to proliferate (or not) (Caronia and Cooren 2014).

Our empirical analysis of what classification work accomplishes to advance the enrolment of actors in support of an innovation is specifically concerned with a "Large Format Blockwork" (LFB) innovation. LFB is a storey height, 600 mm wide, aerated concrete block that is intended to replace traditional smaller aerated concrete blocks. Although used across the European continent for some time, LFB was only introduced into the UK in 2015 by a volume housebuilder (here called "Ash Homes"). The arrival of LFB within the UK volume housing market, where traditional block and brick

construction predominate (Ball 1999), generated complex challenges for the firms involved, given significant differences between the UK and continental European housebuilding sectors. In particular, the existence of large volume housebuilding firms is unique to the UK. LFB can thus be understood as an imported innovation. Ash Homes' motivation for LFB was to reduce the number of bricklayers required for house construction and decrease build times, while maintaining a masonry construction system that was familiar to both British consumers and installers. This was particularly crucial in 2016 given continued shortages of skilled bricklayers, ambitious government housebuilding targets and the high demand for new houses.

To explore the role of everyday classification work in how construction innovations proliferate we analyse a high-stakes event surrounding LFB: a warranty approval meeting that took place in late 2016. The purpose of this meeting was for Ash Homes, the LFB manufacturer ("Block Co") and their main contractor ("Downford"), to introduce LFB to a national house warranty provider ("Warranty Co") to discuss the potential to ensure LFB could be warrantied for general use across all Ash Homes sites (for meeting participants see Table 1). This would overcome the costly and time-consuming restriction of LFB only being approved for use project by project. This meeting was thus vital for the fate of this innovation because most new homes in the UK are purchased using a mortgage and all mortgage providers require warranties to protect the value of the property the loan is secured against from design and construction defects. In short, the absence of general warranty approval means this concrete block cannot travel further across Ash Homes and the UK housebuilding market. Although the eventual decision to approve LFB was not taken in this meeting, it provided a naturally occurring event to explore the interactional classification work that is vital to the proliferation of this innovation. Borrowing ANT terminology, this meeting can be regarded as an "obligatory passage point" (Callon 1986a) in the wider actor-network that ultimately allowed LFB to be approved for use across the UK housebuilding industry.

This warranty meeting was observed and audio recorded by the second author of this paper. The total length of this audio data was 169 minutes. This digital recording was professionally transcribed and thematically coded (with Nvivo 12) in two analytical phases: (i) identification (*What classifications are being used to speak for LFB?*) and (ii) assigning classificatory activities (*How is LFB being classified and with what outcomes for*

enrolment?). These two phases are informed by Nathues *et al.* (2020) VA methodology along with classic ANT concepts of enrolment (Callon 1986a, Latour 1987). In keeping with reflexive principles in ANT and ethnographic research (Law 2009), our analysis was also shaped by our own position as researchers. We undertook our fieldwork with an existing knowledge of ANT and classificatory theories, particularly those of Bowker and Star (1999). This knowledge drew our attention towards the occurrence and significance of classificatory work within this specific warranty approval meeting and influenced the development of this paper. The data presented below consists of verbatim extracts from a meeting. However, some information (e.g. individual and company names, some technical data) has been removed to maintain commercial confidentiality.

During the *identification* phase we coded what classifications were being evoked to speak for LFB and how those classifications then shaped the interactions of those actors. Adopting the conceptual terminology of VA (Nathues *et al.* 2020), this involved identifying “vents” that make “someone do or say something” and “figures” that are “made to do or say something by someone else” (p. 4–5). It must be stated that this distinction between vents and figures is an entirely analytical one: during communication actors can be simultaneously vents and figures, passive and active as their roles are exchanged (Nathues *et al.* 2020). Ventriloquial analysis assumes that “anything and anyone can potentially be identified as a figure or vent, but a necessary condition is that a figure is implicitly or explicitly invoked or a vent is recognised as animating someone or something else” (Nathues *et al.* 2020, p. 8). VA suggests that *explicit* ventriloquising refer to acts wherein participants explicitly speak for other actors (i.e. by mentioning them directly), while *implicit* ventriloquising refers to acts where the analyst identifies the use of a figure as enveloped or implied within an utterance. Finally, we also explored the frequency of attachment between vents and figures within this identification phase as a way of understanding the significance of particular classifications. This is because VA suggests the frequency of attachment between vent/figure pairings is indicative of their significance within an interaction (Caronia and Cooren 2014, Nathues *et al.* 2020). Within this process we identified numerous classifications that were used to speak for LFB, including “elements,” “units,” “system,” “masonry,” “product” and “project.”

