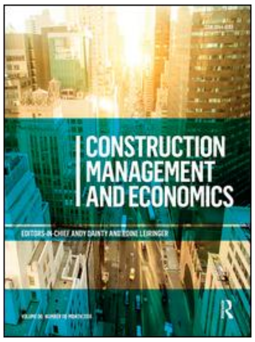

Construction Management and Economics

ISSN: 0144-6193 (Print) 1466-433X (Online) Journal homepage: www.tandfonline.com/journals/rcme20

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To cite this article: Alexander Styre (2017) Thinking about materiality: the value of a construction management and engineering view, Construction Management and Economics, 35:1-2, 35-44, DOI: 10.1080/01446193.2016.1272760

To link to this article: https://doi.org/10.1080/01446193.2016.1272760

CONSTRUCTION MANAGEMENT AND ECONOMICS, 2017
VOL. 35, NOS. 1–2, 35–44
http://dx.doi.org/10.1080/01446193.2016.1272760

Routledge
Taylor & Francis Group

Thinking about materiality: the value of a construction management and engineering view*

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ABSTRACT

The increased interest for materiality as an analytical category in the social sciences provide construction management and economics scholar with new possibilities to better exploit the detailed empirical data being collected in the construction industry and related fields. While constructivist and other idealist theories have tended to dominate the social sciences since at least the mid-sixties when the social sciences sought to release itself from the methodological dogmatism of the "hard sciences", materiality is now recognized and subject to theorizing within different social science traditions. This article advocates a broad engagement with materiality within construction management research and presents a series of analytical concepts and empirical studies that stress how the built environment that human beings inhabit is far from passive, inert and stable as common sense thinking easily misleads analysts to believe. An image of materiality that recognizes an agential, dynamic and more fluid nature of materiality is thus arguably conducive to an intellectually stimulating construction management scholarship.

ARTICLE HISTORY
Received 23 September 2016
Accepted 1 December 2016

KEYWORDS
Materiality; matter; material agency; sociomaterial practices

Introduction

"Intellectual freedom depends upon material things", Woolf ([1929] 2004, p. 119) stated in her classic essay, *A Room of One's Own*. This declaration of independence on the basis of the access to and control over material resources is intuitively appealing but common sense thinking easily betray humans to make us think that the concrete, physical world we inhabit is less dependent on artefacts, technologies and other things than it actually is. In scholarly circles, this tendency to downplay and ignore materiality is even more pronounced as the intellectual imagination easily calls for more deep-seated and profound constructs, helping the scholarly investigator penetrate the surface of things and to explore their inner workings. One such fallacy to understand materiality only indirectly and after making the detour through other concepts is to theorize materiality as *information*. Black (2014) argues that nanotechnology discourse fails to address the *factum brutum* nature of materiality and instead recourses to *information* as the underlying and analytically valid concept that captures the ultimate nature of particles on the nano- and microscales:

> In the age of information, the power of information as a concept depended precisely on the idea that the material and particular could be reduced to information, allowing all the messy, disorganized contingencies of the world to be captured in diagrams and formulae. Nonetheless, of course, like the distinction between form and matter, it depended upon an opposition between the two terms, and the idea that, at a fundamental level, one could not be reduced to the other. (Black 2014, p. 118)

In what Black (2014) calls "the age of information", everything in the world can be presented and manipulated as "information structures", and consequently, Black (2014, p. 119) continues, "the informatics account has conquered every possible territory". This fallacy to reach into the inner workings of materiality, of things, technologies, biological organisms, etc., only by enacting such materialities as the information, is indicative of the problem to deal effectively with materiality in the social sciences.

For a considerable period of time, arguably since at least the publication of Berger and Luckmann (1966) *The Social Construction of Reality* in the mid-1960s, the social sciences have privileged abstract theoretical constructs such as *beliefs*, *norms*, *culture*, *ideology*, *narratives* and *identities*. Within this *episteme* of idealism and abstraction, enacting the social world as what is essentially "in the heads of social actors" or what is constituted intersubjectively through language games, narratives and storytelling, materiality as such has been pushed to the margins and have been treated as being of marginal interest. Orlikowski (2010,

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* This paper is dedicated to the memory of Professor Per-Erik Josephson (1960–2016).

p. 128) proposes that in the field of organization theory, the early interest in manufacturing technology (see e.g. Woodward 1965) and its consequences for organizing did not translate into a viable research programme. On the contrary, organization theory scholars have "mostly ignored the materiality of everyday organizing". Orlikowski (2010, p. 128) explains this marginal interest, where materiality and technology more specifically is either "invisible or irrelevant", on the basis of limited training in and understanding of e.g. the engineering sciences. That is, the lion's share of organization theory, scholars only have a cursory understanding of the technologies (e.g. machines, digital media, laboratory equipment) being put to use in the organizations they study. Needless to say, this failure to recognize materiality impoverishes the analysis and confines organization theory scholars to social constructivist understandings of the object of inquiry.

However, Rose (2013, p. 4) says, his own position being somewhat obscure, "it seems that 'constructivism' is *passé*, the linguistic turn has reached a dead end and a rhetoric of materiality is almost obligatory". Today, we witness a revival of materialist theory and a renewed concern for how the social world is not only dependent on what humans think, believe and communicate, but also how well a mind-boggling variety of material resources are mobilized en route when constituting society on everyday basis. In this awakened interest for materiality as an analytical category, the common sense view of e.g. technology is abandoned and instead highly sophisticated analytical models have been proposed by a community of scholars with a diverse disciplinary background including sociologists, management scholars, political scientists, science and technology researchers, and engineering scholars. For instance, materiality is no longer enacted as a stock of inert, passive and non-dynamic resources, but instead forms of agency is inscribed into materiality, rendering it fluid and changeable, and capable of acting as well as being acted upon: "Matter is no longer imagined here as a massive opaque plenitude but is recognized instead as indeterminate, constantly forming and reforming in unexpected ways. One could conclude, accordingly, that 'matter becomes' rather than 'matter is'" (Coole and Frost 2010, p. 10). In this "new materialism" (Coole and Frost 2010), the social world is no longer understood as a solipsism – primarily enacted embedded in human understanding – but instead assumes that there is a variety of material resources and agencies that needs to be combined and integrated, indeed *managed* to operate smoothly and at the highest level of efficiency, preferably to the point where the very materiality of the technology is overlooked and ignored in common sense thinking.

