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Introduction

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Historically, two very different and yet inseparable impulses have shaped modern business: a quest for more efficient production and the pursuit of competitive advantage through novelty and innovation. Production is typically carried out in enterprises whose survival depends on offering goods and services for which alternatives may be available from a range of competing suppliers. To survive and flourish under such circumstances, enterprises have to make efforts, for example, to reduce prices (by avoiding waste and increasing productivity) and/or to create novel value propositions (by innovating). Although these fundamental agendas are certainly not mutually exclusive, embracing innovation encompasses much more than addressing production and distribution inefficiencies. In his early theory on economic development, the Austrian-American economist Joseph A. Schumpeter suggests that what really counts is the competition from new commodities, new technology, new sources of supply, and new types of organization (Schumpeter 1983). Unlike gradual efficiency improvements, he reiterates in a later work, that innovation 'strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives'. If price competition is comparable to forcing a door, then innovation is more like bombardment, he proclaims (Schumpeter 1976).

However, to succeed in *realizing* innovations is difficult, 'first, because they lie outside of the routine tasks which everybody understands' and 'secondly, because the environment resists in many ways that vary, according to social conditions, from simple refusal either to finance or to buy a new thing, to physical attack on the man who tries to produce it' (Schumpeter 1976). Even though Schumpeter saw that innovation-based competition was becoming institutionalised as 'technological progress is increasingly

becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways', he still maintained that the resistance to innovation based on economic interests vested in the established order would never go away (Schumpeter 1976). Accordingly, when considering construction and the production of the built environment in modern societies, he in the same text noted that vested interests and the weight of tradition in a very significant way stifled innovation, representing 'the great obstacle on the road toward mass production of cheap housing which presupposes radical mechanization and wholesale elimination of inefficient methods of work on the plot'.

As pointed out by Loosemore in Chapter 5 in this volume, a simple linear model of innovation has often dominated thinking about construction innovation in public policy, in academic institutions and in industry organizations and firms. In this linear model, results from scientific research and technological development are supposed to feed into commercial activities and drive industrial development and growth (Stokes 1997). This model of innovation is seen by many as inextricably linked to Schumpeter's theories and his notion of the entrepreneurial function in capitalist economies (Pavitt 2005). Arguably, this model forms a set of implicit premises when it is contended that the construction industry has a troubled record of innovation for growth and competitiveness. This is a recurring theme in the literature on construction. The problem is seen as a lack of willingness to adopt novel results from scientific research and technological development, and even more generally, an inability or unwillingness to learn (e.g. Egan 1998; Lapatner 2007).

Several recent contributions have, however, problematized this view and have pointed out the importance of recognising the varied nature and effects of innovation. For example, in their comprehensive work on the management of innovation, Tidd and Bessant (2013) espouse a process view of innovation, one of 'turning ideas into reality and capturing value from them' (p. 21). They see innovation as far more than the generation of new ideas. Innovation also encompasses the need to carefully select the ideas with potential, to implement them and to capture value from them. Process-oriented research on innovation, such as documented in contributions by Van de Ven et al. (1989, 1999), also shows that innovation does not follow linear pathways and is generally marked by ambiguity and discontinuity. Innovation is often very costly in part because organizations have to reframe their approach to reflect the new circumstances that result from the innovation efforts themselves. Beyond this, innovators and those affected by innovation will also learn to anticipate effects. Hence, reflexivity enters into innovation processes, which means that actions and decisions can be understood only contextually and in a temporal framework. All this serves to emphasise the need to consider innovation as a complex phenomenon and to develop alternatives to the simple linear model that has dominated much of the innovation discourse. Much remains before innovation in construction is adequately understood, and so different standpoints and models should be explored in research.

