R&D MANAGEMENT

In search of lost time: the temporal construction of innovation management

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This paper presents a methodology that is new to the field of innovation management research (IMR), and which is founded upon current interest in theories of time and temporality within organisation studies. We argue that although time is of central importance to innovation management, established methodologies treat time as simply the background against which organisation is done. Even when research is conceptually framed to afford greater attention to time, established methodologies only succeed in highlighting the importance of managers' mobilisation of the past, present and future of innovations. In contrast, we present a methodology that affords time (rather than innovation actors) the more prominent role in analyses and explanations of innovation management. While established research methodologies might offer accounts of the social construction of organisational innovation, we elaborate its temporal construction. The paper reviews the ways in which time and temporality have been deployed (conceptually and methodologically) within IMR. Following a detailed account of the new methodology, its value to innovation management scholarship is demonstrated with a short illustration in which new insights are presented into the emergence of novelty during the management of innovation. The paper concludes with suggestions of areas within IMR where this methodology may generate new insights.

1. Introduction

The core challenge faced by innovation managers is *temporal* in nature (cf. Dodgson et al., 2014, p. 6): drawing upon *past* experiences, how are scarce resources to be allocated between *present* priorities (e.g., improvements with respect to current products or customers), and *future* possibilities (e.g., development of new products or markets)? And yet the methodologies in the field of innovation management research (IMR) rarely, if ever, afford an active role to *time*. Within studies of organisation more generally, issues of time and temporality are not new concerns (Clark, 1985; Bluehorn and Denhardt, 1988; Hassard, 1991). However, despite this well-developed body of literature, time remains a fundamental and elusive concern for management and organisational scholars (Bakken et al., 2013; Hernes et al., 2013; Hernes, 2014; Reinecke and Ansari, 2017). In this paper, we take up the challenge of giving a more prominent role to *time* within IMR and present a new methodology that draws upon current thinking about temporality and time within organisational studies. The salience of these ideas for IMR is demonstrated with a short illustration of the methodology that offers new insights on the emergence of novelty within organisations.

In the first part of this paper, we review the ways in which time and temporality have been treated

within IMR. We draw upon Cambridge philosopher J.E McTaggart's distinction between 'A-Series' and 'B-Series' time (1908) to classify existing conceptual and methodological conventions within IMR. We argue that, although multiple divergent approaches to time are evident within existing IMR, they tend to rely on either subjective or objective conceptualisations. This dualism necessitates the adoption of particular methodological approaches that ultimately fail to fully grasp the fundamental influence of time in innovation management (Holt and Johnsen, 2019). We suggest that to cultivate an enhanced appreciation of temporality, IMR requires the development of a new methodological approach that attends to time, without instrumentalising it as something to 'be used', manipulated or managed (Holt and Johnsen, 2019).

In the second part of the paper, we explain a research method that attempts to *give room* to time and illustrate how time is active in its own right (Hernes, 2014) in the process of innovation management. A short illustration of the method is presented that, in itself, offers a contribution to how novelty emerges through innovation work. Novelty has been a core concept within studies of innovation since the pioneering work of Joseph Schumpeter (McCraw, 2014), and the generation of novelty is considered central to the innovation management challenge (Crossan and Apaydin, 2010). However, following Schumpeter's seminal work, the novelty has often been seen as entailing 'creative destruction'. Within innovation management, the break with the *past* implied by this term risks drawing attention towards the *future* (the newness of the innovation), and away from the *past* (experiences that creatively inform the innovation). Through this illustration, we argue that matters of time and temporality are fundamental to understanding the organizational dynamics of innovation management.

The primary contribution of this paper is methodological: we present a method of researching innovation management that grounds the ontology of such management in its temporality. We argue that this temporal construction approach has two main advantages. Firstly, it offers a means of unpacking apparent stabilities within innovation management, allowing for both stability and novelty to be incorporated within analysis without imposing a clear distinction between them. Secondly, it offers a way to appreciate the subjective, flexible nature of time in IMR, without relying solely on social constructivist accounts that over-emphasise the mobilisation of time by actors but overlook the structuring role of time itself. The paper is structured as follows. Firstly, we review the ways in which time and temporality have been treated (conceptually and methodologically) within IMR. Secondly, we explain a research methodology based upon a *temporal construction* of innovation management. Thirdly, we describe the stages of a research method that enables such temporal construction. Fourthly, we present a demonstration of the method and compare the findings with a conventional method based upon innovation actors' construction of events. Finally, we suggest areas of IMR which might benefit from the adoption of this new methodology.

2. Understanding time and temporality in innovation management research

Within organisation studies, time has been defined as 'a sociotemporal order which regulates the structure and dynamics of social life' (Zerubavel, 1981, p. 2): it is often thought of in terms of 'clock time' (Reinecke and Ansari, 2017, p. 403) that is linear and objective. Whilst time may be measured (and this aids the co-ordination of organisational life), temporality is concerned with 'what time is, and how time is experienced and socially organized' (Reinecke and Ansari, 2017, p. 403). Issues of temporality and time are of course nothing new and questions related to how time can be understood and apprehended have occupied eminent thinkers such as McTaggart (1908), Bergson (1913), Heidegger (1927), and Whitehead (1929). Following other studies of time in organisational research (Bakken et al., 2013), we draw upon McTaggart's conceptualisations of time (1908). McTaggart argued that we experience time as events placed in two kinds of temporal position: 'A-series' and 'B-series'. A-series position events as past, present or future, with the events constantly moving between these positions as what was *future* moves through the *present* to the *past*. The B-series positions events as either 'earlier than' or 'later than' (McTaggart, 1908, p. 458), and such placements of events never change. For example, an account of new product development process might place an event of idea generation earlier than an event of product launch; and this ordering of events will never change. The A-series experience of time suggests that we cannot only view events as occupying fixed temporal positions. Our contention is that most processual studies of innovation management implicitly adopt a B-series conception of time, and fix events in an unalterable series; and we focus first on such research in this section. We then elaborate the implications for IMR based upon an A-series conception of time.