In construction management and economics scholarship, there is a significant research tradition exploring various features of materiality including its role in the institutionalization of technologies, materials and standards (Lees and Sexton 2014, Robinson *et al*. 2016), in construction innovation (Harty 2005, Orstavik 2014), the role of objects in the design and the construction process (Tryggestad *et al*. 2010, Tryggestad and Georg 2011, Walter and Styhre 2013) and the use of visual media and "digital objects" in the design and construction process (Whyte *et al.* 2007, Whyte and Lobo 2010). In this body of research, various aspects of materiality and its manifestation in, say, technology, digital media or new materials are examined in minute detail, arguably for the benefit of a deeper and wider understanding of how materiality is omnipresent in the construction process. To further support and justify research in this materialist tradition of research, this essay stresses that construction management and economics scholars has a great benefit over e.g. more "clean-cut" social theorists inasmuch as construction management scholars tend to intuitively recognize the materiality of their object of study, be it actual buildings, CAD sketches, documents outlining a new technological standards, or more seemingly mundane technologies such as doorstops or speed bumps (with Bruno Latour's two examples). Just as in the case of many of the engineering sciences (e.g. mechanical engineering and electric engineering), construction management and economics scholarship already from the beginning assumes a fruitful and mutually constitutive relationship between the scholar and the material *Unwelt* (a term introduced by von Uexküll (2001) that he or she encounters and explores. Therefore, the awakened interest in materiality as an analytical construct provides many opportunities for construction management and economics scholars to make valuable and lasting contributions to mainstream organization theory. Unlike e.g. business school researchers prone to distance themselves from the immediately experienced life world of human beings and to shield off this seemingly mundane and unobtrusive material world by using a variety of idealist concepts, construction management and economics scholars have comparable little problem in delving into, practically speaking, the nuts and bolts of the life world of the interlocutors and the material resources they operate and make use of. Therefore, this essay concurs, what has been declared as a "material turn" (REFS) in social science scholarship would arguably benefit the expertise and skills of construction management and economics scholars.

The remainder of this paper is structured accordingly: First, the concept of materiality will be discussed as an analytical construct, a term that is interrelated to a series of accompanying concepts such as matter, material agency, tinkering and bricolage. Second, the specific case of materiality handled by engineers and the engineering sciences, complicated to reduce to carefully controlled and closely monitored experimental systems such as in the laboratory sciences of e.g. biotechnology and molecular biology, will be discussed. Using the case of aviation engineering examined by Downer (2011, 2007), this section argues that aviation expertise, just as in the case of the construction industry, needs to construct serviceable engineered technologies on the basis of incomplete data and that certain ambiguities and "blind spots" must be tolerated within this field of expertise. In the third section, buildings and the built environment, the *objet propre* of the construction industry and construction management scholarship, will be discussed on the basis of the theoretical premises discussed in the preceding sections. Finally, some implications for the research in the field of construction management and economics are discussed.

Materiality as analytical construct

To sort out all the concepts and categories within a materialist epistemology is beyond the scope and assigned length of this paper. At the same time, to advocate a materialist epistemology demands at least a rudimentary conceptual structure to be able to present an operative framework for fieldwork and to meet analytical ends. In many cases (but not exclusively so), materiality is revealing itself to humans as *technology*: As tools, machines, apparatuses, but also in the form of, say, fertilizers, pesticides or concrete, i.e. engineered substances that can be acted upon to achieve certain objectives. For the sake of simplicity, we emphasize the case of the tool as one instantiation of materiality. The materialist epistemology advocated in this paper is based on two premises: first, materiality needs to be understood within a socio-materiality framework (Orlikowski and Scott 2008); second, the concept of agency is critically re-examined and used to include also non-humans and biological entities.

The socio-materiality of technology and practices

Leonardi (2013, p. 69) defines materiality as "the arrangements of an artifact's physical and/or digital materialist into particular forms that endure across differences in place and time". In addition, Leonardi (2013, p. 69) proposes that in-between the materiality of a specific technology and its ideal end-goals (e.g. a lawn-mover is designed with the explicit goals to produce well-kept lawns at low cost and for the convenience of the user of the lawn-mover), there are always the users' ability to perceive the utility and limitations of the (i.e. a lawn-mover), that is, all technologies and artefacts offer a set of affordances and constraints, a mix of opportunities and limitations. That is, all material objects contain its own specific *technicity* (with Ellul 1964, term), while it is always accompanied by a *performative element* wherein the end-user enacts the technology at hand to suit the agent's interests. Technology studies scholars have named this ability to make use of technology and under certain conditions as *tinkering* (e.g. Franz 2005) or *bricolage* (with Claude Lévi-Strauss's term), but Leonardi (2013, p. 70) introduces the term *material agency* (first used by Pickering 1993, but stretching back to seminal work of e.g. Latour and Woolgar 1979, in turn seated within a French materialist epistemology represented by e.g. Gaston Bachelard and Georges Canguilhem) to denote how the construction of a technology depends on both the materiality per se and on the actor's "perception of whether materiality affords her the ability to achieve her goals or places a constraint upon her".