Construction Innovation: Concepts and Controversies

The doubts found in some of the research literature regarding the validity of the broad generalization that construction sector stakeholders are reluctant to innovate and to learn new and efficient ways of building (Winch 2003; Abbott et al. 2007; Whyte and Sexton 2011) does not overshadow the overall impression created by industry experts and policy-makers that it is the culture and/or the structural composition of the industry that explains its reluctance to innovate. This perception is compounded by the sector lagging behind other sectors when measured against traditional innovation metrics (NESTA 2007) and commentaries on innovation found within sector reform reports. The most recent UK report – the *Industrial Strategy for Construction* (BIS 2013) – suggests that around two-thirds of construction contracting companies fail to innovate. Indeed, aspects of the production of the built environment have been referred to as ‘backwards’ (Woudhuysen and Abley 2004) and parts of it even as ‘degenerate’ (Silber 2007). It may be that since Schumpeter himself made known his views on the challenges of innovation in the construction and building sector, a suspicion has lingered that the industry is in the grips of particular stakeholder interests that uphold the status quo at the expense of the industry as a whole and of society. It would seem, therefore, that significant challenges remain in terms industrial organization and innovation (Manseau and Seaden 2001).

Signs of insufficient performance in the construction sector are not hard to find, with quality and safety problems, numerous bankruptcies and projects often running late and over budget (Flyvebjerg, Bruzelius, and Rothengatter 2003; Williams 2005). Similarly, there are examples of practices that endure virtually unchanged over years in spite of obvious issues with quality and performance and of indications that compliance with minimum quality requirements in building codes is routinely treated as ‘best practice’ by constructors (Orstavik 2014; see also Chapter 6 in the present volume). Still, novel materials, new business models and new ways of designing built objects are emerging, demonstrating that much creative problem solving and local innovation is actually going on in the sector. Also, tangible results of much creative work remains hidden inside projects and fails to translate across other projects and diffuse more widely (Dubois and Gadde 2002; Abbott et al. 2007). As has been pointed out by Slaughter (1993, 1998, 2000), successful innovation requires a deeper consideration of the social and organizational contexts in which it is located. Such complexity renders the evaluation and quantification of innovation in construction difficult, so traditional metrics such as research and development (R&D) expenditure and patent rates are arguably poor proxies for the actuality of innovation in the sector. Also work by both NESTA (Halkett 2007) and Barrett et al. (2007) has suggested that innovations in service provision or microlevel project innovations developed through interactions between construction companies, consultants and clients are often not picked up by others. What emerges here, again, is a highly complex and contested arena both for defining innovation and for establishing appropriate metrics, and

one that demands a plurality of different perspectives if it is to be understood within the multiple and diverse contexts that make up the construction sector.

Perspectives on Construction Innovation

In trying to open up a more pluralistic perspective on construction innovation, we have sought to include in this volume contributions that mobilise theoretical frameworks as structuring devices or as lenses necessary to bring forth productive interaction and reflection between differing positions. The point here is that we have sought to avoid privileging any particular position over others, instead making clear that concepts can be understood differently. This being said, there are some important points of departure that underpin the contributions of this text. First, we contend, much as Schumpeter did in his early theory, that innovation should be considered more than a purely economic phenomenon. Second, an essential feature of innovation is that it is maintained through dynamic value creation efforts. In fact, innovation can be defined as humanly created changes in established approaches to value creation. We prefer using the term *value creation* rather than *production*, to avoid narrow interpretations of this term. However, the term *value creation* will often be synonymous with the term *production* in discussions and theories about innovation. A third underpinning consideration is that value creation invariably concerns human work, combining diverse elements into ‘new combinations’. These are not necessarily ‘things’ in the sense of tangible objects but anything that human beings care to combine into entities because they think these have value of some kind. ‘New combinations’ is, of course, a term also used by Schumpeter, and we agree with Drejer (2004) that there is nothing in Schumpeter’s theories that reduces innovation solely to concerning physical objects or processes related to producing such objects. Thus, innovation is in this volume seen as humanly created changes in *established ways of creating value*, whatever it is that is made and whatever this value consists of. What is created and consumed does not need to be material, but if we are to speak about innovation, change has to be effected in the way value is created, and this change must be seen by particular stakeholders as meaningful. And it must in some way be lasting (or sticky) because creating a novelty (for instance a technical invention or a novel architectural design for one building) that does not enter into a practice, is not used in other contexts and does not in any way diffuse cannot in itself be innovation. This follows from our definition of innovation itself because it identifies innovation as *changes* in established ways of value creation. Both the ‘established ways’ and the ‘novel ways’ resulting from innovation are institutionalized and, hence, to some extent lasting (Orstavik 2014). However, and as a matter of course, the timespans for which innovations are actually relevant will vary to a great deal.