According to the B-series conceptualisation, time relies on spatial expressions, for example, 'there-then', 'here-now', 'there-when' and is 'discrete, homogenous and quantifiable' (Chia, 1998, p. 351). As a consequence of this intertwinement of time with space, B-Series time assumes the common form of an independent and external dimension against which we classify our experience (Chia, 1998, p. 351; Holt and Johnsen, 2019). This understanding of time is more commonly referred to as clock-time (e.g., Clark, 1990), and is reflected in standardised units of measurement (e.g., years, days, hours etc.) against which we associate events (Ten Houten, 2005; Reinecke and Ansari, 2017). Importantly, this spatial temporality facilitates the conceptual separation of past, present and future, allowing the possibility of causal relationships between events.

What we characterise as B-Series time is prevalent throughout IMR. The most obvious example of B-Series temporality in IMR is stage-gate models (Cooper, 1993) rooted in punctuated-equilibrium logic (Brown and Eisenhardt, 1995; Brown and Eisenhardt, 1997). In stage-gate models, activities and events are broken down into clear and discrete stages that are punctuated by critical 'go or kill' decision points (Cooper, 1993). Although recent attempts have been made to highlight the non-linearity of activities within the stages (Cooper, 2008), the underlying *if-then* logic illustrates the assumption of time as discrete and spatial, since events (irrespective of how many there are) are always locatable or in some sense fixed to a point in time (i.e., the relations of 'earlier than' and 'later than' are permanent). However, B-series objective temporality is still implied in framings that have sought to move away from linear and neat punctuated-equilibrium models. For example, the ambidexterity literature holds that successful radical innovation management requires the continuous balance of attention to exploitation and exploration (Tushman and O'Reilly, 1996; He and Wong, 2004). According to this idea, success requires that managers devote sufficient attention both to the present in which past innovations and investments can be exploited; and to the future by exploring potential avenues for product and market development which may be then exploited at a later present. The concept of ambidexterity relies upon the clear delineation of 'before' (which forms the basis of exploitation and is the venue of exploration) and 'after' (which is explored in the present and forms the basis of potential exploitation). Although ambidexterity has been instrumental in advancing understandings of radical innovation management, the static and unitary assumptions of temporality remain critically unchallenged.

Another example of IMR that is conceptually and methodologically rooted in B-Series temporality is the process research of the Minnesota Innovation Research Programme (Van de Ven and Huber, 1990; Van de Ven et al., 1999). This 17-year research programme treated processes as sequences of activities that describe how the focal innovation developed over time. In other words, time constituted the background against which innovation(s) developed. For Van de Ven and Huber (1990, p. 319) a process theory of innovation development 'consists of statements about the temporal sequence of events that explain an observed stream of incidents or occurrences as innovations unfold.' Thus, rather than offering simple descriptions of the empirical world, this mode of process theorising requires that events be 'strung together' in some kind of temporal order and sequence to explain how and why innovations emerged and developed (Van de Ven and Huber, 1990, p. 319). The foundational step in the construction of such process theories is the creation of bounded units of spatio-temporal experience called 'incidents' (Van de Ven and Huber, 1990, p. 320). Following the collection of data about discrete incidents, sequence analysis is undertaken, which attempts to solve the problem of 'temporal order among events' (Van de Ven and Huber, 1990, p. 325). Clearly, such an approach to theorising innovation management rests upon the delineation of events in time. The ambition is to develop causal models of how one sequence of events that occur at particular (fixed) points in time correspond to other sequences of events that occur at other (fixed) points in time. Time, in this view, is an external dimension against which innovation unfolds and serves mainly to fix activities to discrete points which are then causally related. The key point is that these innovation activities are fixed, bounded and inextricably spatial (there-here), as is the case with B-Series temporality (Bakken et al., 2013).

Although this 'time of regularity' (Bakken et al., 2013) is implicit throughout much IMR, it has recently been challenged by scholars who work from different temporal assumptions; that have been called 'A-Series' temporality (Bakken et al., 2013). McTaggart (1908) casts doubt on the fundamental reality of B-Series temporality, concluding that the clear and solid divisions between past, present and future events did not reflect the fluxing and uncertain reality of time as it is consciously experienced (McTaggart, 1908; Bakken et al., 2013). Rather, our experience of time is one of 'pure duration' (Chia, 1998) reflecting what Hernes (2014) calls a 'living present'. Time is experienced as a succession of qualitative changes that are intertwined, without clear outlines or demarcations (Chia, 1998). A-Series

time then, considers the past, present and future not as fixed and delineated states but as shifting and mobile constituents of the ever-expanding present or duration. According to this view, the past and future are no longer fixed in space along a timeline but are constantly shifting 'seas of meaning' (Bakken et al., 2013, p. 16) that change every time they are evoked in the ever-continuing present. Time is therefore qualitative, discontinuous and non-equivalent, it is 'lived' not 'thought', in the subjective experience of actors as they go about their lives.

We suggest that research that considers how actors relate to time implicitly assume A-Series temporality (Ancona et al., 2001; Bakken et al., 2013), and several recent studies in innovation management are based on this assumption (Bartel and Garud, 2009). For example, in their research on how innovation is sustained at 3M, Garud et al (2011) identified particular innovation practices which enabled actors to work with different temporalities. These different temporalities are characterised as *kairos*, whereby actors attempted to prioritise non-linear serendipitous moments of learning and *chronos*, whereby actors attempted to work with schedules and project plans (Garud et al., 2011). These authors conclude that the capacity to operate with these different temporal logics (or 'agentic orientations') ensures innovation actors become adept at operating with complexity (complexity arrangements) which is key for sustained innovation (Garud et al., 2011). Dougherty et al. (2013) also highlight the different temporal orientations of stakeholder groups (scientists and managers) in the complex innovation process of drug discovery. In particular, they demonstrate that managers work from what they call 'clock-time pacing' (cf. B-Series temporality) whereas scientists work from 'event-time pacing' (cf. A-Series temporality). These authors conclude by suggesting that, to enhance the effectiveness of innovation management, different temporal orientations should be adopted at different levels in order to negate tensions and facilitate integration.