In the *assigning classificatory activities* phase we coded how LFB was being classified in these instances

and with what outcomes for innovation enrolment. The first step of this phase involved the identification of tactics through which meeting participants sought to authoritatively speak for a certain classification of LFB, often by evoking other figures (e.g. building tests, other organisations, other meeting participants, even earlier conversations) in support of their classifications. Although our analysis was primarily concerned with how classifications were used to speak for LFB, VA suggests that to fully understand how these classifications operated they should be situated within wider ventriloquial processes in interactional events (Nathues *et al.* 2020). Thus, we purposefully extended our analysis to explore how a range of other figures were mobilised alongside these classificatory figures to achieve certain enrolment outcomes. In the next step of the second phase we explored the enrolment outcomes produced by these ventriloquial effects. Herein we related VA analysis to ANT to examine how classificatory work constituted specific enrolment tactics that enabled or constrained the wider proliferation of LFB as an innovation (e.g. detours to achieve interests, cutting off existing interests – e.g. Latour, 1987, p. 108–121). It is beyond the scope of this paper to present every instance of classification work involving LFB. Instead, we discuss two vignettes which illustrate the significance and variety of ways classification work can make a difference to the proliferation of construction innovations.

Innovation as classification work

Vignette 1: innovation classification as scoping and normalisation

Our first vignette concerns whether LFB can be classified as a normal “masonry” product rather than a more experimental structural component. We were introduced to the significance of this classification in an exchange between Mark, the Chair of the meeting from Ash Homes, and Santos, the technical manager from the product supplier:

Mark: ... Is it worth [Santos] just explaining the current difficulties we have in terms of the structural design ... is it worthwhile you just explaining for the benefit of people around the table what we’re doing and why we’re having to do what we’re doing?

Santos: Okay so traditionally we’ve got masonry which is interlocking units and all of our design codes based on the fact that that’s what masonry is. These storey height units although they’re made from the same material that they would have been using are larger than what is technically classified as a block basically. So technically we can’t use the masonry code to

design it. Where that's left us at the moment is that we then need to look at each element. We can't look at a wall panel and say that panel is three metres long, design it as three metres long. If we're putting a 600-wide unit into it we have to look at that unit discretely and assume that there's no interaction with the unit next to it. So that's what's taking so long.

Mark then explains that the inability to classify LFB as masonry is making it impossible for this innovation to be scaled up across Ash Homes because Warranty Co are having to undertake extra individual cheques on designs and sites:

Mark: why this is important is for two reasons principally. One, just the time taken to having to work up the calculations and provide them to Kevin to review and certify and then secondly it's been very difficult for [Warranty Co] both from a building control and a warranty point of view because there is no natural code or regulation that bounds this.

Drawing on ANT we can say that this classification work is "making a difference" (Latour 2005, p. 71) to the enrolment of actors in support of LFB. That is, there is an attempt to mobilise an existing black box standard (i.e. the masonry code) to enrol actors in support of a new innovation (cf. Latour 1987, p. 109, Latour 2005, p. 228). With VA we can also go beyond this general insight to understand exactly how and why Santos is mobilising the masonry code. Such granular analysis helps explain the specific role of classification work in processes of enrolment.

First, we need to explain how authority is gained to ventriloquise the masonry code (Caronia and Cooren 2014; Nathues *et al.* 2020). We can start to explore this process at the opening of the above exchange when Mark, as meeting Chair, speaks on behalf of Santos and invites him to ventriloquise "the current difficulties we have". This "we" is implicitly ventriloquised against another group of actors who lack these experiences ("the people around the table") that includes Warranty Co. Santos's ventriloquial act is then framed by Mark as an authoritative elucidatory account about "current difficulties". Mark implicitly classifies LFB as problematic and Santos as able to speak to those problems and possible solutions ("what we're doing and why we're having to do what we're doing?"). We suggest it is useful to conceptualise this process as a hierarchy of attachment. Mark has a certain level of attachment to Santos that is sufficient to enable him to recognise that it is Santos and not him that is most closely attached to these "difficulties" and can authoritatively speak on behalf of them.

