Time in the Triple Helix: A Foundation for Innovation

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There has been considerable work investigating how the 'triple helix' enhances firm-level innovation. The contention is that innovation results from helix participants' activities. However, little attention is paid to the potential for the participants' different temporal frameworks to disrupt innovation. Understanding time in helix activity is therefore important. We describe how participants were able to adapt their temporal frameworks and build 'helix time', based on qualitative data from three helix projects. We theorise that key to building the temporal consensus of helix time is a preparedness to share temporal conceptions and individuals/or institutions capable of temporal boundary spanning.

INTRODUCTION

Over the past two decades, there have been a number of studies, conferences, and special issues dedicated to the role of the triple helix[1] – government, industry, and universities – in enhancing firm-level innovation. The central argument of the 'triple helix' concept is that innovation derives from the interaction and learning between industry, government(s), and postsecondary institutions (Etzkowitz, 2003, 2008; Etzkowitz & Leydesdorff, 1995, 2008). Many have focused on the role of universities in fostering commercialization (Benner & Sandstrom, 2000; Erno-Kjolhede, Husted, Monsted, & Barledo Wenneberg, 2001; Etzkowitz, 2003; Etzkowitz & Leydesdorff, 2000). While others have examined the helix in practice (Bressers, 2012; Jauhiainen & Suorsa, 2008; Johnson, 2008; Khorsheed & Al-Fawzan, 2014; Lundberg, 2013) as well as the networks and relationships between helix organizations (Bressers, 2012; Chen, Lin, & Chu, 2013; Gulbrandsen & Swmeby, 2005; Huggins, Johnston, & Steffenson, 2008; Luna & Velasco, 2010; Martinelli, Meyer, & von Tunzelmann, 2008). The concept of time in helix activities, however, has received very limited attention despite the vastly different temporal frameworks of these helix organizations. Importantly, these different temporal frameworks have the potential to disrupt relationships between helix organizations and, as a result, innovation. Moreover, recently there has been a call for more research on how temporality is negotiated in organizations (Granqvist & Gustafsson, 2016). Fillings these gaps in understanding time in the triple helix and adding to the sparse literation on temporal negotiations is, then, important.

This paper addresses these gaps by examining time in an inductive, micro-level qualitative study of three innovation projects led by the Harris Centre[2], the public engagement arm of Memorial University of Newfoundland in Canada. Our examination leads us to develop the concept of 'helix time'. Helix time is

particularly complex due to the variety of temporal frameworks used by participants compared to single organization projects where participants usually share a similar temporal framework. During helix work the coalescence of these different frameworks creates a unique multifaceted temporality. Helix participants – those doing the work – in addition to their individual temporal expectations and norms, are influenced by their organization's particular temporal culture (e.g. universities have a different temporal framework, tenure, academic calendar etc. – than government, fiscal years, 9 to 5 work patterns etc.). Participants seeking to work together on helix projects must be able to change and adapt their temporal frameworks to those of other participants and the project needs itself. As a result, negotiating, understanding, balancing, and modifying these times are key management activities that create a foundation for effective triple helix work.

The remainder of this paper proceeds in five main sections. In the next section, we develop a deeper understanding of helix time using the organizational management literature, where time studies enjoy a long history, to build our understanding and untangle helix time complexities. This is followed by a discussion of our methodology and our findings, which is largely based on data from interviews with twelve key participants and describes their temporal frameworks. In our analysis section, we discuss how helix time is built and start to construct a theory of helix time. We conclude by examining the main implications of our research for helix activities and suggestions for future research.

LITERATURE

To develop a deeper understanding of time we turn to the organizational management literature where time studies not only enjoy a long history (for example, see: Taylor, 1911) their temporal conceptualizations are useful and appropriate for developing an understanding of helix time. A number of scholars have attempted to define, organize, and categorize the scholarly work related to temporality (for example, see: Ancona, Goodman, Lawerence, & Tushman, 2001a; Ancona, Okhysen, & Perlow, 2001b; Bluedorn & Denhardt, 1988) and as Shipp and Cole recently noted, "…there is no single theory of time" (2015, p. 238). Here we will confine the discussion to a number of temporal ideas/theories/ conceptualizations that aid in the understanding of helix time. This includes the social construction of time, the concepts of entrainment and managerial time, the co-mingling of past, present, and future time, and the scheduling of activities in time.