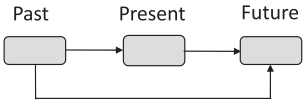
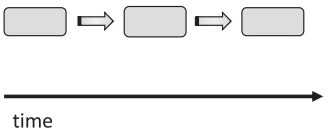
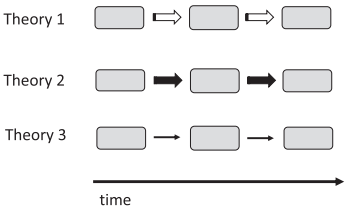
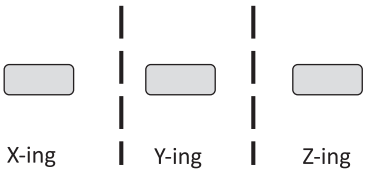
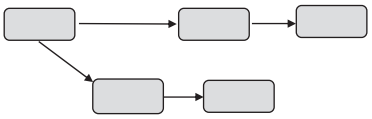
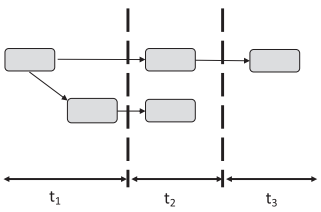
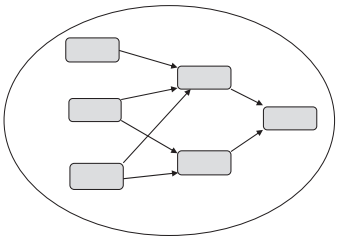
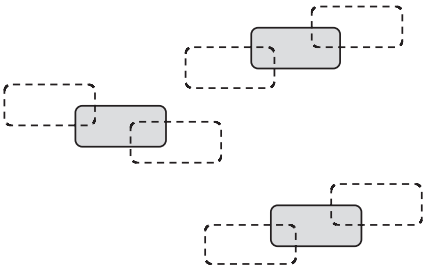
However, whilst both these studies are crucial in highlighting the importance of actors' construction of time, they largely remain silent on how time is active in the innovation process. That is to say, we know that 'temporal structures' (Orlikowski and Yates, 2002; Granqvist and Gustafsson, 2016; Schultz and Hernes, 2020), which reflect the structuring of time [by actors] into past and future events and horizons that are particular to an organisation are important. However, we do not yet fully understand how time itself structures or at least participates in the management of innovation, in terms of how it recursively influences actors and innovation activities. We suggest that whilst these studies assume an A-series temporality, the analytical approaches adopted actually elucidate the ways in which innovation actors *mobilise* time. In the next section, we present a methodology that affords time (rather than innovation actors) the more prominent role in analyses and explanations of innovation management.

3. Research methodology

Our methodological approach builds from the assumptions of A-Series time to enable alternative interpretations of innovation management to those studies founded upon a clock-time or B-series conceptualisation. Thus, we conceptualise time as an 'ongoing present' (Hernes, 2014) or 'pure duration' Bergson (1913) that is experienced as a succession of qualitative changes. Consistent with this view, the past and the future are (only) understood as aspects of the present and events associated with the past and the future are therefore mobile, meaning that they exist only in relation to how they appear in ongoing experience. In other words, events 'transcend into future and past, taking on a mobile, even ambivalent nature within alignments of future, past and present' (Bakken et al., 2013, p. 16).

As highlighted above, such temporality assumptions have been implied within recent approaches to IMR (e.g., Bartel and Garud, 2009; Garud et al., 2011; Dougherty et al., 2013), and are evident particularly in *process* approaches to IMR. Process research methods focus primarily on how things emerge, develop, grow and terminate over time (Langley et al., 2013) and therefore by definition restrict time to a background variable against which the phenomena of interest being analysed. A primary requirement in process data analysis is to firstly to construct 'events', and then discern the patterns between them (Langley, 1999, p. 692). Whilst time is ubiquitous to all modes of process research (Langley, 2009, p. 412), we observe that the 'sensemaking strategies' (Langley, 1999, p. 969) for patterning them all treat time in the same manner: events are placed on a background of inert and linear time. In other words, the research methods foreground the analysis of innovation management, whilst relegating considerations of time to the background. Table 1 takes each sensemaking strategy in turn and explains how events are structured in relation to time; the manner in which the relationships between events may be expressed visually; and an exemplar of the methodology within IMR. The final row in the table shows the additional sensemaking strategy we are advancing in this paper: temporal construction.

Table 1. Sensemaking strategies of event analysis within process research

Sensemaking strategy	How events are structured in relation to time	Visual representation of event structuring*	IMR example
Narrative	An account is structured in some relation to past, present and future events		Entrepreneurial innovation (Garud et al., 2014)
Quantification	Sequences of events are organised in defined chronological progressions		Minnesota studies (Van de Ven et al., 1999)
Alternate template	Comparisons of alternate theories; each expressed in relation to an objective, linear time		Information System implementation (Lapointe et al., 2007)
Grounded theory	Organising of inductive categories into phases labelled as gerunds		NPD portfolio decision-making (Kester et al., 2011)
Visual mapping	Chronological measures of time, running left to right, form backdrop to visual representation of process		Making sense of technology trends (Adomavicius et al., 2008)
Temporal bracketing	Events are structured by temporal phases		Configuring absorptive capacity in research intensive firms (Patterson et al., 2015)
Synthetic	Events transformed into variables that are connected against a backdrop of linear time		Technology adoption (Meyer & Goes, 1988)
Temporal construction	There is no interval between events as the process is not to be understood as a succession of events (and there are no arrows in the visual representation). Rather an event only exists through its relations with other events		This paper

*Boxes represent 'events' and different types of arrows represent various types of progress between events.