Seen in this view, where all technologies contain a material and a "perceptual" or "intellectual" component, a technology is never fully self-enclosed, autonomous, or final, but remains dependent on the material agency. Pickering (1993) suggests that the term material agency underlines the fact that technologies such as machines (Pickering examines the case of laboratory equipment used by scientists) are never "things-in-themselves", but that they constitute dynamic and inherently changeable technological ensembles and systems, including both materials and humans:

> Material agency does not … force itself upon scientists; there is, to put it another way, no such thing as a perfect tuning of machines dictated by material agency as a thing-in-itself; or, to put it yet another way, scientists never grasp the pure essence of material agency. Instead, material agency emerges by means of an inherently *impure* dynamics. The resistances that are central to the mangle are always situated within a space of human purposes, goals and plans. (Pickering 1993, p. 577. Emphasis in the original)

As a consequence, laboratory work, closely bound up with the scientist's ability to make use of a variety of technologies for the production of scientific data, organizational routines are precisely the infrastructural arrangements where technologies and social practices are "imbricated", enfolded into one another, Leonardi (2011, p. 151) says: technologies and human practices are thus mutually constitutive but remains essentially irreducible to one another – they remains singular vis-à-vis other resources involved in the work. Leonardi (2013, p. 71) says that a practice is "constituted in equal parts and interactively by materiality of technology and the social context of use". Expressed differently, practices are "sociomaterial" (Leonardi 2013, p. 71), i.e. they are reducible to neither the materiality they employ nor its social components, but can only subsist as an assemblage including both the elements. By implication, work – the recurrent and repetitive activity to perform routines and social practices – needs to be understood on the basis of "sociomaterial (re)configurations" (Orlikowski and Scott 2008, p. 467); these "reconfigurations" do not just "mediate work", but they "perform organizational realities", Orlikowski and Scott (2008, p. 467) argue.

The concept of agency

If materials imply material agency of part of both humans and materials (i.e. they are both assumed to have the capacity to act), the very concept of agency is increasingly separated from its humanist connotations; not only humans are endowed with agency but also material entities being mobilized need to understand in such terms. Rennstam (2012) proposes the term "organizational objects" to denote material entities that (1) "act on behalf of the organization by establishing knowledge relationships in which members are invited in the process of knowing aimed at solving organizational problems", and (2) "act on their own behalf in these processes by resisting certain treatments and accepting others, that it they 'act back.'" Rennstam (2012) reports the case of how electric engineers participating in developing a sophisticated telecommunication device actively use the technology-in-the-making worked on as an organizational object inscribed with such qualities and agencies. In this engineering work, the participants enact material artefacts as a form of "collaborators" or "companions" that per se can be inscribed with certain qualities that enable or inhibit communication and progression in the product development work. Using Knorr Cetina (1999) concept of *epistemic things*, a term that denotes scientific constructs (say, an enzyme or a protein) that are not yet fully known and mapped into models and images and yet serve as a vehicle for ongoing scientific investigations, Nicolini *et al*. (2012, p. 618) suggest that (organizational) objects embody "what one *does not yet know*". For the telecom engineers studied by Rennstam (2012), the telecom technology device was in a stage of being stabilized and enclosed, but in the meantime it served as an epistemic thing inasmuch as it enabled ongoing communication and interactions between the engineers, each working on their own product development and design problems. Expressed differently, organizational objects are "materialized knots of practical knowledge" (Preda 1999, p. 356): they both embody the state-of-the-art know-how per se, and serve the vehicle for the further advancement of such know-how; they are simultaneously the ends and the means in e.g. engineering work.

A few detailed empirical studies examine how organizational objects are worked upon practically, but the work of Downer (2007, 2011) provides detailed insights into the work of aviation engineers and how they cope with certain technological challenges in the airline industry. In the following, before we turn to the question of the built environment being the domain of expertise of construction management and engineering scholars, Downer's treatment of materiality in aviation engineering will be examined.

Engineering materiality: the case of safety concerns in aviation engineering

Downer (2007) argues that engineering work differs from the laboratory sciences as there are few possibilities for recreating or simulating the full complexity of nature in the engineering work. Instead, engineers need to combine a variety of methods and data-sets to stitch together the best possible design of the artefact given the practical limitations of available methods. "Where scientists modeled simple shapes in the laboratory", Downer (2011, p. 747) says, "engineers had to work with complex forms", and therefore it is "difficult to extrapolate 'science' to 'practice'". That is, engineers rely on a combination of actual data (collected in e.g. "the black boxes" of airline carriers, vigorously sought for in the case of airplane crashes to be able to reveal the unfortunate event in detail), laboratory tests, simulations *in silico* (i.e. "in the computer") and calculative practices: "Engineers cannot perfectly reproduce the 'real world' in their laboratories, in other words, so they must reduce its variables and make subjective judgment about which is relevant" (Downer 2011, p. 748). "Engineering is the art of compromise", Petroski (1996, p. 3) says, "and there is always role for improvement in the real world. But engineering is also the art of the practical; engineers realize that they must at some point curtail design and begin to manufacture or build".

Regardless of this ability to combine and mix methods and data-sets, the design work of e.g. aviation engineers is always "laden with unavoidable ambiguities", Downer (2007, p. 8) says. These ambiguities escape the engineers' attention until deficiencies in the design of the airplane reveal themselves in incidents or even fatal failures. Such failures to anticipate and handle all possible aeronautic events do not suggest that engineers are irrational or fail in their attempts to develop a technology, but rather indicate that the engineering sciences by the end of the day are located "in the wild" – in the actual world where all contingencies and conditions cannot be calculated. Downer (2011) refers to accidents that occur in the "white spots" on the aviation engineer's map as *epistemic accidents* – accidents that cannot be anticipated because the data needed to conduct the design needed to handle the new situation only materialize *ex post facto*. This is the demon of the aviation engineer, that no matter how hard they try to anticipate and respond to possible (but unlikely, statistically speaking) events pertaining to both human and technological and material conditions, they can only learn and reconstruct a full picture of the event when it is always already too late. By implication, today's remarkably high safety levels in the aviation industry are indebted to the historical events from which aviation engineers have learned many valuable lessons; without them, we wouldn't know how to make airplanes better and safer. If the adage, "one learn from one's mistakes", is true someplace, it is in aviation engineering.