Elements of these underpinning characteristics can be traced throughout the contributions contained within this volume and in the way the chapters are organized. Each chapter is intended to provide a different viewpoint on

innovation in the built environment and to challenge some conventional way of thinking about construction innovation. Among the most widely diffused common-sense assumptions about innovation is that it is profitable and that the fundamental driving force for innovation is the economic gains that innovation brings. In Chapter 2 on incentives for innovation, **Finn Orstavik** challenges such assumptions. He argues on the basis of Schumpeter's perspective on innovation that even though innovation is a decisive factor in competition between firms, innovation is much more than an economic phenomenon for these firms. Actually, innovation is the outcome of actions and decisions that are of a different kind than those recognized as economic and rational. In fact, the gains from innovation are highly uncertain; therefore, innovation is more like a lottery than it is a normal investment in expansion of an existing business. For Orstavik, it is essential to understand reasons for innovative behaviour in construction and therefore *not* to jump to conclusions about motivations. For example, one should certainly not simply assume that stakeholders are irrational when they decide to avoid investing in innovation. Observers have to ask, rather, what it is with construction that makes it less enticing to play the lottery of innovation there than in other industrial sectors. The answer, Orstavik argues, is found in the ubiquitous presence of asymmetric information in building activities and in the fact that construction production involves the creation of bespoke complex and dynamic systems. The specific form of production dominant in building entails multi-parametric optimization, not limited to the establishment of a novel line of production, but integrated into the actual production operations themselves. The complexity of building operations and design makes multi-parametric optimization essential and unavoidable. This is a fundamental reason that innovation is less appealing in the construction sector than in many other sectors.

Multi-parametric optimization is also at the heart of **Kristian Kreiner's** contribution in this book. In Chapter 3, he examines a particular case, a construction project that was aimed at producing *the world's most accessible office building*. Considering the value aspect of innovation, Kreiner finds that the aim of this project in itself represented an ambition for carrying out an innovative building project. The innovative content could not, however, be clearly defined in terms of the resulting building being more accessible than any other building. It proved impossible to operationalize this concept because accessibility is multidimensional and it depends to such an extent on the enormous diversity of human wants and needs. The task of creating the world's most accessible building involved an effort in multi-parametric optimization with no clear solution. What the project did contribute, however, and what was a genuine novelty in the approach to creating value (a new building), was not a new technical system or a new architectural design, but rather the way the building design process was conceptualized. This concerned both the *rationale* and the *modus operandi* of the design process. Rather than creating a single, optimal, or nearly optimal design for the building, the solution was to conceive of the building and its users as a 'living ecology'. Rather than being a fixed structure with assigned meanings, the building was to be seen as a living ecology where meaning would

be continually created by the users. In this project, therefore, the essential innovation – if what has been developed is actually carried over into later projects and in this sense is sticky – is the changed way of thinking about design in the design work and in the overall building process. In his fascinating story, Kreiner draws attention to both the inherent difficulties in determining the qualities of a product and the fragility of the conditions that shape the eventual material outcome. He also sensitizes us to the ambiguities that can face us when trying to determine the actual value of an innovation. In this case, what is created is a larger space for human beings to creatively contribute to the making of meaning in their own life worlds in interaction with the material and social realities surrounding us.

These issues resonate across many of the chapters that follow, and not least with the subsequent Chapter 4 by **Gonzalo Lizarralde, Mario Bourgault, Nathalie Drouin, and Laurent Viel**. In their text, the authors are concerned with what they see as an overly restricted vision of value and of what construction innovation is about in general. A stakeholder perspective on construction innovation is mobilized, and the argument is made that more stakeholders ought to be involved in building and in design. Rather than sticking to a narrow – statistical – understanding of what is to be counted as construction, many more activities have to be considered as relevant. In general, all those involved and affected by innovation in the built environment should be considered stakeholders and ought to have a say in these processes. Also, the value of innovation cannot be considered only in terms of added value and profitability realized by construction firms. A broader understanding of value, resulting from interest articulation and negotiations among stakeholders, is essential for the ability to organize innovation in the built environment in good ways. Also, there is an urgent need to understand that *integration champions* are essential in innovation in the built environment. Champions are often aiming for quite different things than economic profit. Instead, they are working to integrate stakeholders and facilitate stakeholders' active involvement and the champions are as such essential both for innovation in the built environment and for our ability to understand what innovation in the built environment and in construction is fundamentally about.