The visual representations in Table 1 draw attention to the way in which time is treated in different analytical approaches. We suggest that even those studies which have imputed a role for time, actually emphasise the social construction of time and obscure the actual functions of time (the past and the future) in the analysis. For example, even Garud et al's (2011) study (introduced above) which highlights the importance of different agentic (temporal) orientation' relies on sensemaking strategies which are underpinned by B-Series' assumptions. The study uses retrospective data and real-time interviews to construct 'events' which are visually mapped onto a chronological timeline (Langley, 1999). Chronological narrative accounts are then created which help organise analysis. Finally, thematic coding of raw data in light of the chronological narratives generate an explanation of innovation practices that are termed 'complexity arrangements'. Thus, it may be surmised that a combination of visual mapping, grounded theory and narrative sensemaking strategies are employed to analyse the collected data (Langley, 1999). Temporal dynamics themselves are considered a 'complexity arrangement' (Garud et al., 2011) and are conceptualised as enacted practices that cultivate different 'agentic orientations' towards the past, the present and the future which are linked via innovation narratives. This analytical approach focuses on how actors construct and enact time as opposed to how time actively constructs aspects of innovation management. We suggest our temporal construction approach (final row in Table 1) brings us closer to apprehending what time does in the context of innovation management.

In the following section, we present a research method that is consistent with A-Series temporality assumptions, and which avoids an analytical focus on how actors mobilise time. We outline how process data collection and analysis can be conducted, such that the time dimension of the actor-time relationship is given greater visibility and consideration within analytical accounts. Our motivation is to extend existing methods that consider time and temporality, and in doing so allow a more thorough examination of innovation activities.

4. Research method

4.1. Data collection

It is important that data are collected in a manner that will allow a sensemaking strategy of temporal construction. Langley has suggested three temporal orientations for the researcher contemplating process research (Langley, 2009, p. 413): tracing back through the past; following forward to the future; and reconstituting the evolving present. A method of data collection and analysis is needed that allows for on-going sensemaking of the past, the present and the future. The researcher enters the field in the mode of the ethnographer (Agar, 1980) but with the intention of following his subject not only forward through time, but also backward into the past.

In the beginning, it is necessary to avoid a strong framing of the phenomenon under study (and the interview protocols and a priori categories that this might generate). Rather, the researcher needs to adopt what Marshall and Reason call an 'attitude of inquiry' (2008) driven by curiosity and an awareness of the complex processes of interpretation with which they are engaged. At this point in the empirical work data collection is triggered through direct engagement in and around organisations who themselves are complicit with the innovation phenomenon under study. In this the approach is comparable to established process methodologies, but this paper departs from those methodologies in relation to how events are structured (cf. Langley, 1999, p. 699). Once something of interest is noticed through engagement (Klag and Langley, 2013), then all the conventional methods of qualitative data collection become potentially relevant. Crucially, the past, the present and the future associated with a particular empirical category need to be kept within the purview of the analysis. For instance, data collection that simply 'follows' the organisational actors into the future, risks neglecting the enduring influence the past can hold on the future (Cunha, 2004).

4.2. Data analysis

The data analysis incorporates a number of activities which are described below.

4.2.1. Activity one: 'scaffolding'- generation of categories

The first analytical routine involves the inductive generation of categories that are central to understanding the innovation management phenomenon being studied. This activity is recognisable as an analytical step in any inductive thematic analysis of qualitative data (e.g., Gioia et al., 2013). As the research proceeds, it may be that the initial stock of categories is insufficient to describe the latest data, and so new ones may be generated. However, no categories are ever removed from the analysis, as all will be used into the later activities of this

method. Here, it is important to note that categories are delineated by the analyst arbitrarily, based on their perception of differences in the collected data (i.e., based on the perception of things that are distinctive). Categories are useful inasmuch as they allow for a verbal representation of the phenomena but it is of utmost importance that these categories are treated *as representations* rather than as actual real things. The categories derived here are abstractions from experience and thus they should not be afforded the same ontological status as 'events' or actual lived experience. Our method of analysis seeks to unpack how these abstractions are given form or definition by their temporal relations to other 'events' and categories (Hernes, 2014; Hussenot and Missonier, 2016). Examples of categories might include things such as 'strategy', 'actors', or 'resources'. The point is that each of these categories is abstract: they do not exist outside of time but are defined or *constructed* through temporal connections within the data.

4.2.2. Activity 2: category enrichment

The categories created in activity 1 are used to drive further data collection. Crucially this search for data is not simply concerned with real-time observation in the present but will include generating data about the *past* of the category, e.g., retrospective interviews or archival research. Similarly changes in the way the *future* of the category is viewed needs capturing, e.g., through the use of focus groups and management diaries. As the research unfolds it is not unreasonable that the researcher's own theoretical framing might undergo revisions, and the so personal research diaries that document interpretations of a category should also be included. In this activity, the categories become repositories for data and interpretations. Here, efforts should be made to record how data and interpretations are temporally constituted (i.e., are they invoked as past(s), present(s) or future(s)).

4.2.3. Activity 3: from categories to event-formations

Established sensemaking strategies for process research organise data into events, and so too in this method. The sensemaking strategies outlined above define events as fixed spatio-temporal locations. Following Hernes (2014, p. 85) we conceptualise events as 'temporal experiences marked by closure' that become provisionally settled spatio-temporal entities. For example, a meeting becomes an event when it has reached closure and meaning can be attributed to it as it is related to other events (Hernes, 2014, p. 85). In accordance with process philosophy (Whitehead, 1929), every entity may be considered a provisionally settled event, but settlements at critical junctures in the phenomenon under study might reasonably be expected to be germane to the creation of theory. Such critical junctures could be recognised as durations of time in which the direction of flow of work activity changes; maybe a tipping point (Phelps et al., 2007), or a practice breakdown (Lok and de Rond, 2013). This could be associated with a specific event in the context under study such as a meeting. However, it could also be a cluster of encounters that coalesce together to alter the direction of innovation activity, or a shift in the conversation.

Event-formations (Hernes, 2014, p. 189) are generated for each category, at the selected moment, by incorporating reinterpretations of its past and its anticipated future, into an explanation of its temporal present. Taken together, the reinterpretation of past and future of every key analytical category, constitutes the structure of this event. In other words, what the category *is* is defined in the present by 'the past' and the 'future'; in unpacking how the past and the future define the category in the present, we focus explicitly on the *temporal construction* of the category (and in a more general sense of innovation). Thus, we make time *active* in analysis by illuminating how the relations between events (past and future) define *event-formations*.