When Santos then starts to speak he does not explicitly ventriloquise LFB but instead speaks for a

classificatory figure: the masonry code. This classificatory figure is not a tangible object, like LFB, but an abstract object defined by thresholds of material composition, properties (interaction with adjacent elements) and size as set out in a formal standard. VA suggests that Santos is not just actively speaking for this classificatory figure rather it is also a vent that is speaking through him. Or more precisely, the failure of the masonry code to speak on behalf of LFB (variously referred to as "elements," "units," "panel") is forcing Santos to speak ("larger than what is technically classified as a block"). Santos's passivity in this agential exchange is discernible in his choice of words ("Where that's left us at the moment"). Santos is undertaking this classification work because he is closely attached to LFB and the masonry code which sensitises him to a disconnect between these two non-human actors. Indeed, if the masonry code could speak for LFB as masonry, if Santos could speak on behalf of LFB using the masonry code, there would be no classification work. Santos speaks because the masonry code cannot speak for LFB. This means that LFB must be classified as an experimental structural element that is subject to expensive (in terms of time and cost) ad-hoc design work.

This short conversation helps to explain how classification work operates and its effects on the proliferation of innovations. Importantly, as Bowker and Star (1999) propose, it is clear that classification work is far from a purely cognitive-linguistic process where a sovereign human being categorises a tangible object in a typology. Instead, classification work is triggered when non-humans resist human agency. That is, human actors such as Santos are forced to undertake classification work due to the inability of one non-human actor to ventriloquise another non-human actor: the masonry code that cannot speak for LFB meant that Santos could not speak for LFB ("we have to assume that there's no interaction with the unit next to it"). This exchange also demonstrates how classification work is sustained across a hierarchy of attachment wherein different (human) actors recognise the limits of their agential sensitivity to register disconnects between non-human actors and then take a passive role in an exchange while inviting other actors to speak – as Mark with Santos. Thus, we suggest one outcome of interactional classification work is scoping: a process wherein new actors, human and non-human, are admitted into an interaction when an existing abstract classificatory actor, like the masonry code, cannot speak for a new tangible actor like LFB.

However, such scoping is far from an undirected process, rather it itself serves a related process of normalisation that feeds into processes of enrolment. The relationship between this process of scoping and normalisation can be grasped as Santos continues his explanation of the masonry problem:

Santos: ... In the background we have been doing some work to try and show or establish the fact that there is some interaction between elements. There is a bonded joint between them that's giving some interaction and we've been through various phases testing it. ... We've had independent reports by people involved with masonry looking at it ... pulling everything together so they're looking at all the various testing that's been done, all the various report, pulling everything together and their report hopefully, fingers crossed will say we can basically treat it as a masonry design approach.

Paul: Are you getting any preliminary feedback ... ?

Santos: We've had a draft through that we've commented on and I think was doing that and it was all looking good and positive ... [and we are undertaking] some more tests and they used the digital imaging technique which is basically painting a wall, putting lots of dots on it and then seeing if there's any microscopic movement to measure the stresses and strains on the surface and I think that again was positive. It shows a bulge rather than a sort of straight line spread, but that again shows it did go across the joint

Santos starts this discussion with Paul from Warranty Co by explicitly speaking for the joint between LFB elements ("There is a bonded joint between them that's giving some interaction"). Santos then explains that his ability to speak on behalf of the existence of this "bonded joint" is pivotal to the ability of the masonry code to speak on behalf of a classification of LFB as masonry ("hopefully, fingers crossed will say we can basically treat it as a masonry design approach"). Here Santos recognises that his capacity to speak on behalf of LFB and dispel his earlier equivocation ("assume that there's no interaction with the unit next to it") is also dependent on the ability of a non-human actor (the mason code) to speak on behalf of another non-human actor (LFB). With VA we can register how this inability to speak for LFB pushes Santos to explicitly evoke a series of new actors in the exchange that can, he expects, speak on behalf of LFB ("independent reports," "testing," "digital imaging techniques," "microscopic movement" "bulge"). The admission of these new nonhuman actors to enable classification is what we term here "scoping". This process is passive in the sense that Santos is forced to speak by these actors due to his inability to

ventriloquise LFB. However, this process is not directionless. Rather it serves a wider (human) instrumental intent – to normalise the use of LFB across the industry.