Our study of helix participants and their activities leads to literature on temporal theory focused on how time is experienced and built. An appropriate starting point – and crucial to understanding helix time – is the theory of socially constructed time developed by Orlikowski and Yates (2002) building on Giddens' (1994) notion of 'structuration'. They suggest that 'temporal structures' are the processes through which time is experienced during "…people's everyday engagement in the world. As part of this engagement people produce and reproduce what can be seen as temporal structures to guide, orient, and coordinate their ongoing activities" (Orlikowski & Yates, 2002, p. 684). Helix participants, according to this theory, would therefore dynamically and collectively build their temporal framework/helix time as they work, based on their temporal worldviews. The social construction conception is key as it emphasizes both the dynamic nature and how a shared temporal conceptualization, in this case, helix time, is built by participants. The social construction of time also supports the view that temporality is modified by context. Thus, using this theory we can start to build an argument suggesting that helix time exists and is distinct from the other temporal frameworks participants enact and construct.

We also experience time as cyclical, composed of cycles like the seasons or the biological life cycle. The theory of 'entrainment', borrowed from the natural sciences, suggests that the pace and cycle of organisational activities like projects can change to match or synchronise with another more powerful or dominant activity (e.g. fiscal year end, academic terms, calendar year) (Ancona & Chong, 1996; McGrath, Kelly, & Machatka, 1984) is also important in assisting our understanding of helix time. Entrainment is somewhat complementary and also different to Orlikowski and Yates' (2002) notion of temporal structures. Each suggests that, despite the forces of time that tend to reduce change, there could be innovations and adaptations as time's pace, cycles, rhythms, or structures. However, Orlikowski and

Yates (2002) posit a much larger role for human actors in effecting temporal structures, where workers both acquiesce and create the rhythms of their work lives, whereas Ancona and Chong emphasise that entrainment exists largely outside human interference - what they term an 'exogenous influence' - and is therefore less subject to human intervention (1996, p. 255). Given that helix time is heavily influenced by human actions, the prominence afforded to human actors by Orlikowski and Yates seems a more appropriate view, as long as the exogenous imperatives of entrainment are not entirely ignored. Using the idea of temporal structures also enhances our sensitivity to the construction of time during helix activities. They also help explain why the commodification of time or the idea that 'time is money' is so powerful and familiar to helix participants (Adam, 2003).

Dubinskas (1988a), in his work examining different temporal patterns in biotechnology firms, found what he termed 'managerial time', which likely influences time in helix work. Managerial time was closely aligned with clock and calendar time, these being understood and experienced by everyone in a similar way and therefore objective or homogeneous (See: Clark, 1978; Clark, 1985, for an insightful discussion of these theories). It also closely aligns with the idea of time is money. Dubinaskas goes on to describe managerial time as being tightly controlled and a time of "…short-term plans and closed-frame problem solving…linked…to a model of a world of finite 'economic realities' [his emphasis]…" (1988, p. 11). Managerial time, then, is characterised by intense project planning, driven by the economic realities of project work, and understood as such by project participants (Dubinskas, 1988a). In Gersick's (1989) and Lindkvist, Soderlund, and Tell's (1998) work, which examined time pressures during innovation projects, the clock and calendar temporal imperatives of managerial time drove project teams innovation's. Managerial time, then, is a powerful framework in most time worlds including those of helix participants.

Another relevant area of experiential temporal theorizing relates to how we might view the interaction of past, present, and future times. Schatzki posits a theory of time perception that involves, "…the co-occurrences of past, present, and future in the organization's actions, the joinings [sic] of past and future in the performance of these actions." (2006, p. 1871). Similarly, Adam in an thoughtful discussion describes the 'colonization of time', whereby "…contemporary economic and scientific-technology reach into the past and future." (2003, p. 71). Both Schatzki's and Adam's work echoes Gurvitch's (1964, see also Clark, 1985) slowed down 'enduring time' where the present seeks to control and dominate the future. Most recently, Lord et al., (2015) in their theoretical work apply notions from quantum mechanics to suggest a temporal flow whereby potential futures move towards the present – thereby enabling, they argue, a view of alternative futures from the present. The main significance of this theorizing for helix work is that it highlights the potential co-mingling of past/present/future, the pressure on project teams to be able to predict or dictate the future, and, similar to the social construction of time theory, the potential for changing interpretations of time.

How we map activities to time, where the focus is on the rate, duration, and scheduling of activities also affects our experience of time in helix work (Ancona, et al., 2001a and b; Mitchell & James, 2001). Here, rate refers to how often an activity occurs (e.g. once, multiple times during a project etc.), while duration delineates how long the activity takes, and scheduling takes into account when the activity(s) takes place usually in relation to other activities like a project. Helix participants and particularly those with project management responsibilities would create project schedules based, in part, on their heuristics associated with these time variables, creating schedules that reflect expected rates and durations during project work.