Engineers are rightly acclaimed for their ability to develop and maintain advanced technological systems, but the public image of engineering as a flawless and autocratic dominance over these technological systems and, by implication, nature as such (e.g. the "shrinking of geographic distance" in the case of aviation engineering, where the distance from, say, New York to Sydney is now primarily measured in hours – and not days or weeks – and not even in miles) belies the "messy reality" that engineers handle in their day-to-day work. In this everyday practice, Downer (2011, p. 740) says, experts operate "with high levels of ambiguity and routinely making uncertain judgments":

> "Engineering," as the civil engineer A.R. Dykes once put it, "is the art of modeling materials we do not wholly understand into shapes we cannot precisely analyze so as to withstand forces we cannot properly assess, in such a way that the public has no reason to suspect the extent of our ignorance" (speech to British Institution of Structural Engineers, 1976). (cited in Downer 2011, p. 745)

Albert Camus's insightful comment, "One cannot create experience, one must undergo it" (cited in Downer 2011, p. 758), is thus both a slogan and credo for engineers. Engineers operate in the borderland between "science" (which demands reproducibility and full control over the experimental system) and "practice" (which denote the skills to practically accomplish technology-mediated services, including airplane flights, train journeys, or provide electricity through the socket or water through the tap), and yet this domain cannot be properly reduced to either component, leaving engineers with a set of practices, methods, algorithms, etc., to accomplish their work as good as they are capable of and on the basis of incomplete data and ambiguities. In his summary, Downer (2011) extends this general insight regarding aviation engineering to be a valid proportion for all sorts of "man-made systems", and make the concept of *judgment* a key engineering skill:

> All man-made systems, from oil refineries to financial models and pharmaceuticals, are built on theory-laden knowledge-claims that contain uncertainties and ambiguities. Constructing such artifacts requires judgments: judgments about the relevance of "neat" laboratory knowledge to "messy" environments, for instance, or about the similarity between tests and the phenomena they purport to represent. These judgments are usually buried deep in the systems themselves, invisible to most users and observers. Yet these are always present, and to varying degrees, they always hold the potential of "surprise." (Downer 2011, p. 758)

This predicament, to operate in a domain riddled by incomplete data and an indeterminate level of ambiguity, is also familiar for construction engineers and managers and the scholarship derived from their practices. While collapsing factories and bridges swinging wildly in hurricanes are indicative of the failures of construction engineering (or mere fraud in cases where some buildings may be erected with impunity and regardless of existing policies, industry standards, and expert recommendations); the failures of the construction industry are rarely as spectacular as in the aviation industry. Poorly designed or built constructions may instead fail too early or be too costly to complete (the project management literature abounds with cases of "failed construction projects," including a series of airport renewal projects), or otherwise demonstrate shortcomings that does not translate into losses of human lives. Nevertheless, as simultaneously being material artefacts and technological systems, the buildings are designed, constructed and maintained on the very same basis as airplanes; they are constructed and built in the intersection between science and practice, and ambiguities that follow therefrom needs to be accommodated by both relevant practices and scholarly theoretical frameworks.

Buildings as technology

Corbusier (1946) defined a building (a "house") as a "*machine-à-habiter*", a "machine for living" (as a matter a fact, a chair was similarly defined as "machine for sitting"). This declarative statement is certainly part of the famous Swiss architect's modernist project to associate the built environment with the overarching culture of the post-Second World War machine age, but it is also indicative, following from Downer's (2007, 2011) analysis of engineering work, of how buildings are part of an advanced late modern infrastructure including the flows and circuits of electricity, water, information, traffic and not the least humans. To balance all these agencies and affordances was one principal challenge for Le Corbusier and architect of his and later generations, Rankin (2010) argues:

> For Corbusier … the problem of modern architecture was finding the socially optimal balance between individual autonomy and the rational (repressive) logic of the machine age. As Le Corbusier argued from the 1920s through the end of his life, the architect's role was that of an enforcer: "We must create the mass-production spirit. The spirit of constructing mass-production houses. The spirit of living in mass-production houses." (Rankin 2010, p. 791)

Mass production is intimately associated with the idea of machines and their ability to produce standardized commodities, but the machine per se is, as Canguilhem (2008, p. 8) remarks, the distinguishing mark of human accomplishment and their ability to master nature and the forces of energy: "In a sense, nothing is more human than a machine, if it is true that man distinguishes himself from animals through the construction of tools and machines". However, regardless of anthropocentric images of machines and machinery, Pickering (1995, p. 7) argues that a machine is "the balance point, liminal between the human and nonhuman worlds (and liminal too, between the worlds of science, technology, and society)". Part materiality, part human ingenuity, partially a passive technological artefact and partially an animated, almost vital entity endowed with agency, the machine is in the intersection between humans and their life world. While common sense thinking is prone to enact machines (and technology more broadly) as what remain within our full control and to portray humans as indubitably being the master of the technology they have invented, some scholars suggests a more collaborative and mutually constitutive view of human–technology interactions: "We construct our technologies, and our technologies construct us and our times. Our times make us, we make our machines, our machines make our times. We become the objects we look upon but they become what we make of them", Sherry Turkle (1995, p. 46, cited by Valentine 2000, p. 28) says. To assume that humans are the masters of technology and being capable of keeping it within full control is an anthropocentric fallacy, Turkle and others insist being little more than a flattering assertion that human autonomy remains within its *Umwelt*. Unfortunately, such claims do not really hold water on closer inspection. Instead, humans have at best a partial understanding of how technology affects their everyday lives, and many technologies remain ambiguous, unexplored or even to some extent mysterious to the everyday users.