Stakeholder involvement is a theme discussed further by **Martin Loosemore** in Chapter 5. As mentioned earlier in this introduction, Loosemore questions the linear model of innovation, which he sees lifting its head much too often in discussions about innovation in construction and when the challenges facing the industry are debated. Innovation should not be conceived of solely as an outcome of scientific research and technology development and the discussions about construction innovation should not simply be on the transfer of technology or the ability of firms to learn and their willingness to innovate. Construction firms have to continually renew themselves and their mode of doing business, given the demanding realities of innovation based competition. The source of novelty for this kind of competition is more often than not the creativity and collaborative potential of people doing project work. Loosemore raises the questions to what extent innovation actually can be planned and managed and to what extent innovation is

rather an emergent phenomenon originating in the creativity of and the collaboration between those people who are themselves involved in the construction projects. Loosemore proposes to adopt a grassroots perspective on innovation and draws attention to some important recent contributions to innovation theory, amongst others targeting service provision industries and aiming to supersede conventional innovation analyses anchored in a view of economic growth as based on the expansion of efficient volume production of standard products.

The non-linearity of innovation processes is a theme further developed by **Carl Abbott, Martin Sexton, and Catherine Barlow** in Chapter 6. These authors are also interested in the role of stakeholders in construction and construction innovation and have used a socio-technical network perspective to analyse how decisions are made on adopting sustainability-related innovations, such as micro-generating technology in new build housing. Several case studies have been performed that have given novel insights into the complex ways in which technology, regulation and organizational processes combine to shape the innovation context. In the chapter, an illustration based on one of these case studies is used to show that innovation can be triggered by regulation but that outcomes often do not necessarily reflect ultimate policy objectives in an effective way. The adoption of an innovation is decided through a recursive process of interest articulation and negotiations, and the fundamental impulse for innovation comes from above such as from regulations formulated on the national level. The outcome – the innovation – can end up being a compromise that does not, or only partially, fulfil needs of stakeholders. Policy aims can be stifled and the diffusion of innovation inhibited due to the entirely logical behaviour of actors with misaligned needs.

We have seen that two strikingly diverse perspectives are developed in Chapter 5 and 6. The former proposes a bottom-up view, the latter a top-down perspective on what triggers – or should trigger – innovation in the built environment: grassroots initiatives versus state-imposed regulations. For those feeling the urge for moving towards a synthesis between the two, potentially useful conceptual resources and arguments are found in Chapter 7. Here, the authors **Lena Bygballe, Håkan Håkansson and Malena Ingemansson** present an industrial network perspective on innovation. They acknowledge the many interdependencies necessary for realising innovation and the involvement of many stakeholders located along the value chains of building. Furthermore, they call attention to the fact that the realities of construction innovation are consistent with the important general point made by Schumpeter (1983) in that resources necessary for innovation most often are committed to entirely other purposes. This means that innovation cannot but be disruptive to some extent, and this nearly always creates significant obstacles. Innovation can be successful only when new or different interfaces are created between technical and organisational resources. Innovation is driven forwards by way of interaction and adaptation processes between actors and their resources. This close interaction involving learning, long-term relationships, and trust is not compatible with basic neoclassical market models, has obvious and important implications for any

attempt to formulate effective innovation policy, and for companies' own structuring of their innovation efforts.