Finally, in the last few years an embryonic conversation has developed related to how temporal work is negotiated (see for example: Das, 2006; Renecke & Ansari, 2015; Slawinski & Bansal, 2015). One of the interesting strand of this conversation relates to whether and how actors change, build, and settle their temporal orientations to suit work or organizational needs. Curiously, some authors suggest that temporal negotiations amongst organizational actors leads to open and transparent change settlements (Kaplan & Orlikowski, 2013) and while other suggest settlements are concealing conflict and leading to covert actions (Granqvist & Gustafsson, 2016; McGiven et al., 2017).

This overview of time literature provides a strong theoretical backdrop for addressing the objectives of our work. Despite times' complexity, utilizing these theories enables an understanding of how project participants create, view, and modify time. Specifically, our objective is to address the following questions: what are the shared and unique temporal conceptions of the organizations/participants involved in triple helix projects; what is helix time and how do project participants build and manage it; and what theory of helix time can we develop from this understanding? After describing our methodology in the next section, we will move to a discussion of the different time worlds for each helix participant in the findings section, where these theories are exhibited in their activities.

METHODOLOGY

This paper is based on qualitative data from interviews with twelve key participants and documents related to three helix projects led by the Harris Centre (**HC**) - helix relationships are usually based on projects and are an accepted unit of analysis (Edmondson & Nembhard, 2009). The HC was established over 10 years ago to facilitate and coordinate Memorial University's activities in regional economic development and public policy. It had a unique role on campus as a trusted knowledge broker and mobilizer of helix projects. These three projects represent a cross-section of the numerous projects the HC has been involved in since its creation. All three projects involved participants of helix organizations and examined some aspect of firm-level or social innovation in the province of Newfoundland and Labrador (see, Table 1 for more details).

TABLE 1
PROJECT DESCRIPTIONS

Project Title	Description	Triple Helix Activities
Social Dynamics of Economic Performance in City-Regions	This project was focused on three themes: the social dynamics of innovation, talent attraction and retention, and civic governance and inclusion.	• Advisory Committee • Participants at workshops and other meetings • Research participants
The Rural-Urban Functional Regions Project	A multi-partner social innovation initiative to assist stakeholders in better understanding the interdependencies between urban and rural communities and labour markets as well as develop new tools for policy and practice	• Advisory Committee • Participants at workshops and other meetings • Research participants • Dissemination and implementation of project results
Advancing Innovation in Newfoundland and Labrador Project	This project was concentrated on synthesizing and sharing knowledge related to innovation and ways it can be fostered with key innovation stakeholders	• Advisory Committee • Participants at five workshops and an innovation summit • Dissemination and implementation of project results

Involvement by participants ranged from committee membership and document review to participation in dissemination and implementation of project results. The interviewees were drawn from

each triple helix organization and included senior and junior personnel (for more details, see Table 2). Most had participated in all three or at a minimum two of the projects. The interviews, conducted by the co-authors, were semi-structured and lasted from 20 to 50 minutes. In addition, we were granted access (with some restrictions) to project documentation (e.g. emails, meeting agenda's, and project charters, and evaluations etc.).

TABLE 2
INTERVIEWEE: DESCRIPTION & PROJECT ROLE

Helix Actor	Description	Project Role
Government	• One representative from local government • Two representatives from the provincial government • Two representatives from the federal government	• Financial Support • Committee Membership • Provide relevant documents and information • Document review • Dissemination and implementation of project results
Industry/Business	• Two representatives from industry associations or organizations that work directly with businesses • One business person	• Committee Membership • Provide relevant documents and information • Document review • Dissemination and implementation of project results
University	• One tenure-track scholar • One tenured scholar • Two administrators	• Financial Support • Project coordinators • Committee Membership • Research, writing and presentations • Dissemination and implementation of project results

We used an inductive approach in our data analysis, which occurred in two main phases (Denzin & Lincoln, 2017; Yin, 2003; Gioia, Corley, & Hamilton, 2012). In the first phase, the transcribed interviews and documentation were reviewed with the objective of identifying any time related matters. This phase of the research was open-ended, exploratory, and iterative (Bryman & Bell, 2007). More specifically, we examined the data with an interest in answering three main interrelated questions:

1. What were project team participants' times during the helix activities?
2. What aspects of time (e.g. clock time) were affecting the activities? And
3. What was the impact of various times on the activity and triple helix participants?