In the domain of construction management and engineering, and architecture, Winston Churchill's famous statement, "We shape our buildings, and afterwards our buildings shape us" (cited in Brand 1994, p. 3), is exemplary of how materiality informs human lives. At the same time, it is only in hindsight and with the help of historians – the professional group carrying the burden and serving the social function to remind their fellow humans of what "they wish to forget", in Eric Hobsbawm's account (cited in Judt 2015, p. 28) – that we as humans are capable of seeing how e.g. the built environment qua materiality profoundly shape and constitute human lives. For instance, Schivelbusch (1986) stress how the visual affordances of the railway technology translated into a new architectural regime based on heightened visibility – a form of "esthetics of transparency" – that would be the leitmotif for the most of the twentieth century, the century of visuality or even voyeurism *per excellence*:

> The railroad reorganized space. In architecture, a similar reorganization occurred with the introduction of glass and steel as new building materials. The railroad machine ensemble, multiplied (speed and capacity of traffic; steel and glass multiplied the capacity of roofed structures. Both the railroad and the glass buildings were direct expressions of the multiplied productivity brought about by the industrial revolution. The railroad brought new quantities of goods into circulation; the edifices of glass architecture – railroad stations, market halls, exhibition palaces, arcades – served as places of transit and storage. The spatial capacity of glass architecture stands in a similar relation to the capacity of traditional architecture as the railroad's capacity stands to that of preindustrial transportation. (Schivelbusch 1986, p. 45)

In Schivelbusch's (1986) view, the infrastructure and transportation technology of the railways, perhaps the defining mark of the industrialized world together with the telegraph system, coincided with Georges-Eugène Haussmann's new city outline project and the development of the *Grands Magasins* in Paris, the extravagant and luxurious department stores (e.g. *Bon Marché*, *Printemps*, *Samaritaine*), wherein technological transport systems were bound up with the idea of a new visuality (see e.g. Crary 1990):

> While Haussmann transformed the old Paris into a new city of flowing traffic, a similar change was taking place in the realm of retail business. In 1852, Aristide Boucicaut opened the first Parisian department store, the Bon Marché. The similarity was not coincidental: the department store, as a new form of retail merchandising, was predicated on a well-developed intra-urban traffic system … As Haussmann's traffic arteries were connected to the rail network by means of the railway stations, and thus to all traffic in its entirety, the new department stores, in turn, were connected to the new intra-urban arteries and their traffic-. The *Grands Magasins* that arose during the second half of the nineteenth century were concentrated on the boulevards that supplied them with goods and customers. (Schivelbusch 1986, p. 188)

Rappaport (1995, p. 131) adds, speaking about Gordon Selfridge's department store in London, that the new temples of consumption of the Victorian era were in many cases associated with female passivity and consequently denigrated as a "wasteful, indulgent, immoral, and possibly disorderly female pleasure". The department stores effectively exploited such moralist beliefs and portrayed the shopping experience at the new department stores as being a sensual and pleasurable experience, at times even bordering to a form of emancipatory practice for the upper-class and middle-class women they targeted in their marketing:

> Shopping was advanced as pleasurable and respectable precisely because of its public setting, which Edwardian business presented as a context for female self-fulfillment and independence. Selfridge addressed women not only as urban actors but also as bodies to be satisfied, indulged, excited, and repaired. Shopping, he repeatedly stated, promised women access to a sensual and social metropolitan culture. (Rappaport 1995, p. 131)

Speaking about the built environment as a form of materiality bound up with material agency and affordances that demands the presence of and collaboration between humans and materiality, the department stores are exemplary in how they emerged at the intersection between engineering projects and modernization ideologies and various movements, social changes and reforms. These included an emerging feminist sentiment that women and their pastimes after all deserved to be taken seriously and to be regarded as being something different than some kind of supplement to the *pater familias*. In this case, a number of novel ideas regarding city planning, transportation, visuality, consumption, emancipation and public life more generally both propelled the development of the department stores at the same time as these newly constructed buildings served as the vehicles for such modernist beliefs, political programmes and reforms. The department stores, dominating the era between the 1830s and 1990s (after that, many famous department stores including Paris's Samaritaine and Chicago's Marshal Field's closed down), were "machines for shopping" (with Goss 1993, p. 33, apt phrase) and yet they were many other things at the same time: Engineered spaces, aesthetic environments (the stained glass *cupole* of Printemps in Paris being one remarkable case of industrial art), sites of political and emancipatory projects, social spaces, symbols of modernist progressivism, etc.

A more recent innovation in the built environment pertaining to both retailing and social and economic progress is the North American innovation of the shopping mall. While the department store is closely bound up with the European inner-city, urban bourgeoisie, the shopping mall bears the distinguishing mark of the American way of life and the American dream, structured around salaried work, increasingly higher living standard, mass consumerism, a suburban way of life and automobility (i.e. the private ownership of cars). Despite being an conspicuous mark of Americanism, it was the Austrian immigrant Victor Gruen that developed the shopping mall concept (Hardwick 2004, Wall 2005), and marketing researchers still refer to the ability to transform "task-oriented buying" into "less focused shopping experience" as "the Gruen effect" – the ability to induce "a dreamlike state in which consumers lose track of time and space" (Csaba and Askegaard 1999, p. 36). In the North American setting and way of life, materializing over the course of the twentieth century, the shopping mall became a social sphere and one of the obligatory passage points of American life. Countless Hollywood feature films include scenes from malls and shopping centres, being a form of built-in plaza or arcade protecting the consumers from meteorological conditions (freezing cold or scorching heat dependent on location and season), social malaises such as street crime and visual poverty, and equipped with shops, restaurants and cafes, and recreation possibilities (including e.g. ice skating rinks or even roller-coasters). In Goss (1993, p. 33) account, this built environment employs "crude, but very effective" behaviourist principles to guide the visitors through the facilities and to make them spend as much time (and, by implication, money) as possible at the mall. That is, Goss (1993, p. 35) continues, the shopping mall is a "strategic space, owned and controlled by an institutional power, which, by its nature, depends upon the definition, appropriation and control of territory". The built environment is not a neutral ground or some "public space" in the conventional sense of the term; it is a fabricated space that enfolds architectural and engineering expertise with marketing and retailing and know-how to engender a comfortable and even pleasurable experience at the same time as the ROI per square metre/feet carefully monitored and hopefully maximized. Expressed differently, the shopping mall is a material and technological system that enables certain material agencies and provides certain affordances, but these agencies and affordances are thoroughly regulated, monitored and modified to accomplish the goals and objectives of the owners of the shopping mall, in many cases real estate conglomerates and consortia.