4.2.4. Activity 4 – aggregating the event formations

The final stage involves aggregating the event-formations (i.e., the temporal constructions of each category) from Activity 3 to explain the event itself. It is important to note that this aggregation posits no ordering of the events, against a backdrop of linear time (cf. the seven sensemaking strategies in Langley, 1999). Even though our analysis is of one particular event in the on-going flow of experience, it is not a cross-sectional analysis (as that term is normally used) of the flow, because reinterpretations of the past and the future are enfolded into our understanding of the event in the present. Visual representations of this aggregation should not imply (linear) temporal progression (some things happen after other things) either by use of arrows or position on the page. The way to visualise this process would be to consider our seemingly fixed categories at the foreground of the page, with their temporal construction of associated past and future events stretching into the background of

the page. In the visual representation of the event boxes in the final row in Table 1, we show this with the use of shadow boxes drawn with dashed lines. By these means, we wish to convey that what we see immediately in the foreground appears stable, but by looking back and forward, we can see how it *became*, or how it achieved this apparent stability. In this visual representation, we seek to convey what Chia calls the 'logic of the glance' (Chia, 1998, p. 360); allowing the viewer to appreciate not only innovation management in the present but also the temporal traces of its formation.

The aggregation of the event-formations seeks to be consistent with the idea that the organisation (of innovation) unfolds in a continuous present. This means creating an explanation of the innovation phenomenon that shows how its organisation resides in its temporality. This is achieved by asking three questions of each (re-constructed) event-formation: what work does the past do? What work do 'neighbouring' events do? (Hernes, 2014) and What work does the future do? It is the answers to these questions that then provide the basis for explaining the event-formation. It is not just about the way in which actors mobilise past and future events in their own meaning-making. Rather, in seeking to account for the work done by the past, present and future, the analytical method attributes agency to events, and thus time itself.

5. Demonstration of methodology

In this section, we present a demonstration of the methodology that draws upon a longitudinal study of a university-based medical technology innovation centre. A small subset of the data is considered here in order to illustrate the methodology within the space allowed. The data were collected from the time between the production of a proposal for Government funding of the technology centre, through detailed consultations with key stakeholders, and ending with the centre allocating funding to technology development projects. The data collected were in the form of interviews, observations in stakeholder consultation meetings, and documentation covering the development of the technology centre. These data were subject to qualitative analysis in order to identify key thematic categories. The categories identified with this analysis were: 'innovation acceleration', 'technology development model' and 'Stakeholders'; which was further broken down into 'commercialisation partners', 'academic', 'funder' and 'technology transfer office (TTO)'. Thus, in the first activity of the data analysis, these abstractions or labels provided the basic scaffold for understanding the dimensions of innovation management within the centre.

The founders had a vision for the centre that they argued was a significant departure from established practice for university-based TTOs. This was initially articulated in the following terms: 'we will accelerate innovation by focusing research and development on those activities that increase the probability of a successful regulatory and reimbursement outcome, thereby reducing the risk of costly late failures' (Funding Proposal). This objective would be realised by adopting an 'innovation acceleration' philosophy that comprised new practices for early-stage decision-making to inform 'Go/Kill' decisions at critical project junctures (cf. Cooper, 1993). These practices included preclinical assessments of clinical outcomes and health economic analysis at an earlier stage than it would normally be deployed. Whilst originating with the founders of the technology centre, the ideas were refined and made practical through regular consultation with centre stakeholders. These included the academics whose original research was the starting point for technology development; partner organisations (industry and clinical) who might commercialise these technologies; and representatives from the department of Government that was providing the public funding for the centre.

When engaging in the second activity of the method, these categories provided the impetus for the search for further data. For example, in relation to the category 'technology development model', different forms of data were collected with different temporal orientations. In 'the present' interviews were conducted with Centre board members to understand the meanings they attached to such development models. In relation to 'the past', retrospective interviews were conducted with TTO officers and stakeholders who had managed technology development projects during the previous 5 years. In relation to 'the future' we collected meeting notes and PowerPoint presentations from the team at the Centre who were charged with the Centre's organisational design. Some data collection opportunities afforded insights into more than one temporal orientation. For example, we also collected participant observation data from a series of stakeholder meetings involving industrialists, clinicians and academics. In these meetings, participants were invited both to reflect upon their experiences of technology development projects at the host university and share their future hopes for the operational model of the new centre. Table 2 summarises the enrichment of the category 'technology development model'.

Table 2. Illustration of category enrichment

Phase 1 – Generation of key categories		Phase 2 – Category enrichment		
Category	Data sources	Temporal code	Sub-theme	Data sources
Technology development model	Centre funding proposal documentation	Past	Established technology development model at host university	Retrospective interviews with TTO officers, and academics
	Interviews with board members		Previous funded programmes for medical technology development	Programme documentation
			Completed/terminated development projects	Participant observation at the stakeholder consultation event.
		Present	Meanings of 'technology development model'	Interviews with board members
			New Tools	Interviews with specialist analysis providers (e.g., health economists, & clinical trials experts)
		Future	Centre organisational design	Notes and diagrams from meetings of the design team
			Stakeholder expectations	Participant observation at the stakeholder consultation event.

The third activity of the analysis revolves around an 'event' that is a point of inflexion in the on-going flow of activity. The analysis proceeds by assuming a settlement in that flow, and an explanation is made for what is happening in the temporal present for each category, that incorporates reconstructions of its past and its future. The 'event' chosen in this illustration considers the moment when the technology centre could be said to have become operational. In instrumental terms, this can be thought of as a settlement in the operational routines that surrounded the decision to invest in the development of nascent technology concepts. These routines consisted of searching for candidate projects; writing investment proposals; deciding on investments; on-going support of technology development; and articulating a proposition for commercialisation funding.

In the temporal present of this event then, the event-formation for the category 'Technology Development Model' encompasses the innovation management support provided by the centre to technology projects. The centre existed to support the early-stage creation of novel medical technologies and all of the administrative activities were conducted in relation to this development process. The espoused vision of the centre had been to make a break (cf. Schumpeter's creative destruction) with the technology development process of the TTO at the host university, and in this matter, we observed marked tensions between the managers at the centre and the TTO. Novelty was indeed evident in the innovation support provided to projects. Where the traditional TTO approach had revolved around a generic (to all technology types) development process, the centre enacted strict 'test often/fail early' philosophy that was supported by people with experience in the private medical industry. However, other aspects of the traditional process endured, including how intellectual property rights were established and managed.