A number of major themes emerged from this iterative preliminary examination, including:

- the impact of time was multifaceted;
- the role of project coordination was highlighted; and
- participants had an understanding of the various times affecting project activities.

In the second phase, the analysis focused on the emerging themes and understandings generated in the first phase. In this phase we applied a coding system based largely on the three temporal categories – conceptions of time, mapping activities to time, and actors relating to time – suggested by Ancona et al (2001b) to the interviews and documents. Using this coding system, we focused and developed our ideas which resulted in our main findings and subsequent discussion.

FINDINGS

Our findings are divided into two main components. First, we describe the shared time conceptions of helix participants. Secondly, we discuss the different temporal conceptions of helix participants based on whether they work for government, university, or industry. We divided our findings using these two components to highlight the shared temporal conceptions, which enable the construction of helix time while acknowledging the different timeframes that can lead to temporal tensions that might threaten helix work.

Shared Time

Project participants shared a number of time conceptualizations. Naturally, project participants shared the project schedule. The power of project schedules to promote collaboration between those with different temporal frameworks has been noted in other work (see for example: Tukiainen & Granqvist 2016; Yakura, 2002). Of particular interest, in terms of helix time, was the construction of two shared times unique to these HC managed projects. Participants agreed to the time needed to, what the HC termed 'ground truth', project findings. Ground truthing involved participants travelling to locations throughout the province and discussing/soliciting feedback in public meetings/workshops on preliminary project findings. These 'roadshows' in a large province like Newfoundland and Labrador required substantial participant time (e.g. up to two days for some, as travel to certain locations could not be accomplished in a day) and contributed to a longer project schedule. However, project participants considered workshops essential for knowledge flows – which lead to innovation - and for legitimizing the project's work to all stakeholders. Similarly, participants, in order to save time at the end of projects, granted report authors - normally a project output would include a written final report - editorial authority, thereby reducing the time that would likely be otherwise needed to negotiate report wording. This, given the political sensitivities of project participants and funders was no minor concession, as they would normally require an extended period for approvals and revisions on any document that carried their name.

Participants also had a similar view of clock time or, as described by one interviewee, 'project' time. They recognized the imperative of trying to adhere to agreed deadlines and attending meetings on time. In other words, they understood a schedule based on clock and/or calendar time. Indeed, all interviewees made reference to the project schedule when asked about time in the projects. Helix activities, particularly projects, are conducted against this backdrop of managerial time that consists of precise and controlled clock/calendar time schedules and most participants shared and often accepted, without question, this managerial time perspective as normal.

Most interviewees also perceived projects as being loosely cyclical. The key cycles in helix activities were project lifecycles (i.e. start, middle, and end) and the budgetary fiscal year. Helix participants would normally have had experience with the project lifecycle and fiscal years and implicitly understood their rhythms. Arguably, the best candidate for a dominant timeframe or pattern was the project schedule. The beginning would often be characterized as enthusiastic, participants were anxious to get the project going or as one interviewee noted "there's interest and excitement on day one." The end was often seen as rushed with participants trying to finish the work or as one interviewee described it "I think the finish is always too rushed. Because you've reached the point of there's a deadline or exasperation." The project cycle was a temporal framework that all participants usually agreed upon and shared.

A number of interviewees also noted a shared understanding of project funding timeframes. For example, government funded-research usually has strict fiscal year-end requirements. As one interviewee explained, "for us our cycle is fiscal. So it's March 31. That's when the money disappears. So you got to have it done before that." This both fixed and, in many instances, enhanced adherence to project schedules. Interestingly, a number of the participants we interviewed also shared a reasonably clear idea of the timeframes affecting other participants. For example, one business interviewee noted that: "…government is not gonna (sic) move at the speed of industry…", while a university interviewee noted that: "…whereas we academics might have been more comfortable in stretching things out a little bit more…normally they (referring to business) want things done in a pretty timely manner…". Finally, all

interviewees, unsurprisingly, experienced some degree of lack of time during the project activities. One interviewee described this time scarcity evocatively as being "…torn in a thousand directions…"

University Time

University time is complex with university participants being affected by different temporal imperatives. There were distinct differences between the time conceptualizations of university faculty and HC employees. For faculty, their 'career' time - where they are in terms of their careers – had crucial temporal influences. Postdoctoral researchers and tenure-track faculty (i.e. junior faculty, who typically have five years in which to achieve a permanent position at Memorial) were extremely sensitive to delays that could impact 'academic' outputs like journal articles. Tenure-track faculty also needed to balance research with other time commitments like teaching and service (i.e. working on university or faculty committees). This 'tenure time' was a preeminent temporal concern and it has the potential to override helix project work which is not typically highly regarded in the evaluation of tenure track faculty. Tenured faculty also experienced similar time pressures. One tenured interviewee described it as a trade-off between writing papers versus working on helix projects that might include travel and meetings and "giving up multiple days of writing." Several interviewees described, in general terms, how the academic timeline does not always align with helix activity timelines. One academic interviewee noted, for example, that the time commitments needed for teaching often meant that they were only available for helix work when the semester was over. While another interviewee described at length the impacts the academic timeline has on businesses:

> *I deal with...private sector companies…that have tried to engage the university on a research project for example. The university will be on a certain timeline, which is built maybe around an academic year. You know availability, well I'm teaching this semester I'll deal with that next semester. The companies are built around things like fiscal year ends but also bid deadlines. You know I have to have this bid in, if the bid is not in it doesn't matter…it's not a case of oh we know you're going to work that out later. If you don't have that firmly in place every partnership nailed down the bid doesn't happen right.*

University faculty time was, then, based somewhat on seniority and heavily influenced by the temporal requirements of tenure and teaching.

On the other hand, staff in the Harris Centre (HC), which was housed in the university, could prioritize helix projects giving them the ability to work on a project fulltime, if needed. Their position in the project was unique because, while they are part of the university and considered a knowledge broker, they are not an academic unit. In this way, they straddle or boundary span the divide between university and other organizations. Supporting this boundary spanning ability was the HC's intimate knowledge of time inside and outside the university. In the words of one HC employee "…we were built to do this work [referring to triple helix work]…" Importantly, the HC had developed the ability to balance the time constraints of participants and organizations in the triple helix. For example, project funders and university accounting procedures and timeframes seldom match. In response, the HC has developed expertise enabling them to navigate the procedures in these organizations to ensure that the timeframes of project funding match project needs. In a sense, they had developed helix time management expertise. This expertise was also apparent in the HC interviewees when they discussed the necessity for perseverance, relentlessness - a near ruthless project management ethos - in driving the projects, and the need to create a project charter that identified roles, relationships, and timelines. In addition, one of the HC members inevitably takes on project management responsibilities. Many interviewees from other helix organizations identified a key person from the HC who 'regimented' the project, keeping it going and, more or less, on time.

The HC had also, as one HC based interviewee noted, developed other time management strategies for helix projects. In common with project management generally, they have come to expect the unexpected and build in slack or redundancies, so even unpredictable events did not usually prove fatal to a project. Despite their project management abilities, the HC employees did emphasize the need for participant cooperation. Put simply, they cannot force other participants to act, which may not be the case

in single organization projects where project management has greater authority. As one HC interviewee explained, when asked how project timing could be improved:

> *I think more rigorous project management schedules, tracking, nagging but the reality is we weren't the boss of most of these folks. So you have peer pressure, you have guiltiness, some financial imperatives we, I think, have developed the ability to manage the unmanageable and that doesn't mean control, that doesn't mean prediction that means adaptable systems.*

The HC, therefore, played a unique role in comprehending different participant times, anticipating unexpected events, and balance these against the requirements of the project schedule.

Government Time

Government time had both common elements and differences based on the type of government (e.g. municipal, provincial, or federal). In general, all government participants were affected, to some extent, by government time - the timing of government budgets, elections, and cabinet shuffles etc. - which could disturb helix project schedules. There was also a temporal aspect to getting credit for the helix work. In some instances, elected officials wished to announce findings that suited their political timeframe versus a time that suited other helix members or the project's schedule. Many government participants were unionized and had set working hours. While government interviewees did not explicitly mention this, they did talk about convenient meeting times during the day. Both university and business participants were aware of this aspect of government time. For example, one interviewee described how often government participants are only available during the week until 4:30pm, which did not always align with business or university timeframes that could include weekend work. Government interviewees also discussed how their time commitment extended beyond the project work and project conclusion, as they would often need to prepare briefing notes or implement project results after the project had finished for other participants. As, one interviewee explained,

> *What happens with us is as government if we're involved in any of these projects. We have to be responsible to report back to the department. So my time commitment isn't necessarily on the project itself it's writing the briefing note to inform our superiors, whether it be Manager, Director, ADM* [Assistant Deputy Minister]*, right up through.*

As a result, their helix work usually had a longer timeframe than that of the university and business participants. Finally, government participants were highly sensitive to the project budgetary cycle which, if the project was funded in whole or in part by government, was usually a one-year timeframe (in Canada, April 1 to the following March 31st) with funding agendas and budgets usually set in September/October of the preceding year.