This process of normalisation is vital to allow Santos, and indeed Warranty Co, to speak on behalf of LFB and approve the system as a whole. That this is the case becomes clear when Paul goes on to explain to Santos his frustrations with his lack of ability to speak for LFB later in the discussion:

Paul: ... we've put a lot of manpower into checking this as it goes through, that reinforces the reason why we want those calculations and report to be issued as soon as possible so that we can then sign off the last bits. As with all of these types of systems our mission is to normalise it, to make it as normal as possible without having to put a lot of manpower into checking the checkers, etc. etc. So that's really where we are.

Mark: I understand that. We always perceived this project as just a big block and I will maintain it is just a big block ... it didn't occur to me at least that the design codes would be such an issue, so it was a lesson learnt I think in that.

Mark's response to Paul echoes his frustration: he cannot unequivocally ventriloquise LFB as "just a big block" as such a ventriloquial utterance has now become dependent on whether the masonry design code can speak for LFB.

These classificatory processes of scoping and normalisation feed into the wider capacity of actors to enrol and be enrolled in support of LFB. In this sense they can be considered part of the process of enrolment described in ANT as crucial to the proliferation of innovations as "black boxes" (Callon 1986a, 1986b, Latour 1987). More specifically, classificatory scoping and normalisation enables new innovations to "piggy-back" upon pre-existing enrolments in other "black boxes" (e.g. standards, standardised tests, scientific epistemologies) (Latour 1987, p. 109–111). Although ANT already recognises the importance of standards in the proliferation of innovations (Latour 1987, 2005), it often presents this process as one led by heroic, Machiavellian, innovators. These innovators are said to be capable of identifying and enrolling "less controversial arguments," "simpler black boxes," "less disputable fields" and "huge and efficient laboratories" to support their own (Latour 1987, p. 109). Our interactional VA analysis challenges this view to show how the enrolment of existing black boxes in support of innovations can be triggered as much by a displacement not augmentation of human agency. More specifically, it is when non-human classificatory actors like

the masonry code fail to speak on behalf of actors like LFB that human actors are driven to undertake classification work. And this classification work can then involve further displacement of agency as humans enrol other classificatory actors (e.g. laboratory tests) that speak through them. In other words, our research shows that passiveness, voicelessness, and modesty, rather than heroic network building and confident spokespeople can enable the classification work that allows innovations to proliferate. Becoming a spokesperson for an innovation (Callon 1986a, 1986b, Latour 1987) therefore involves recognising the limits of our capacity to speak for that innovation and a willingness to allow/invite others, human or non-human, to speak for us. This does not mean that human agency is absent in such exchanges but rather that human agency is sometimes conditional on its diminution (Sayes 2014). Before discussing the wider implications of this finding, we will turn to our second vignette to further understand the role of classification work in innovation proliferation.

Vignette 2: innovation classification as disruption and transformation

Classificatory processes of scoping and normalisation can allow construction innovations to proliferate. However, further analysis of our data suggests that such initial enrolment processes are often themselves disrupted and transformed by subsequent classification work to keep actors enrolled. The following discussion by John and Andrew which follows on from a discussion of a LFB pilot project helps elucidate these processes:

John: ... The reference being made is basically to the very first job ever ... what we've gained in this period is experience and lessons learnt right through, processes, responsibilities as Peter's touched on there. So, it's the same for anyone in any walk of life, you do it on day one, you get experience from thereon. The training's there and it's definitely moved leaps and bounds.

Andrew: I think for us the key thing now is what you touched on earlier [Caroline], it's whatever the testing says is that being done on site? And I think what we've noticed now is those key stage inspections are absolutely vital. So, you do a ground floor, it gets inspected, it gets signed off. You do a floor, it's installed, it's signed off. So, you don't move onto two until one has been satisfied and to be honest it's been the biggest difference for us. You can see where before you're five houses down and then you're checking all five houses check it, sign it off, move on, check it, sign it ... There's the system manual. That's exactly how it should be. That's how it is. Are we

happy? And to be fair obviously with the involvement with the [Warranty Co] guys on the ground it's right discussion, so for me the system manual with those checks, that's how it should be on site.

In order to fully analyse this exchange, it is useful to refer back to the conversation Andrew ventriloquises in the passage above at the start of his response to John:

Caroline: ... What is absolutely key is what happens on site in terms of forming the joint is the same as what has happened in the laboratory. I don't know how careful they were with the forming of the joint or whether they were partially filled joints and they tested those as well to get some sort of a broader understanding.

Santos: [The tests] were done with good joints, what we call good joints ... they did two panels. One was with a good joint and the other was half filled, wasn't it? And again, both gave good results.