In these two cases, of the Victorian and the Edwardian department store and the post-Second World War shopping mall, the latter being closely entangled with the automobile as an iconic mass consumption symbol and American way of life entitlement, the built environment is simultaneously mirroring wider social changes and transformations and serves as the very vehicle for and a mechanism supporting such changes. In addition to this view of the built environment on the macro or mesoscale, there are several studies of how materiality inform and structure individuals' uses of buildings. For instance, Pallasmaa (1996, p. 40), an architecture theorist, stresses how humans perceive the building with and through their bodies and thus advocate what Merleau-Ponty (1964) referred to as "the primacy of perception". In this view, a seemingly mundane and unspectacular artefact as a door-handle becomes an almost animated object that the visitor first encounters when entering the building:

> The door handle is the handshake of the building. The tactile sense connects us with time and tradition: through impressions of touch we shake the hands of countless generations. A pebble polished by waves is pleasurable in the hand, not only because of its shape, but because it expresses the slow process of its formation; a perfect pebble on the palm materializes duration: it is time turned into shape. (Pallasmaa 1996, p. 40)

Speaking in less philosophical terms, but recognizing the role of buildings in human beings' lives, Gieryn (2002, p. 35) says that "buildings stabilize social life"; they "give structure to social institutions, durability to social networks, persistence to behavior patterns". In this view, buildings "solidify" society against time and its "incessant forces for change" (Gieryn 2002, p. 35). With Latour (1991), we can say the buildings are "society made durable". That is, buildings serve the exact opposite function of *fashion*. In fashion theory, the social function of fashion is to resolve paradoxes (see e.g. Barnard 2007), to impose a sense of change and transience while in fact life is essentially repetitious and to enable possibilities for individualism and personal expression within a regime of social conformity:

> Fashion is the discrete solution of the subtle conflict. The slight changes from the established dress or other forms of behaving seem for the moment to give the victory to the individual, while the fact that one's fellows revolt in the same direction gives one a feeling of adventurous safety. (Sapir, [1931] 2007, p. 40)

Fashion is thus associated with playfulness, change, creativity, individualism and escapism. Buildings, in contrast, Gieryn (2002) says, serve to neutralize this ceaseless change of time; they stabilize and render what is fluid and ephemeral fixed and solid. Yet, Gieryn (2002, p. 35) continues, buildings share with fashion – its counterpoint – the quality of being what occurs or sits "between agency and structure". Just like fashion may seem restlessly fluid and changeable, separated from more deep-seated social norms and beliefs, or at least playfully transcending or ignoring such norms while in fact being closely dependent on such norms and beliefs to make sense at all in the first place, so too must buildings become immutable and concrete structures, at times taken for granted or simply being overlooked, as everything else is in flux. For instance, Gieryn (2002, pp. 38–39) continues, once buildings are completed, they conceal all the possibilities that *did not* materialize, and they mute or bury "the interests, politics, and power" that shaped the design that *did* materialize. Once buildings are erected, they, practically speaking, as vernacular language let us to say, "are what they are". Therefore, Gieryn contends, buildings qua material and technological artefacts must be unconcealed so that the analyst can fully understand under what terms and conditions the building in question in fact did materialize – a form of scholarly inquiry into the mysteries of the built environment humans inhabit and make use of:

> Buildings are technological artefacts, made material objects, and humanly constructed physical things. To see them this way brings buildings within the compass of a promising theoretical orientation developed initially for the study of machines. The focus is on the recursive qualities inherent in technological artefacts, at once, the produce of human agency and a stable force for structuring social actions. Buildings, as any machine or tool, are simultaneously the consequence and structural cause of social practices. (Gieryn 2002, p. 41)

For construction management and engineers, this statement includes nothing surprising or contains few provocative declarations. This is simply how buildings are understood. Yet this very idea, that materiality per se deserves to be theorized and properly understood demands an elaborate vocabulary and analytical tools that the social sciences can offer, at least the branch of the social sciences that now has started to take materiality seriously.

Discussion

As all construction management scholars know on the basis of disciplinary training, materiality *do* matter (neither pun, nor pleonasm intended). The social world as taken for granted, our life world is composed by a variety of material resources and are shaped by material conditions, whereof some remain under the full control of humans while other do not. This manifold of material conditions in turn represent what Garfinkel (1988) refers to as "a plenum of agencies", a number of actors and actants (in the actor-network theory vocabulary) that both *acts* and *are acted upon*. To consider this plenum of agencies, Cooren (2006, p. 85) argues, "[r]equires that we take into account all human and nonhuman entities that, day by day, contribute to its building and organizing". Construction management and economics scholars do and should further exploit the capacity to examine materiality as a free-standing, yet socially embedded and socially enacted resource. Moreover, such an analysis can move "from the bottom up", starting perhaps with how e.g. new building materials interact with e.g. biological organisms such as algae, mould and fungus when it is practically mounted onto façades of buildings (especially in a cold and damp climate such as in Scandinavia), and potentially ending in e.g. urbanist debates about how e.g. so-called signature buildings are indicative of wider socioeconomic, political and institutional changes in competitive capitalism. This most diverse research programme is unified by a recognition of the term materiality and an understanding that materials are never as inert and passive as we humans are accustomed to think, but it is capable of executing its own idiosyncratic agency, which in turn call for further social action including e.g. new policies, reforms and protocols. More specifically, a materiality research agenda may include the study of how new technological and building standards, measuring techniques and new materials development are developed and institutionalized in the construction industry. Other issues may include the study of how new architectural designs are propelled by the development and use of e.g. advanced computer technologies and other visual and digital media, or how public and semi-public spaces (in e.g. shopping malls) are modified when e.g. consumerism changes now when online shopping account for an increasingly larger share of the retailing industry.