Government time in the Newfoundland and Labrador context also depended, in part, on whether participants were federal, provincial, or municipal employees. Municipal government participants usually have less time to work on helix activities. As one interviewee noted their core function is to serve citizens "…in a direct way…" thereby leaving them with little time for additional activities. Provincial government participants, especially at the senior level (e.g. Deputy Minister, Assistant Deputy Minister), had a more variable temporal work rhythm and needed to assign priority to unexpected events making them well-intentioned but often unreliable participants. This led, in part, to a constant churn among provincial government people in the projects, whereby a senior person would often have different staff step into the project on their behalf. These more junior government participants, while able to devote more time to helix activities, were less likely to fully engage being often cautious about what they said or did (i.e. they were less able to commit departmental time and other resources or comment, in a timely manner, on needed information or government processes). Some of these more junior participants were explicitly told that they needed to ensure time spent on projects did not encroach on other work. This meant helix project time was not counted as part of their government work time. One interviewee, though not from government, insightfully suggested that federal government participants seemed the least time challenged because they "…are not in Ottawa [Canada's national capital] close to the minister [i.e. the senior politician in the ministry]…so that the distance from the minister gives greater capacity to engage

and fulfil commitments without the daily, on the spot [ministerial] command to do briefing notes…". As these examples demonstrate, government, like university, has a number of timeframes operating simultaneously and times that are influenced by the type of government and participant seniority.

Business Time

The overriding time issue for business participants was the simple lack of clock time, which made it difficult for them to engage with helix project activities. Time spent on helix activities often meant time spent working away from the business and as one industry interviewee noted 'time is money'. For example, one business participant (a consultant) noted that he divided time into 15 minute segments and that every waking hour was a potential billable hour. In addition to the lack of time, interviewees also noted that businesses often "…lacked patience…" One interviewee compared this notion of time to government and academic time, explaining:

> *In general business doesn't want to waste time, so if they're coming to a meeting they want to make sure that it's productive and it's not just a session to sit and discuss nothing. So the sense is that when you sit around the table, government is used to a bit more free time for other discussion but business wants to get right to the point because they want to get back to work. They want to leave the meeting and go back to their business whereas there's a lot more discussion on the academia side of things. They tend to see all the what ifs and what fors…*

Another interviewee noted how the private sector also wanted a tangible deliverable from helix work that could be acted on immediately. They explained that their "measurements are today" versus government and academia which have different measurements that are longer term. Business participants were also concerned with bid time, the time needed to respond to request for proposals as well as quarterly or three-month time cycles rather than a fiscal year. Business participants where then willing though impatient, driven by the need to make the duration of activities as short as possible.

ANALYSIS

The purpose of this research was to address a number of questions related to helix time: what are the shared and unique temporal conceptions of the organizations/participants involved in triple helix projects; what is helix time and how do project participants build and manage it; and what can this contribute to the development of a helix time theory? In the previous findings section, we addressed the first question and in this section, we will address the remaining two. Clearly emerging from our data were key elements in the building and managing of the different perceptions and imperatives of 'helix time'. Project schedule adherence among participants was, arguably, the most important in the building of helix time. The theories of socially constructed time, entrainment, and managerial time help to explain this adherence to schedule. Orlikowski and Yates (2002) suggest that socially constructed time is based on shared temporal structures that enable work, including project work, to be done collectively because the workers mutually observe and follow shared times. In these projects this theory explains the ways in which helix participants use and re-use more or less shared temporal structures in their repertoire of helix activities and also, crucially, that these times are changeable. They put it this way:

> *Our (temporal) structuring lens sees this not so much as the existence of multiple times, but as the ongoing constitution of multiple temporal structures in people's everyday practices. Engagement in such temporal multiplicity has important consequences for people's experiences of time. That is, by enacting multiple and often interdependent temporal structures, actors engage with alternative, interacting, or contradictory expectations about how to temporally structure their activities…through such engagement they…may realize the possibilities of alternative temporal orders, and may act to* ***change*** [our emphasis] *their practices, and thus their temporal patterns.* (Orlikowski & Yates,2002, p.687).

This is a subtle and important point which when applied to the helix context highlights that not only are there multiple times in the participant's lives, but also that these times can interact and change to

affect helix work. Understanding the interaction of multiple temporal structures may enable participants to change or reconstitute the temporal structures that affect them. In their work examining time in projects, Nandhakumar and Jones (2001) observed participants changing time to suit project needs. Similarly, Kaplan and Orlikowski (2013) in their work investigating the temporal effect on strategy practices in a technology firm found that participants negotiated and linked their sense making temporal frameworks. In our research, helix participants created a unique helix time, for example, when time was added to the schedule enabling ground-truthing. Arguably, different helix times could be created for each project.