Andrew: Hopefully one was done the [Downford] way and one was done the bricklayer way. Though which was which – that's not for the tape! [laughter]

These two exchanges contrast to our first vignette. Specifically, Caroline disrupts Santos's normalisation of LFB as masonry by implicitly ventriloquising a second classificatory actor – site workmanship ("I don't know how careful they were with the forming of the joint"). The introduction of this classificatory actor, and a continuum from good to bad workmanship, disrupts the notion that laboratory tests can unequivocally speak for the classification of LFB as masonry. In response Santos is again forced to scope and speak on behalf of new actors in an effort to (re)normalise LFB. Namely, he explains that laboratory tests encompass a range of site practices. Andrew's light-hearted riposte appears to support this argument and the conversation quickly moves on. And yet ten minutes later Andrew ventriloquises this earlier exchange and now unambiguously disrupts Santos's efforts to normalise LFB by suggesting that it is "vital" that site-level tests continue to be carried as "whatever the [laboratory] testing says, is that being done on site". Andrew then ventriloquises a range of site-level tests and a new classificatory actor – the "system manual" – to formally classify acceptable site workmanship.

Across these two linked conversations, Santos's efforts to normalise LFB are disrupted by the introduction of a new classificatory actor – site workmanship – that disrupts the ability for laboratory tests to speak for LFB as masonry. Although at first Santos is able to counteract these disruptions, when John and Andrew, as LFB installers, detail the vagaries of site operations and lessons learned, Santos remains silence. This is

not surprising. Santos is not attached to site operations and cannot speak with authority on behalf of them. VA suggests that Andrew's closer material attachment to site operations effectively forces him to speak on behalf LFB and actors such as site workmanship. But more than this, by ventriloquising a universal experience of learning as a process of disruption and transformation ("it's the same for anyone in any walk of life, you do it on day one, you get experience from thereon"), John appears to invite Andrew to disrupt and transform earlier classificatory normalizations of LFB. Indeed, Andrew does not merely disrupt Santos, rather he transforms how LFB will be normalised. Namely, he explicitly introduces a third classificatory actor: the system manual. In a subsequent conversation Andrew, Caroline and Mark then go on to explain that the purpose of this classificatory actor is to speak for both the masonry code and acceptable site workmanship:

Andrew: by having that [system manual], once that is agreed that's the standard we're working to. Then it helps us and it helps our site team to say if there's any question, whether it's a site manager or [Warranty Co] or a site manager saying that's actually the agreed document exactly what we're working to, so again without going off piste too much, there is a massive challenge at the moment with the [Warranty Co] say they like to see lots of glue pouring out underneath the joists. Now we are putting glue in like it's going out of fashion. We've got scrapers in the factory because it's all on the floor but we're still being told there's not enough glue. We've now gone to the [glue] manufacturers and they say if you put too much on now, actually the joint weakens. So, I almost want to go back to a stage in the factory that we can prove now that right, that one piece down the centre of the joist it actually is doing its job, then we can show that in the system manual, so when the load inspector he is not expecting to see all these ripples down the joist flange. Whether that's right or wrong, but things like that I think are going to make a massive difference for us.

Caroline: So all those details and ... ?

Andrew: I think it's got to.

Mark: I think rather than details, photos ... we've got a fantastic library now of photographs of good and not so good practice and you should know as a bricklayer or a carpenter or an electrician, "I want it done like that, not like that," you don't need lots of text and lots of standards and specifications. So, photographs I think are becoming more and more important for us.

In this exchange Mark, Caroline and Andrew transform how LFB is to be normalised. Instead of relying only on laboratory testing to speak for whether LFB is

masonry, a system manual, encompassing technical specifications, standards and photographs of "good practice" will be created to enable the masonry code to speak for LFB. The existence of this manual entails that the question of whether LFB can be normalised and classified as masonry, or whether the masonry code can speak for LFB, will now have to be tested at site level through a wider material assemblage of actors drawn together with further classificatory work.