The event-formation for the category of 'innovation acceleration' captured the distinctive principle of the centre's innovation management vision in its own proposal for Government funding. However, at the moment of the 'event' considered in this illustration, this principle had undergone a marked re-interpretation. Originally the rhetoric of acceleration had encompassed the whole of the medical innovation journey: 'halving the time from bench-to-bedside and back again' [Centre planning documentation]. The logic of this proposition was that technology concepts that survived a strict test-often/fail-early regime would be more robust and so able to progress through downstream commercialisation stages more quickly. Consultation with stakeholders witnessed a reframing of the innovation acceleration principle

so that it fell within the scope of the centre's own innovation management. The rhetoric shifted to helping projects to 'investment-ready propositions' more quickly.

The event-formation for the category of 'stakeholders' acknowledged that success in developing early-stage medical concepts had long been recognised to involve partnerships between clinicians, university researchers, university-based technology development managers and industrialists. However, we noted a widely-held perception of slowness in the university's established technology transfer model. The aspiration of the new centre to accelerate innovation was welcomed but also moderated by a requirement to align to the pace of innovation at downstream commercialisation partners.

Figure 1 shows a visual representation of the event-formations. It seeks to convey the way in which past experiences and future aspirations were reinterpreted, and became manifest in the temporal presence of the centre becoming operational. The categories derived from the case data are shown in bold boxes, with the reinterpretations that reveal the relations between categories presented in italics. Each of the boxes for the temporal present have thin solid lines to convey their provisionally-stable nature. The traces of how they came to be, through the intertwinement of reinterpreted past and future, is conveyed visually by placing those reinterpretations within shadow boxes drawn with dashed lines.

The final activity of analysis involves aggregating the reinterpretations in order to provide an explanation of the event itself. This aggregation proceeds by asking what 'work' is being done by the past, present and future at this particular event. This event was constructed from reinterpretations of the established ways of collaborating with stakeholders (i.e., the TTO model of the host university from the past), and the ambition to create a new technology development model based upon principles of innovation acceleration (i.e., a new vision of the future). In its becoming operational, the scope of the technology development model was delimited to the articulation of an 'investment-ready propositions' for each technology project in its portfolio; and engagement with stakeholders and the innovation acceleration principle acquired new interpretations (in the temporal present). The future and past acted in concert (cf. Figure 1) to construct this scope in the manner explained below.

Being informed by potential future investors that the centre would need to align with the pace of their innovation systems, meant that future commercialisation trajectory was not the Centre's control (as their original vision had implied). This had two implications for the way in which the centre

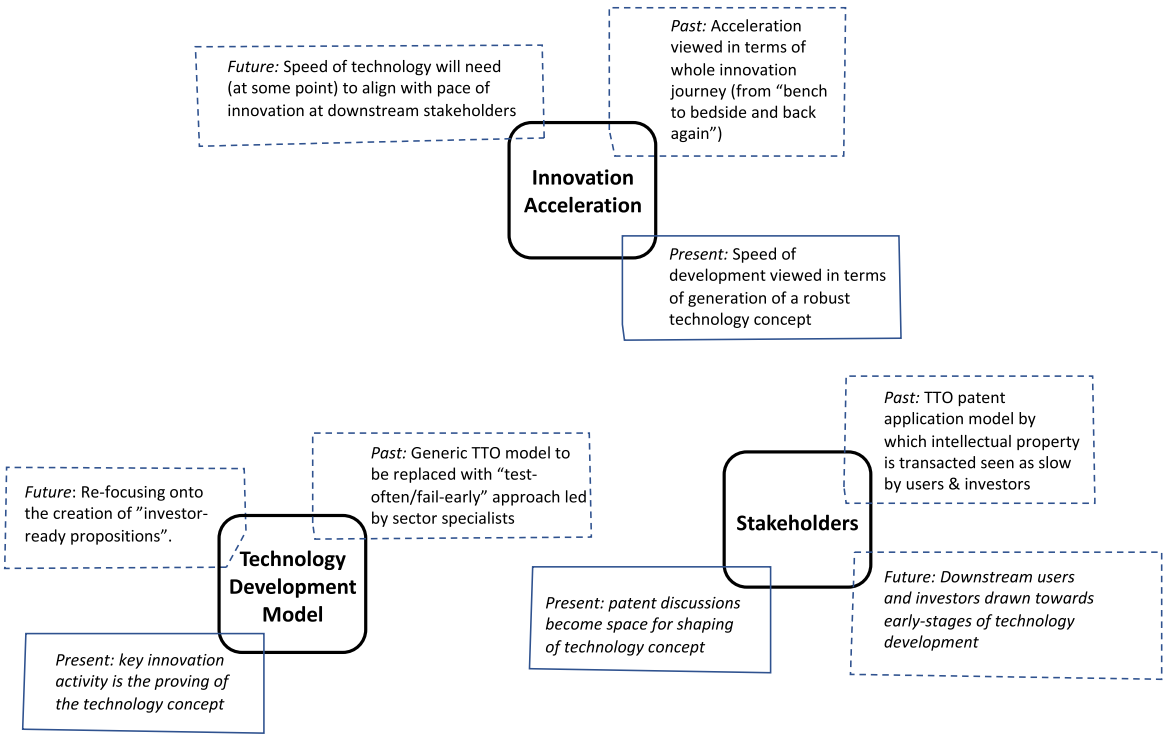


Figure 1. The event-formations: the technology centre becomes operational.

was trying to be novel (i.e., the innovation acceleration philosophy of test-often/fail-early). Firstly, while this philosophy was still valid, its use was reinterpreted to be less directly concerned with speed, and more about building a robust technology concept. Secondly, there was a need to align, at the earliest possible opportunity, with the pace of commercialisation of the next stage investors. In turn, these implications of the reinterpreted novelty each had consequences for the centre's original intentions to break with the established processes of the TTO at the host university. The robustness of a technology concept might be evaluated as part of a patent application; and this was a process owned by the TTO. Engagements with downstream stakeholders concerning a new technology would revolve around a critical element of the patent process: 'freedom to operate'. By these means, the traditional patent application process at the host university was no longer seen as something that slowed down innovation through intractable valuation discussions. Rather, it was reinterpreted as a space to allow potential future investors into shaping the trajectory of the early-stage development. Within the event of the centre becoming operational, and the reinterpretations of the future and the past, we can read the entanglement of stability (i.e., established modes of technology transfer) and novelty (i.e., the new acceleration practices) in the same acts (Figure 1).