Orlikowski and Yates similarly noted that changes to temporal structures are often associated "with innovations intended to improve industrial, organisational, or societal effectiveness." (2002, p. 687). Likewise, the central argument of the "helix" concept is that social and economic innovation derives from the interaction and learning between industry, government(s), and postsecondary institutions (Etzkowitz, 2008, Etzkowitz, & Leydesdorff, 1995, 2000). Change or innovations to a participant's and project's temporal foundations, therefore support and assist the innovative purposes at the heart of helix work. Put another way, innovations to the temporal foundations, arguably, enable innovations in helix outputs – innovating to innovate.

In its timekeeping project role, the HC was enhancing the ability of entrainment to generate temporal consensus. This was another major element in adherence to project schedule. Participants and organizations were entrained to a project's temporal needs assisted by the HC's timekeeping role (i.e. managing and driving projects). Despite the other temporal frameworks in their lives participants respected the project timeframe enough to ensure its success. Our research suggests that participants developed their understanding of other participant's time worlds because of their project involvement. Also working in favour of entrainment was the strong relationship between time and management, suggested by Dubinskas (1988a). Managers, he argued, are more clock/objective time orientated than other professional communities. While university and government helix participants may come from outside the managerial class, they are usually very familiar with managerial time having been previously exposed to management thinking of various kinds. This was certainly the case in the projects we examined. The effects of managerial time assisted entrainment here in the sense that it was a powerful representation of time and, thus, lent power to the HC project managers.

Individuals and/or institutions like the HC also seem essential for the temporal boundary spanning needed for constructing helix time and coordinating activities, particularly in helix projects where participants have disparate temporal frameworks. The absence of conflict and covert temporal politices which was noted by other researcher (i.e. Granqvist & Gustafsson, 2016; McGiven et al., 2017) was likely due to HC's ability and, of course, that in these projects participants were usually willing volunteers. The HC has developed the sensitivity and understanding to span the time views of helix participants. As part of the university, it is familiar with that temporal worldview and also has key employees who have extensive experience working for government and business. As one HC interviewee noted "I think about fiscal year from both the government and…university perspective." Lundburg (2013) in her work examining a Swedish helix project underlined the need for boundary-spanning individuals and organizations in helix projects. She noted that: "…the Triple Helix model provides no practical directions on how to bridge differences and nurture cooperation. Undoubtedly, the differences…call for boundary spanners…able to connect systems...among conflicting demands…[and provide the semantic translation] needed to bridge and mediate cultural differences." (p. 213-214). With their boundary spanning understanding of different temporal frameworks, the HC was able to, for example, find participants project roles derived, in part, from an appreciation of their framework (e.g. university participants conducting their work in non-teaching terms).

The HC's temporal repertoire included the ability to track time in multiple temporal frameworks. As one interviewee noted, the HC operated with logistical time – the time of calendars and clocks used to control project administration – coupled with an "…almost zen state of project management efficiency, manic delivery, coupled with a lack of continuity, lack of predictability, lack of effectiveness and capacity in all parts around us." As a result, the HC was on the one hand, clock and schedule driven and on the

other, relaxed about the schedule, accepting of delays and prepared to change a projects timeframe to suit circumstances.

Like the HC, scholars have also noted that the formal accounting for time designed to measure and control work and workers is likely to be poorly suited for tasks where the project-based work needs to be flexible and collaborative as it does in helix projects (Nandhakumar & Jones, 2001). Individuals and/or institutions like the HC must also innovate with time in order to support and drive the innovation needed for helix work, as previously noted – innovating to innovate. Even at a mundane level, the coordination of helix activities requires innovation around temporal constraints. For example, using scheduling tools like doodle, scheduling meetings over breakfast or lunch, or partnering with other events that already involve participants. The simple mechanics of multi-organization collaboration demand detailed attention and constant innovation, with the management of the temporal elements of the various helix organizations representing a challenge to successful project outcomes. The HC's nuanced understanding of time and the mechanics of project administration coupled with a willingness to innovate at this foundational level likely enabled or, at least, enhanced the helix work. In sum, these projects provide a solid illustration of helix time construction and management.