The interactions above explain how existing enrolments and classification work can be disrupted and transformed through the introduction of new classificatory actors (i.e. site workmanship). By ventriloquising site workmanship and the system manual, Andrew, Caroline and Mark disrupted the hierarchy of attachment that allowed Santos to speak on behalf of the classification of LFB as masonry. And yet, these new classificatory actors did not entirely challenge the significance of the masonry code to enrol actors in support of LFB. Instead, the introduction of these new classificatory actors (site workmanship and the system manual) generated opportunities to enrol new site-level actors in support of an overarching classification actor (the masonry code). Thus the three classificatory actors discussed so far in this paper can also be conceptualised in a nested hierarchy, with the informal classification of site workmanship and the attendant system manual serving to support the formal classification of the masonry code. However, it is important to draw a distinction between these classificatory actors. That is, neither site workmanship nor the system manual can be understood as a black boxed classificatory actor in the manner of the masonry code. Instead, these classificatory actors involved as yet to be determined, or demonstrated, classifications founded upon photographic interpretations of workmanship rather than laboratory testing. Viewed through ANT, the use of such actors to enrol others in support of LFB is a counterintuitive finding. This is because it reverses Latour's (1987) notion that it is through identifying and enrolling "less controvertible arguments," "simpler black boxes," "less disputable fields" and "huge and efficient laboratories" that actors can be enrolled (Latour 1987, p. 109). In our case it is through ventriloquising more controvertible arguments (e.g. site workmanship), more complex black boxes (e.g. an unfinished system manual), more disputable fields (e.g. like amateur photography) and small and inefficient laboratories (e.g. building sites) that a black boxed actor, like the masonry code, can be enrolled in support of an innovation. Put more formally, the proliferation of an innovation seems to

depend as much on enrolling actors because of, and not despite, their weakness and mutability. To rephrase an old ANT maxim: if viewed from a distance an innovation “is only as strong as its weakest link” (Latour 1987, p. 121) then perhaps up close and within the flow of a conversation it is also only as weak as its strongest link.

Discussion and contributions

Throughout this paper we have argued how classification work makes a difference to construction innovation. Existing ANT construction innovation research has variously, albeit briefly, suggested that classifications make a difference to the enrolment of actors in support of the proliferation of construction innovations – whether in terms of; shaping what actors are included in processes of enrolment (Harty 2008, Linderoth 2010, Lindblad 2019), what innovation classifications can enrol what actors (Harty 2008, Tryggestad *et al.* 2010, London and Pablo 2017) and how non-human actors can support and disrupt existing enrolment tactics related to classifications (Lovell 2009, Tryggestad *et al.* 2010, Lindblad 2019). In this final section we explore how our VA analysis develops each of these three existing themes. In so doing we elaborate three contributions to these three respective lines of research and then the implications of these contributions for construction practice.

Contributions to research

Our first contribution concerns how actors are enrolled in support of an innovation. Specifically, our analysis of classification work challenges the heroic orientation of some ANT research where a Machiavellian human network builder surveys “vital” or “indispensable” human and non-human actor to enrol in support of an innovation. This image can be found across ANT construction innovation studies (London and Pablo 2017, Lindblad 2019), wider ANT innovation studies (Callon 1986a, 1986b, Latour 1987, Sarpong *et al.* 2016) and some critiques of ANT (Star 1991, Law 2009). We propose three interlinked concepts – scoping (and normalisation) and hierarchies of attachment – that problematise this heroic view of enrolment.

In developing our challenge to heroic versions of enrolment we do not deny the self-reflexive skill and expertise of the human actors involved in proliferating innovation. Instead, our findings suggest such human capacities to enrol actors in support of innovations are conditional on displacements of human agency. One

such displacement involves a process we have conceptualised as scoping. Scoping occurs during enrolment when human actors cannot deploy an existing classificatory actor (e.g. a masonry code) to speak on behalf of that innovation and achieve its normalisation. Such disconnects happen when aspects of an innovation, for example its size or shape, do not align with an available classification. To resolve such disconnects new actors, including non-humans, have to be identified that can speak on behalf of that innovation and allow it to speak to a different aspect of that classification (e.g. interlocking joints). Scoping is triggered by a displacement of the ability of human actors to mobilise a classification to speak on behalf of an innovation. Moreover, scoping can also result in the mobilisation of a non-human actor, such as a laboratory test, to speak for that innovation. Thus, scoping can involve a displacement of human agency. This is because VA suggests that some actors are more or less more or less attached to other actors and thus able to speak on their behalf (Caronia and Cooren 2014). We propose the term “hierarchies of attachment” to refer to these degrees of attachment. Importantly, within scoping actors must often recognise the limits of their capacity to speak on behalf of other actors and their subordinate position in a hierarchy of attachment. Indeed, in our case if Mark had not invited Santos to speak for LFB, or if Santos had not allowed laboratory tests to speak for LFB, then the disconnect between the masonry code and LFB could not be overcome. Thus, through these interlinked concepts of scoping and hierarchies of attachment the seemingly self-reflexive skill and expertise required to achieve enrolment is shown to be conditional on displacements of human agency.