6. Discussion

The aim of this paper is to develop a research methodology that affords *time* a greater role within process studies of innovation management. It is our contention that whilst the core challenges of innovation management are temporal in nature (i.e., integrating past experience, current priorities and future possibilities), time itself is treated (analytically) as a backdrop or axis upon which to place innovation acts. The paper contributes a methodology that affords time (rather than innovation actors) a prominent role in analyses and explanations of innovation management. This section starts by positioning the methodology with extant process research of innovation management. We then consider the illustration above and explain how this research methodology enabled a more nuanced probing of innovation management dynamics than a conventional longitudinal case design. Finally, we discuss the applicability of this methodology to IMR more broadly and a research agenda is suggested.

6.1. Temporal construction of innovation management

In our review above on how time and temporality have been addressed within IMR we drew upon McTaggart's classification of time into 'A-series' and 'B-series' (1908) in order to conceptualise the different orientations of IM scholars toward time. We argued that the majority of IMR implicitly adopts the assumptions of B-series time, and went on to offer a methodological critique of this research. We also acknowledge that some IMR has given a more prominent role to different conceptions of time (e.g., Garud et al., 2011; Dougherty et al., 2013). However, despite the greater attention paid to *time* in these studies, we suggest that their data analysis sees time as the background upon which different innovation tasks are positioned. In other words, they embrace A-Series assumptions at a conceptual level, but are constrained by existing process research methods implicitly adopt B-Series temporality. As a consequence, these studies are insightful in bringing attention to the social construction of time, but they neglect the possibility that time itself has a role to play in constructing our understanding of innovation management. In seeking to address this discordance between theory and method in research that advocated 'A-Series' understandings of time, we have developed a process methodology of 'temporal construction'.

Whilst B-series assumptions require researchers to place their categories 'earlier than' or 'later than' others, our methodology (with its A-series assumptions) requires researchers to construct an explanation of an innovation category from reinterpretations of the past, present and future of that category (Figure 1). This approach enables a (temporal) unpacking of apparently stable concepts within innovation management, in a way that allows them to be probed analytically without imposing fixed distinctions (e.g., stability or novelty). The construction of innovation concepts from reinterpretations of past, present and future enables an appreciation of the subjective nature of time in IMR methods. In this, it reduces the dependency on analytical approaches that privilege the (social) construction of time by actors and overlook the structuring role of time itself. Instead, we demonstrate that *time* participates in the structuring of innovation concepts through the past, the present and the future.

The possibility of generating extra insights with this methodology might be illustrated by considering the demonstration above, and the conclusions that would have been derived if a conventional longitudinal

case study methodology had been adopted. A conventional analysis might reasonably have explained the creation of the technology development model in terms of a sequence in which established ideas were punctuated by new thinking. Taking just one example of research with similar objectives to the illustration above, McAdam et al. (2017) adopted a longitudinal comparative case design in order to study how engagement with industry and end-users informs the business model of university technology transfer. Qualitative data (interviews and documents) were generated at four discrete points, separated by two-year intervals, and thematically-analysed using a rigorous coding process (Miles and Huberman, 1994). The findings were interpreted in terms of the transition of a business model from a 'triple helix' to a 'quadruple helix' model (Carayannis and Rakhmatullin, 2014). The authors report that: 'at the end of the research period, it was evident that both universities were in a state of disequilibrium and had slowly transitioned their [business model] to a point where they were exhibiting a hybrid [model] where they were exhibiting elements of both a [triple-helix based model] and a [quadruple helix based model] simultaneously' (McAdam et al., 2017, p. 468). In other words, change in the innovation business model is explained as incremental adaptive incorporation of new practices (i.e., novelty) between two equilibrium states (i.e., stability).

Examining the case data in our paper's illustration, it would be possible to draw similar conclusions to those of the research by McAdam and colleagues. The production of an operational model by the management at the centre following engagement with stakeholders, might be explained as a transition from the earlier modus operandi of the host university TTO towards a more user-facing approach. Adopting the language of McAdam et al we could have explained the operational model of the centre as a hybrid exhibiting elements of both the traditional TTO model and new approaches advocated by the centre's founders. However, such a conclusion simplifies the innovation dynamics of the centre's operating model, reducing changes to the model to 'before' and 'after' states, thus ignoring the enduring influence of past experience and re-imagining of anticipated future states.

The research methodology presented in this paper allows for a more nuanced understanding of the emergence of novelty during innovation management. This new methodology proceeds on the assumption that organisational life is understood as permanently 'on the move' (Hernes, 2014, p. 11) or in a perpetual state of *becoming*. As a consequence, an understanding of the emergence of novelty through innovation management may be elucidated through the analysis of the temporal construction of the centre's operational model (in our illustration), and not simply their social construction (i.e., the epistemology underlying McAdam et al., 2017). The B-series assumptions (McTaggart, 1908) of the latter leads to the Triple Helix model being place *earlier than* an hybrid model, which in turn is *earlier than* the anticipated future Quadruple Helix model. The explanation of novelty is thereby conceptualised as an unfolding of a series of discrete models. This leads these authors to conclude that the past operated to limit the transition by means of 'path dependence where the internal culture reflected … the norms regarding academic engagement with industry and end users' (McAdam et al., 2017, p. 469). In contrast, temporal construction involves building an understanding of categories from interpretations of data related to their past, present and future, that is to *time*. This result is a more nuanced explanation of how novelty emerges during innovation and how it is intertwined with prevailing arrangements through time. Thus, the past is not something that innovation managers must break away from, and the future is not something they strive to attain. Rather whilst being re-enacted (and framed in terms of an on-going view of temporality), both past and future also open to re-interpretations that make way for their creative influence in the present. It is in this way that it can be said that the past and future (i.e., time) is *active* in the innovation process.