Graeme Larsen further explores the realities networks in construction innovation in Chapter 8. His focus is not so much on the first creation of novelties as it is on the diffusion of innovations, and the transformation of innovation taking place as they are diffused to ever-new firms. Larsen is interested in the large number of small and medium sized constructors in the UK industry, and presents an interpretive analysis of a large data set on network linkages. The data is analysed with the help of social network analysis software, and graphic illustrations provide a rare view into the complex realities of networks that actors in construction are embedded in. Actors are part of dynamic networks through which innovations are shaped, changed and contested over time, albeit not in isolation of the immediate surroundings nor unaffected by broader institutional forces. Networks inside and outside organizations are visualised, hence, the discussion regarding the nature of industrial innovation networks in Chapter 7 is complemented and increases our understanding of just how ubiquitous such networks are. An important policy implication highlighted by the author is that efforts to promote diffusion of innovation must be context specific and localized, rather than based on generic best practice initiatives, if they are to be effective.

Another take on innovation networks and collaboration is developed by **Kim Haugbølle, Marianne Forman and Frédéric Bougrain** in Chapter 9. Here and similar to Chapter 11 later in this volume, the focus is not on the networks as such, but on the specific role played by clients in the context of innovation. An analysis is presented that details the ways clients can influence innovation – in their role as stakeholders: as producers, as users or as intermediaries. In a similar way as in Chapter 6 that discussed the intricacies of deciding on employing micro-generation technology, the authors of Chapter 9 point out that innovation is realized not by individual people acting on their own, but through complex interactions among actors and technologies that together can be seen as forming dynamic socio-technical systems. Indeed, moving close to the idea of grassroots driven innovation (Chapter 5) regarding the actual sources of innovation, the authors find that clients often are closely involved in innovation development, and they are found to be effective in promoting all kinds of innovation: not only novel products but also innovative processes and organizational and market innovations.

All of the chapters in this volume from Chapter 4 through to Chapter 9 are concerned fundamentally with different types of actors, their role as stakeholders, and the complexities of their linkages and interactions in innovation. Abbott et al. in Chapter 6 concentrate attention on the effects of policies and policy instruments while maintaining the focus on actors. In this way, the authors introduce the institutional arrangements into the analysis in a way that goes beyond the idea that individual actors are integrated in networks.

In Chapter 10, without departing fully from the established track, authors **Timothy Rose and Karen Manley** emphasize even more than Abbott et al. the significance of institutional arrangements for innovative behaviour and

decision making. Rose and Manley's point of departure is comparable to that also formulated by Larsen in Chapter 8, and by Wamelink and Heintz in Chapter 11: namely, that innovation in construction generally happens through diffusion. In Chapter 10, Rose and Manley are concerned with the adoption of innovative building products, not so much the decision-making processes in which adoption is effected, but how institutional frameworks impact on such processes. Their analysis is based on earlier research, specifically on a focus group-based study of industry experts' views on conditions for adoption of novel construction products in Australian road building. The aspects of the institutional framework that the industry experts themselves draw attention to are first and foremost narrow project tendering practices, and the difficulties in making clear the actual risk distribution across stakeholders. The experts suggest remedies such as up-front product certification, performance-based specifications, innovation performance assessment (after the construction project that contains an element of innovation is concluded) and finally that trust is developed between relevant stakeholders (product suppliers and road asset operators in particular) for example through prior collaborations in the context of other projects.

Chapter 11 by **Hans Wamelink** and **John Heintz** represents a similar interest in innovation as adoption and as diffusion as in earlier chapters. Also, these authors are concerned with institutional arrangements. This time, however, these arrangements are not seen as a surrounding context, but as a property of the industry itself. The authors do not dispute the significance of networks, but argue that fragmentation and dis-connectedness are prominent features of the industry structure, and that this represents major obstacles to construction project performance. Rather than deploring the fragmentation's possible negative effects on innovation, they turn the issue around and propose that what we should be concerned with is not innovation per se, but innovation as an essential instrument in efforts to reduce the detrimental effects of industry fragmentation. Certainly, not all innovation is essential in this perspective. The authors discuss three forms of innovation, all technology based and all driven by demanding clients. Over the last years in the Netherlands, the experience is that in order to satisfy their clients, leading construction firms have been driven to further the integration of stakeholders in their projects. The three ways this has been done are through integrated project delivery, by way of building information modelling and through supply chain integration. All these are major strategies by which technological innovation can be used to promote a tighter coupling of firms and other organizations, and ultimately a better performing industry. The key to all this is seen by Wamelink and Heintz as the demanding client.