Second, some existing ANT studies have suggested that certain classificatory labels for innovations (e.g. “radical,” “incremental”) or stakeholders (e.g. “co-designers” or “users”) are more or less useful in enrolling specific actors in support of innovations (Harty 2008, Tryggestad *et al.* 2010, London and Pablo 2017). Our study extends these discussions in at least two respects. Firstly, our analysis suggest that the classificatory labels applied to innovations (e.g. “masonry”) can be conditional on classification of work involving human actors (e.g. “good and not so good practice”). This is noteworthy because existing studies tend to suggest that certain classifications are either deployed to innovations (Harty 2008, London and Pablo 2017) or the actors to be enrolled (Tryggestad *et al.* 2010). Secondly, our findings suggest that formal classificatory standards (e.g. the masonry code) and informal

classifications (e.g. norms of good practice) may be far more closely entangled than is usually considered. This means that informal classifications can sometimes be vital to how black boxed standards are mobilised to enrol actors in support of innovations.

Third, our analysis elaborates the general argument that non-human actors can support and disrupt existing enrolment tactics related to classifications (Lovell 2009, Tryggestad *et al.* 2010). In our first vignette, the introduction of the size of LFB elements, and their potential lack of joint interaction, disrupted the enrolment of actors in support of the innovation through the classification of LFB as normal masonry. The subsequent introduction of laboratory tests demonstrating interaction between LFB elements appeared to overcome this difficulty and allowed actors to be re-enrolled in the classification of LFB as masonry. However, in our second vignette it was a human actor – varying norms of site workmanship – that disrupted the validity of these laboratory tests and the enrolment of actors in support of LFB. These problems were then to be overcome by the introduction of a new non-human actor – a system manual – that promises to extend the classification of LFB as masonry to site-level by standardising working practices.

Across these vignettes it is possible to identify how non-human actors forced human actors to support/transform their planned enrolment tactics. However, such a conclusion risks simplifying the relational constitution of agency that ANT and VA strives to explore. That is, as Sayes (2014) puts it, “nonhumans do not have agency *by themselves*, if only because they are *never* by themselves” (p. 144; original emphasis) rather “It is the action itself that is the important thing to trace ... whether this action is locatable in humans or nonhumans is meaningless – or at least sociologically irrelevant” (p. 145). With VA we have been able to glimpse how certain actions – scoping, normalisation, disruption and transformation – are comprised of ventriloquial acts of classification that are always relationally constituted. Although human actors like Santos were sometimes confidently able to speak for LFB they achieved this in part because of agential attachments that forced them to speak and ventriloquised them (e.g. laboratory tests, building codes etc). Moreover, as our second vignette demonstrated there also exists a hinterland of other more minimally attached actors (e.g. site workmanship, the system manual) that were tacitly excluded from such acts. Under specific interactional conditions (e.g. when John ventriloquised a universal experience of learning) these latent/potential actors then disrupted and transformed existing ventriloquial classification work and

attendant enrolment tactics. VA offers a more granular analysis of such dynamic agential relations than archival or interview-based ANT research. We suggest this serves to help ANT construction innovation research explore enrolment processes in ways that go beyond analyses of actually existing actors that are strongly attached to an innovation. VA thus also helps address critiques of ANT where the influence of both historical/structural and future/potential actors is downplayed (Elder-Vass 2008, Farías 2014, O’Mahoney *et al.* 2017, Sage *et al.* 2020).

Contributions to practice

These three contributions to research also have important implications for construction practice. First, our analysis demonstrates that the capacity of practitioners to speak on behalf of innovations through classifications, such as black boxed standards (e.g. the masonry code) is often crucial to enable construction innovations to proliferate. However, this classification work should not be misunderstood as a “top down” endeavour where senior managers and engineers heroically survey projects, firms and sectors to classify innovations and “vital” stakeholders to scale those innovations up. Instead, the classification work associated with enrolment demands a much more modest, and sometimes passive, approach where managerial actors recognise they may sit at the bottom of a hierarchy of attachment to identify and speak for the actors to be enrolled in support of an innovation. This finding acts as a caution to much construction innovation research. This is because despite longstanding emphasis on the “bottom up” generation of new technologies and ideas (Tatum 1987, Ercan 2019), the agency of senior managers is often said to be paramount to the proliferation of innovations (Tatum 1987, Blayse and Manley 2004, Larsson *et al.* 2006, Gambatese and Hallowell 2011, Davidson 2013), particularly in the case of relatively more “radical” innovations like LFB (Slaughter 1998, 2000).