While our methodology does not enable broader theoretical generalizations, it does offer some important foundations for developing a theory of helix time. The first point for discussion is: why posit a helix time at all, isn't the pre-existing temporal theorizing enough? The short answer is, no for a number of reasons. The complex nature of helix activities has already been identified as distinct and worthy of separate study and we argue that this extends to their temporal frameworks. There are also precedents for conceptualizing helix time as something separate from other temporal frameworks. The precedent of managerial time proposed by Dubinakas (1988a) described above is very useful for highlighting the peculiarities and implications of that temporal framework. Our work here clearly describes the three-distinct participant temporal frameworks. Finally, more prosaically, we can all appreciate, from personal experience, the colleague or acquaintance that seems to function in a different temporal framework i.e. is always 15 minutes late. As a result, we think there is precedent and a need for theorizing about a particular temporal framework like helix time.

In an effort to help this process, we see a number of potential components in a theory of helix time. Helix time seems to require that one of the organizations involved in a particular project take the temporal lead. Just as, in the projects discussed here, the HC provided the temporal lead. This role was, perhaps, made possible or partially legitimated by their position as a boundary spanner/honest broker in the community and by their given position as project lead. It may be natural in these projects for the project lead to recognize and also fulfil the role of temporal lead. Secondly, participants must agree and adhere to their project's helix time – and this in itself will be innovative to most. Helpful in this adjustment process would be familiarity with temporal frameworks like clock time and project schedules. Participants would, then, need to be explicit about their temporal framework(s), adjust them for helix time, and discuss potential temporal problems and solution. Thus, and thirdly, unlike the generally applicable prerogatives of say managerial time, helix time is uniquely constructed in each project, and, indeed, seemingly dynamic within a project, whereby adjustments are made during project activity. Despite this fourth dynamic aspect in helix time, also key here is familiarity with clock and calendar time temporal frameworks which provide an overarching temporal framework implicitly understood by participants enabling a basis for the initial conversation about constructing helix time.

Therefore, an initial theory of helix time posits that effective helix time is constructed by participants from their pre-existing general and organization specific temporal frameworks, requiring a temporal lead and dynamic modification during helix work.

CONCLUSIONS AND IMPLICATIONS FOR HELIX MANAGEMENT

In examining time in these three projects we see a number of implications and avenues for further research. The key implication of this work is to underline the importance and complexity of time as a foundation in helix projects. By examining the multiplicity of times in these helix activities we have been

able to, as Clark (1985) suggests; "…penetrate behind the metaphor of clocktime… to incorporate a notion of the plurality of time-reckoning systems which are embedded in the social constructs of organization members and in their individual biographies." (p. 36). Our work demonstrates that time in helix work is complex and deserving of further research. In particular, additional research could examine time's impact on the success or failure of helix activities. We strongly suspect, given its influence, that times play a significant role in the outcome of helix activities. We already know that projects in general are judged a success if they simply meet their schedule (see for example: Alvesson & Karreman, 2004; Lindkvist et al., 1998). While judgements about the success of helix projects would need to be more nuanced, the role of time in contributing to project success or failure should be the subject of more research, especially with projects that are considered failures.

On a practical level, there are several implications this research offers for day-to-day helix management activities. Helix project participants need to discuss time explicitly during the initial set-up phase of the project. This discussion should also move beyond the project schedule to examine each participant's particular temporal framework. This could enhance helix activities by promoting greater understanding between participants and would also make, as suggested by an interviewee, time at the beginning of a project for relationship building. In addition, an explicit discussion of time would ensure participants are consciously aware of each other's temporal frameworks and could foreshadow a change to their temporal framework to meet project needs. Or, in other words, enhance the prospects for the creation of a project appropriate helix time. From another perspective, helix participants and organizations should not depend on entrainment to work in an automatic manner. Instead, temporal modifications must be explicitly discussed to ensure project success.

Our research also suggests that having a lead entity like the HC drive the project process by convening meetings, providing timely logistical support and creating moments that enable shared decision making and collaborative action, can enhance helix activities. Most interviewees highlighted the role of the HC as crucial in these project activities. Ideally, this lead entity should, as the HC does, have a sophisticated appreciation of participant's and other organization's temporal frameworks. Overall, this research highlights the importance of time in helix work and the need for a greater understanding of how different temporal frameworks impact this work.

ENDNOTES

1. The triple helix conceptualization has been expanded to include the addition of community or civil society in the quadruple helix (Carayannis & Campbell, 2009; Leydesdorff & Etzkowitz, 2003) and more recently the environment in the quintuple helix (Carayannis, Barth & Campbell, 2012).
2. More information on The Leslie Harris Centre of Regional Policy and Development can be found at: http://www.mun.ca/harriscentre/about/ The Centre's work has also been noted by the OECD (Garlick, Davies, Polèse, & Kitagawa, 2006).

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