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University–industry collaboration: using meta-rules to overcome barriers to knowledge transfer

A. Alexander¹ · D. P. Martin² · C. Manolchev³  · K. Miller⁴

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Abstract

University–industry knowledge transfer is an important source wealth of creation for all partners; however, the practical management of this activity within universities is often hampered by procedural rigidity either through the absence of decision-making protocols to reconcile conflicting priorities or through the inconsistent implementation of existing policies. This is problematic, since it can impede operational effectiveness, prevent inter-organisational knowledge-creation and hamper organisational learning. This paper addresses this issue by adopting a cross-discipline approach and presenting meta-rules as a solution to aid organisational decision making. It is proposed that meta-rules can help resolve tensions arising from conflicting priorities between academics, knowledge transfer offices and industry and help facilitate strategic alignment of processes and policies within and between organisations. This research contributes to the growing debate on the strategic challenges of managing knowledge transfer and presents meta-rules as a practical solution to facilitate strategic alignment of internal and external stakeholder tensions. Meta-rules has previously only been applied in a computer intelligence context however, this research proves the efficacy of meta rules in a university–industry knowledge transfer context. This research also has practical implications for knowledge transfer office managers who can use meta-rules to help overcome resource limitations, conflicting priorities and goals of diverse internal and external stakeholders.

Keywords Organisational capability · University–industry collaboration · Knowledge transfer · Meta-rules · Strategy · Organisational learning

JEL Classification D23 · D81 · D83 · L1 · L80

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1 Introduction

Collaboration between universities and industry has been high on policy and research agendas ever since the Bayh Dole Act 1980 (Miller et al. 2018). In 2000, the European Council's Lisbon Strategy for Growth and Jobs identified the continued importance of academic knowledge for regional economic initiatives (Schoen et al. 2014). This encouraged universities to further develop their technology transfer policies and offices to help create, capture and diffuse academic knowledge. More recently Europe 2020, specifically targets 'smart growth'¹ through strengthening the connection between research institutions and industries (European Commission 2017). However, whilst there is considerable research exploring university–industry knowledge transfer (Cunningham and O'Reilly 2018; Perkmann et al. 2013; Rothaermel et al. 2007), understanding how to effectively manage this process on a day-to-day perspective still remains a challenge (Sharifi and Liu 2010).

University–industry knowledge transfer comprises of two-directional flows of know-how, skills, capabilities and knowledge between collaborating partners (Guerrero et al. 2015; O'Shea et al. 2008). It can occur across dyadic or multiple relationships and via a range of knowledge transfer mechanisms (or channels) (Alexander and Childe 2013). With increasing pressure to make an impact on society, combined with reduced funding streams, universities are actively trying to develop their collaborations with industry (Miller et al. 2014). From an industry perspective, knowledge transfer with universities can provide a source of new knowledge, skills and equipment which can aid innovation and economic development (Hobbs et al. 2017). However, despite the inherent benefits, challenges are remain. First, performance of university–industry knowledge transfer activities (in terms of the economic benefits) within Europe continues to be below the levels of the US and Far East (D'Este and Neely 2007; Easterby-Smith et al. 2008; PACEC 2012). Second, funding being offered by western economies for the creation of new knowledge in the university environment is reducing in real terms (D'Este and Neely 2007). Furthermore, the process of dissemination and diffusion of university knowledge is becoming more complex due in part to an increased number of actors involved in the process. Consequently, universities require the presence of effective internal mechanisms or frameworks to aid knowledge dissemination (Cunningham and O'Reilly 2018; Wit-de Vries et al. 2018; Argote 2011; Easterby-Smith et al. 2008).

In the past 10 years, many universities have realigned their business models to position research and knowledge transfer (or research and impact) as their first priority (Miller et al. 2018). Regardless of these shifts there has been an increasing practical divergence between aspirational and espoused behaviour. This is due to the misalignment of knowledge transfer activities with many of the established operational norms of universities, most notably the performance and promotion mechanisms which measure academics against their ability to publish, obtain grant funding for their research and of course, teach (O'Shea et al. 2008; Perkmann et al. 2011a, b). Despite this, academics are faced with pressures to extend their remit and become involved with external research collaborations, initiate service provision (contract research, executive education and consultancy), create a financial equilibrium between research and commercial income, achieve international visibility and have an impact on society (Alexander et al. 2016;

¹ The 'smart growth' goal is under the remit of the Innovation Union, which seeks to better convert knowledge and ideas into industry-embedded products and services (European Commission 2017).