This type of research work is already conducted today and reported in journals such as *Construction Management and Economics*, but to make an even more explicit contribution to the mainstream management studies and organization theory field, construction management and economics scholar may benefit from exploiting their intimate and detailed understanding of the built and material environment by articulating analytical and theoretical frameworks that even better serve to bring out the details of the empirical material already being collected. That is, theories of materiality and its wide-ranging recognition hold the promise to increase the level of e.g. construction industry studies in mainstream journals. To date, given the fact that the construction industry is the second-largest sector most OECD economies rivaled only by the health care sector, there is a surprising sparse representation in the so-called top tier journals, in the ABS 4* journals and elsewhere. A more comprehensive recognition of materiality as analytical concept and research practice vehicle may arguably change this condition.

Conclusion

Buildings, houses, freeways, parks and other elements of the built environment are all immutable structural and infrastructural objects and systems that are simultaneously (and seemingly paradoxical) both conspicuous and ignored and overlooked; humans sense and perceive their *Umwelt* but to minimize the energy consumed to navigate in such environments, the physical world are quickly reduced to a series of standardized and embodied routines, including way of walking, standing and sitting (de Certeau 1984). This behavioural optimization of the energy humans need to spend when walking in this built environment, a consequence of sheer biological necessity (Ravaisson [1831] 2008) easily misleads also academic scholars to assume that this built environment per se is unworthy of more detailed attention and/or intellectual investigation. If only scholars were more willing to recognize the plenum of agencies that are contained in these structural and infrastructural objects and systems, concealed by the human needs to render them precisely as passive and inert matter to be able to concentrate on other activities and objectives, they would be surprised to learn that also the most seemingly trivial and mundane technology or device embodies elements of human ingenuity, inventiveness and components derived from the institutional and cultural surrounding wherein the technology is located. Mundane and unspectacular technologies such as a door-closer (Latour 1991) or a paper clip (Petroski 1996) naturally induce less enthusiasm than, say, a space shuttle (Vaughan 1996) or a nanobot (Bensaude-Vincent 2007), but they too are constitutive of the contemporary society and everyday life of humans. Thus, the capacity "to see the world in a grain of sand, and eternity in an hour" (as William Blake's beloved poem puts it) is a skill and virtue that scholars intrigued by materiality as analytical construct and practical accomplishment should nourish.

Disclosure statement

No potential conflict of interest was reported by the author.

References

Barnard, M., ed., 2007. *Fashion theory: a reader*. London: Routledge.

Bensaude-Vincent, B., 2007. Nanobots and nanotubes: two alternative biomimetic paradigms of nanotechnology. *In*: J. Riskin ed. *Genesis redux: essays in the history and philosophy of artificial life*. Chicago, IL: University of Chicago Press, 211–236.

Berger, P. and Luckmann, T., 1966. *The social contruction of reality*. London: Penguin.

Black, D., 2014. An aesthetics of the invisible: nanotechnology and informatic matter. *Theory, culture and society*, 31 (1), 99–121.

Brand, S., 1994. *How buildings learn: what happens after they're built*. London: Viking.

Canguilhem, G., 2008. *Knowledge of life*. Trans. by S. Geroulanos and D. Ginsburg. New York, NY: Fordham University Press.

Coole, D., Frost, S., 2010. Introducing the new materialisms. *In*: D. Coole and S. Frost, eds. *New materialisms*. Durham, NC: Duke University Press, 1–43.

Cooren, F., 2006. Organizational world as plenum of agencies. *In*: F. Cooren, J.R. Taylor, and E.J. Van Every, eds. *Communication as organizing: empirical and theoretical explorations in the dynamic of text and conversation*. Mahwah, NJ: Lawrence Erlbaum, 81–100.

Corbusier, L., 1946. *Towards a new architecture*. Trans. by F. Etchell. London: The Architectural Press.

Crary, J., 1990. *Techniques of the observer: on vision and modernity in the nineteenth century*. Cambridge: The MIT Press.

Csaba, F.F. and Askegaard, S., 1999. Malls and the orchestration of the shopping experience in a historical perspective. *Advances in consumer research*, 26, 34–40.

de Certeau, M., 1984. *Practices of everyday life*. Berkeley, CA: University of California Press.

Downer, J., 2007. When the chick hits the fan: representativeness and reproducibility in technological tests. *Social studies of science*, 37 (1), 7–26.

Downer, J., 2011. "737-Cabriolet": the limits of knowledge and the sociology of inevitable failure. *American journal of sociology*, 117 (3), 725–762.

Ellul, J., 1964. *The technological society*. New York, NY: Vintage.

Franz, K., 2005. *Tinkering*. Philadelphia, PA: University of Pennsylvania Press.

Garfinkel, H., 1988. Evidence for locally produced, naturally accountable phenomena of order, logic, reason, meaning, method, etc. in and as of the essential quiddity of immortal ordinary society, (I of IV): an announcement of studies. *Sociological theory*, 6, 103–109.