To recap, the methodology outlined here enables researchers to capture the influence, activity or in the most extreme sense the agency of time in the innovation process (Hernes, 2014). This is important because process studies of innovation implicitly highlight the significance of time (both A and B series), yet all have been unable to capture or otherwise elucidate *what time does* in the innovation process, principally because existing process methods are rooted in an understanding of time that implicitly denies the possibility of temporal agency (Hernes, 2014). Following the methodology that we outline here, temporal agency becomes visible and amenable to analysis. This has significant implications for any area of IMR that attempts to unpack different aspects of the process of innovation management, some of which are elaborated below.

6.2. *Implications for innovation management research*

As suggested above, our methodology allows different innovation management processes to be re-examined in order to explore how they are

actually *accomplished*. In other words, our method allows us to probe more deeply into IM processes that appear to be settled, fixed or taken-for-granted, to explore how this apparent settlement or fixity is achieved, thus unveiling the *becoming* of innovation management. Thus, the scope for future research, that emphasises the *becoming* of innovation management and the associated activity of time is vast, since all innovation management processes become open for re-examination. Therefore, we would encourage future research that first unpacks the dynamics of established innovation management processes. In the following paragraphs, we suggest some specific aspects of IM literature for which a temporal construction methodology might prove generative.

Following Chesbrough's seminal work (2003), accounts of open innovation (OI) have either explicitly or implicitly, framed the phenomenon in contrast to closed innovation, and this creates paradoxes. For example, one particular intractable problem for theories of OI is to explain the simultaneous need for an organisation to protect its own intellectual property in order to secure appropriate returns (cf closed innovation), whilst at the same time engaging in open forms of collaboration with other organisations (Bogers, 2011; Laursen and Salter, 2014). Existing explanations of OI express the interactions between organisations in terms that reveal their B-series temporal foundations. These organisational demarcations between 'in-here' and 'out-there' dissolve with the A-series temporal assumptions of the analysis we present in this paper. In this manner, research might ask how classifications of innovation as 'open' and 'closed' are drawn and given definition by the pasts, presents and futures invoked in the innovation process. This novel approach would allow researchers to contribute to the research agendas articulated by leading OI scholars. For example, the comprehensive framework for OI research advanced by Bogers et al. argue that theory of OI must deal with paradoxes and explain the 'inherent interdependencies in OI' (2017, p. 28). In their more recent exploration of open innovation in a digital age Enkel et al. call for novel methodologies that examine interdependencies and co-evolution (2020, p. 165).

The concept of organisational ambidexterity is an important one for IMR as it concerns a capability to manage current demands (expressed as 'exploitation' in this literature) whilst innovating (or 'exploration') for the future (Turner et al., 2013). The concept is also inherently temporal in nature (March, 1991). An important thread of current research relates to the paradoxical relationship between exploration and exploitations and resolving the organisational tensions that follow (Raisch and Zimmermann, 2017; Koryak et al., 2018). Indeed there have been calls for taking time into account in ambidexterity research (Raisch et al., 2009, p. 689). Adopting a temporal construction methodology would allow IM researchers to explore how the demarcations around 'exploration' and 'exploitation' are made and how these concepts are given definition as the innovation journey unfolds, thus providing richer accounts of how ambidexterity is actually accomplished.

Prompted by increased concerns surrounding climate change sustainability-oriented innovation (SOI) is emerging as an important aspect of innovation management (Adams et al., 2016). Sustainability has come to be defined as development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987); a definition that has led to the pursuit of business sustainability being informed by a principle of inter-generational equity (Bansal and DesJardine, 2014). Thus the management of SOI is temporal in nature. Slawinski and Bansal (2015) study how firms attend to the tension between the short-term and long-term that they argue is inherent to business sustainability. They identify three practices to managed this tension and coin the term 'temporal ambidexterity' as referring to 'firm's attempts to balance their short-term and long-term needs' (Slawinski and Bansal, 2015, p. 544). This call for a balance between present concerns and future possibilities here seems both reasonable, and also recognisable from those other areas of the IMR literature noted above. The methodology of temporal construction with its emphasis on interdependencies over time, offers a different framing of collaborative innovation between generations, and creates an alternative to the search for an elusive balance or accommodation.

One immediate way in which researchers could engage with this methodology would be to revisit data that they have wholly or partly analysed already. Studies that have sought to highlight the flexibility and subjectivity of time have provided a robust starting point from which to generate fresh perspectives on familiar situations (Garud et al., 2011; Dougherty et al., 2013). These authors have demonstrated that different temporal orientations are important in understanding innovation processes but have focused largely on the social construction of time by actors. While we recognise this as important, our temporal construction approach can extend this analysis by exploring *how time* defines (or constructs) actors, concepts and material elements of the innovation

process. That is how the past and future work in the present to connect, disconnect or otherwise reconfigure the seemingly fixed elements of innovation management. Whilst we are not arguing for the complete abandonment of the social construction of time, we are seeking to offer time an equal footing to actors, in the innovation process.

7. Conclusion

In this paper, we have argued that affording a more active role to time within processual studies sheds additional light of the organisational dynamics of innovation management. This methodology makes two main contributions. First, we offer a means of unpacking apparently stable dichotomies within innovation management, allowing for both to be incorporated within analysis without imposing a distinction between them. Second, our approach offers a way to appreciate the subjective, flexible nature of time in IMR, without relying solely on social constructivist accounts. Most importantly, our analytical approach provides researchers with a way to reveal the activity of time within innovation management. This is important because innovation management is an inherently temporal activity and established process methodologies often obscure the activity of time in existing IMR. We conclude by highlighting how this method may be usefully employed to re-examine innovation management processes, such as ambidexterity, open innovation, and sustainable innovation, enabling a focus on the dynamic accomplishment of such innovation processes.

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