In Chapter 12 **Edward Minchin** and **Martha Gross** are also concerned with the demand side in their analysis of innovation in road building, this time not in Australia, but in the USA. While client demand for innovation is recognized as a key determinant, Minchin and Gross reintroduce the institutional framework as a structure shaped by policy, and see innovation as a 'dependent variable'. They argue that the structure of delivery systems is essential for the propensity of builders to incorporate the use of innovative

building products, and for their willingness to engage in other kinds of innovation. Based on several case studies, the authors find indications that some types of structural business arrangements are much more conducive to innovation than others. Specifically, ‘design-build’ (DB) and ‘construction-manager-as-general-contractor’ (CMGC) are configurations of delivery systems that promote innovation, while ‘public-private-partnerships’ (PPP) seem not to have the same effect.

In the final contribution to this volume, in Chapter 13, **Heli Koukkari** and **Finn Orstavik** take up the discussion concerning innovation for sustainability in construction, which was analysed also in Chapter 6. As the lead author, Koukkari has been able to draw on her earlier research on developments in the industry and in policy in Finland. The argument is made that construction products have huge impact on the ways the built environment is produced, used and maintained. It is quite surprising that despite the obvious significance of physical products for the environmental footprint of construction, innovation activities of construction product manufacturers are seldom investigated in their own right. Today, global environmental concerns, not least the climate challenge, accentuate the need to understand determinants of product innovations. In the chapter, the authors explain how a study was conducted in Finland to explore more in depth how manufacturers perceive and respond to societal concerns, and to related market challenges. A multiple case study was conducted, and historical data on product innovation processes of ten manufacturers gathered. The key findings are that environmental issues have gradually grown from weak global signals towards market and regulation-based drivers in Finland. Energy-efficiency has been the single most important impetus that has resulted in a multitude of product modifications and novel products. On the national level, policy for furthering the construction industry has been transformed from a largely technology-driven and linear policy (compare the discussions in Chapter 4 and 5), to a broader systems orientation for sustainable development of the industry. Increasingly, technological opportunities have come to be seen in the context of medium- and long-term needs for development. This holds not only on the level of national policy, the authors argue, but also on the level of firms and their organisations: Innovation activities of firms are increasingly motivated and rationalized as efforts to develop technological and commercial solutions compatible with the emerging ‘green’ economy. This is not the result of any irrational idealism, but of a combination of real policy frameworks and incentive schemes on the one side, with outlooks and modes of thinking among industry leaders on the other.

Instead of Conclusions

It would be at odds with the whole purpose of the present volume to draw firm conclusions on the basis of the diverse arguments presented throughout this volume. The key themes and theoretical perspectives of each of these chapters have been outlined briefly in this introductory chapter, and in bringing the perspectives together in this way, we have tried to illustrate

how the multiple perspectives on innovation taken by the chapter authors are connected at some points, but also that they are different in important respects.

We have used this review of the contents of this book to draw particular attention to the different ways in which the concept of innovation is used in the literature on construction innovation. It has been our goal to show that it is possible to define the concept of innovation in a clear and general way, without limiting the scope of the debates on innovation in construction. Also, we have wanted to show that there are multiple actors who come together around innovation, and that innovation outcomes that result also are multidimensional. Even though many think of innovation as the gradual diffusion of advanced technologies originating in research laboratories and in science, this aspect of innovation provides only a partial picture, and may be one that is not very representative.

Above all, what emerges throughout this volume is a picture of innovation as a largely emergent, non-linear, multi-level and hence, highly complex phenomenon. We have seen this complexity and the contested nature of the debates as to how this phenomenon should be understood in the construction literature, as a trigger for mobilising multiple perspectives on innovation in the built environment. Indeed, it was the recognition that this discourse encompasses what appear to be multiple, often opposing and yet seemingly valid perspectives, that provided the inspiration for the work with this book. It is our hope that it will act as a trigger for more analysis and further debate, and that it can be effective in promoting more nuanced views and more constructive future debates on innovation in the sector.

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