Gieryn, T.F., 2002. What buildings do. *Theory and society*, 31 (1), 35–74.

Goss, J., 1993. The "magic of the mall": an analysis of form, function, and meaning in the contemporary retail built environment. *Annals of the association of American geographers*, 83 (1), 18–47.
Hardwick, M.J., 2004. *Mall maker: Victor Gruen, architect of an American dream*. Philadelphia, PA: University of Pennsylvania Press.
Harty, C., 2005. Innovation in construction: a sociology of technology approach. *Building research and information*, 33 (6), 512–522.
Judt, T., 2015. Downhill all the way. *In*: *When the facts change: essay 1995–2010*. London: William Heineman, 13–29.
Knorr Cetina, K., 1999. *Epistemic cultures: how sciences make knowledge*. Cambridge: Harvard University Press.
Latour, B., 1991. Technology is society made durable. *In*: J. Law, ed. *A sociology of monsters: essays on power, technology and domination*, 103–131. London: Routledge.
Latour, B. and Woolgar, S., 1979. *Laboratory life: the construction of scientific facts*. Princeton, NJ: Princeton University Press.
Lees, T. and Sexton, M., 2014. An evolutionary innovation perspective on the selection of low and zero-carbon technologies in new housing. *Building research and information*, 42 (3), 276–287.
Leonardi, P.M., 2011. When flexible routines meet flexible technologies: affordances, constraints, and the imbrications of human and material agencies. *MIS quarterly*, 35 (1), 147–167.
Leonardi, P.M., 2013. Theoretical foundations for the study of sociomateriality. *Information and organization*, 23 (2), 59–76.
Merleau-Ponty, M., 1964. *The primacy of perception and other essays on phenomenological psychology, the philosophy of art, history and politics*. Trans. by J.M. Edie. Chicago, IL: Northwestern University Press.
Nicolini, D., Mengis, J., and Swan, J., 2012. Understanding the role of objects in cross-disciplinary collaboration. *Organization science*, 23 (3), 612–629.
Orlikowski, W.J., 2010. The sociomateriality of organisational life: considering technology in management research. *Cambridge journal of economics*, 34, 125–141.
Orlikowski, W.J. and Scott, S.V., 2008. Sociomateriality: challenging the separation of technology, work, and organization. *The academy of management annals*, 2 (1): 433–474.
Orstavik, F., 2014. Innovation as re-institutionalization: a case study of technological change in housebuilding in Norway. *Construction management and economics*, 32 (9), 857–873.
Pallasmaa, J., 1996. *The eyes of the skin: architecture and the senses*. London: Academic Press.
Petroski, H., 1996. *Invention by design: how engineers get from thought to thing*. Cambridge: Harvard University Press.
Pickering, A., 1993. The mangle of practice: agency and emergence in the sociology of science. *American journal of sociology*, 99 (3), 559–589.
Pickering, A., 1995. *The mangle of practice*. Chicago, IL: The University of Chicago Press.
Preda, A., 1999. Turn to things: arguments for sociological theory of things. *The sociological quarterly*, 40, 347–366.
Rankin, W.J., 2010. The epistemology of the suburbs: knowledge, production, and corporate laboratory design. *Critical inquiry*, 36, 771–806.
Rappaport, E.D., 1995. 'A new era of shopping': the promotion of women's pleasure in London's West End, 1909–1914. *In*: L. Carney and V.R. Schwartz, eds. *Cinema and the invention of modern life*. Berkeley, CA: University of California Press, 130–155.
Ravaisson, F., (1831) 2008. *Of habit*. London: Continuum.
Rennstam, J., 2012. Object-control: a study of technologically dense knowledge work. *Organization studies*, 33 (8), 1071–1090.
Robinson, W.G., Chan, P.W., and Lau, T., 2016. Sensors and sensibility: examining the role of technological features in servitizing construction towards greater sustainability. *Construction management and economics*, 34 (1), 4–20.
Rose, N., 2013. The human sciences in a biological age. *Theory, culture and society*, 30 (1), 3–34.
Sapir, E., (1931) 2007. Fashion. *In*: M. Barnard, eds. *Fashion theory: a reader*. London: Routledge, 37–45.
Schivelbusch, W., 1986. *The railway journey: the industrialization and perception of time and space in the 19th Century*, Leamington Spa: Berg.
Tryggestad, K. and Georg, S., 2011. How objects shape logics in construction. *Culture and organization*, 17 (3), 181–197.
Tryggestad, K., Georg, S., and Hernes, T., 2010. Constructing buildings and design ambitions. *Construction management and economics*, 28 (6), 695–705.
von Uexküll, J., 2001. An introduction to Umwelt. *Semiotica*, 134, 107–110.
Valentine, J., 2000. Information technology, ideology and governmentality. *Theory, culture and society*, 17 (2), 21–43.
Vaughan, D., 1996. *The challenger launch disaster: risky technologies, culture, and deviance at NASA*. Chicago, IL: The University of Chicago Press.
Wall, A., 2005. *Victor Gruen: from urban shop to new city*. London: Actar.
Walter, L. and Styhre, A., 2013. The role of organizational objects in construction projects: the case of the collapse and restoration of the Tjörn Bridge. *Construction management and economics*, 31 (12), 1172–1185.
Whyte, J. and Lobo, S., 2010. Coordination and control in project-based work: digital objects and infrastructures for delivery. *Construction management and economics*, 28 (6), 557–567.
Whyte, J.K., *et al.*, 2007. Visual practices and the objects used in design. *Building research and information*, 35 (1), 18–27.
Woodward, J., 1965. *Business organization: theory and practice*. Oxford: Oxford University Press.
Woolf, V., (1929) 2004. A room of one's own. *In*: T.J. Wren, D.A. Hicks and T.L. Price, eds. *Traditional classics on leadership*. Cheltenham: Edward Elgar, 113–123.