Second, our findings should encourage practitioners to remain open minded about the classificatory labels that are required to be enrolled in support of innovations. That is, while formal standards (e.g. the masonry code) may rightly be understood as “obligatory passage points” (Callon 1986a) through which innovations must pass to proliferate, these formal standards may themselves be composed of informal classifications (e.g. “good and not so good practice”). This means that a mixture of classificatory work, combining standardised scientific testing as well as informal rules of thumb, is likely unavoidable and necessary to allow

Table 1. Industrial participants meeting one.

Participant pseudonym	Job title	Type of firm	Pseudonym of firm
Mark (meeting chair)	Technical Director	Volume housebuilder	Ash Homes
Frank	Group Technical Manager	Volume housebuilder	Ash Homes
Kevin	Director	Structural engineering consultant	Venoxo (working for Ash Homes)
John	Operations Director	Main contractor	Downford
Andrew	Managing Director	Main contractor	Downford
Peter	Housing Manager	Main contractor	Downford
Curtis	Development Manager	Product Supplier	Block Co
Santos	Technical Manager	Product Supplier	Block Co
Paul	Technical Manager	Warranty Provider	Warranty Co
Caroline	Structural Engineer	Warranty Provider	Warranty Co
Max	Principal Surveyor	Warranty Provider	Warranty Co

innovations to proliferate, even with more complex innovations such as LFB. Thus, although the proliferation of new standards and regulations accompanying construction innovations is a necessary part of the classification work required to allow those innovations to proliferate it is likely never sufficient.

Third, our analysis emphasises how the identification of classificatory actors to be enrolled to proliferate innovations can be influenced by seemingly banal social interactions. While a wide variety of factors – from regulations (Blayse and Manley 2004) to innovation champions (Gambatese and Hallowell 2011) to technological capacity (Ercan 2019) – have been identified as vital to the proliferation of construction innovations, very little attention has been placed on the design and function of specific social interactions such as workplace meetings. Our research suggests that it is vital that the human participants at such meetings are closely attached to a wide variety of absent non-human and human actors. This can allow heterogeneous actors to speak through them and then those absent actors to be taken into account in the classification work being mobilised to proliferate an innovation. However, there is also a risk that actors, like Andrew, may not speak on behalf of other actors, like site workmanship, until the interactional conditions are conducive. Our research suggests that certain interactional tactics, like John ventriloquising a universal experience of learning, may promote such conducive conditions even though such talk may seem inconsequential. Such interactional sites and tactics are worthy of future exploration in understanding the proliferation of construction innovations.

Concluding comments

Classifications have long accompanied construction innovation research and practice. However, the significance of the work involved in classifying has by and large been invisible within studies of construction

innovation. Instead, construction innovation research has focussed on pronouncing, elucidating and problematising a wide variety of classifications to represent the objective reality of construction innovations (e.g. construction innovation as “incremental” or “radical,” “organizational” or “technical,” “product” or “process”). Despite their theoretical intricacy such taxonomies may play only a marginal role in the dynamic interactions that practitioners employ to proliferate innovations. But whether or not these categories influence practice always remains an open empirical question to be analysed and one surely deserving of further exploration. We combined ANT and VA to inform such a research trajectory in a specific industry context – UK housebuilding. Other interactional and practice-based theories may offer complementary insights into countless other construction innovation contexts. However, we must also acknowledge the limitation of such interactional analyses. Namely, although such research can shed light on how classification work makes a difference to the mechanisms used to enable innovation proliferation, owing to its granular nature it cannot help researchers fully explore how LFB proliferated across a firm or industry. Thus, such granular interactional analyses of classification work might be usefully deployed alongside other approaches, including longitudinal ANT analyses, that can map the wider proliferation of innovations. Such combined research, which is beyond the scope of this paper, may provide insights into how various interactional mechanisms, including classification work, may influence wider innovation outcomes. All we hope is that we have found some room among the myriad classifications of construction innovations to classify classification work itself as worthy of attention.

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