Cunningham et al. 2018). This extended academic remit causes inherent challenges with scarce resource allocation for both academics and knowledge transfer offices, who are faced with pressures at an institutional level (McAdam et al. 2016). Furthermore what weighting to allocate to each activity is a source of contention for academics wanted to progress their career. University policies aim to balancing objectives of academics, knowledge transfer offices and industry, however, each have conflicting objectives which can affect behaviour (Miller et al. 2014) and as a result, a number of interlinked problems occur. First, the increased demands placed on academics, places the management of university–industry knowledge transfer in a contested terrain of organizational legitimacy (Suchman 1995; Thornton and Ocasio 2008; Dowling and Pfeffer 1975). Where knowledge transfer offices (KTOs) often struggle to achieve congruence or fit between knowledge transfer activities and the wider university institutional environment (Suchman 1995; Bansal and Clelland 2004). Second, challenges still remain on what are the ‘appropriate’ mode of university–industry collaboration, when there are conflicting priorities and policies prevailing and/or in some instances a complete lack of governance processes. Third, university departments often implement ad-hoc policies to suit their own individual situations, however this challenges the overall process of knowledge transfer. Furthermore, it can exacerbate problems of scarce resource allocation since universities operate in a field of competing stakeholder interests and it is not always clear what stakeholders objectives are being represented, and whose interests are being fulfilled (Alvesson and Willmott 2012). Fourth, while organizational processes have a purpose of fulfilling diverse stakeholders needs and expectations, there is an organizational ‘cost’ in the instance of asymmetry, opacity of decision-making and misplaced control within organizational systems (Deetz 2003). To overcome these problems, there is a need to create a context in which these conflicts can be identified (and competing processes examined), in order to improve the effectiveness of university–industry knowledge transfer processes.

This research aims to solve these problems by adopting an organisational knowledge ‘system’ (Suchman 1995) approach and proposing ‘meta-rules’ as a solution. Meta-rules are defined as ‘rules about rules’ and ‘information about information’ (Davis 1980), applying to the ‘epistemic’ rather than the ‘object’ level. They can help clarify the order of application of existing, codified rules within organisations (Dubois et al. 2011) to help organisational decision making. It is proposed that these properties can help resolve tensions arising from conflicting priorities between academics, knowledge transfer offices and industry and help resolve, inconsistent application of policies within and between organisations.

This research makes a number of key contributions. First it contributes to the growing debate on the strategic challenges of managing knowledge transfer and presents meta-rules as a practical solution to facilitate strategy alignment of internal and external stakeholder tensions. Second, meta-rules has previously only been applied a computer intelligence context. However, this research proves the efficacy of meta-rules in a university–industry knowledge transfer context. Third, this research extends organisational learning literature by illustrating the applicability of meta-rules to aid organisations to learn through embedding experience and multi-level alignment into their processes. Lastly this research has practical implications for knowledge transfer office (KTO) managers who can use meta-rules to help overcome resource limitations and conflicting priorities and goals of diverse internal and external stakeholders.

The paper is structured as follows, first, we consider the university context and outline barriers to establishing knowledge transfer mechanisms. Next, we discuss practical challenges for implementing established knowledge transfer mechanisms and propose

meta-rules as a decision-making approach. Lastly, we put-forward a reference framework, which can be used to derive meta-rules, enabling knowledge transfer implementation mechanisms for any given institution.

2 Knowledge transfer within a university context

Knowledge transfer in a university context is a term used to encapsulate a wide range of activities ranging from less formal joint projects between universities and industry such as joint publications, student projects and executive education to more formal collaborative research, consultancy and start up activity (Alexander and Childe 2013; Perkmann et al. 2013). University knowledge transfer activities exist at multiple levels and involve a wide range of internal and external stakeholders such as general administrative staff, various subject faculties, staff within dedicated research centres, knowledge transfer managers, university senior managers, government bodies, research funders, industry and societal stakeholders (Robinson et al. 2010; Miller et al. 2014).

According to Perkmann and Walsh (2008) effective knowledge transfer is reliant upon long-term partnerships, engagement and trust which both increases the probability that knowledge will be freely shared and increasing the breadth of knowledge available for transfer. Whilst many universities are attracted by the commercial benefits of short-term commercial exploitation and the sale of intellectual property, this type of knowledge transfer activity is fraught with difficulties (Benneworth et al. 2016). Lockett et al. (2008) suggest that success rates improve if supportive internal management and governance regimes are allowed time to develop. Furthermore, Paradeise et al. (2009) suggest the need for universities to adopt an appropriate level of corporate governance which can, in turn, support university–industry interaction in the longer term.

The challenges involved in the management and governance of university knowledge transfer processes can be categorised into three factors, (1) contextual factors, (2) organizational factors, and (3) stakeholder factors. Each are now discussed before offering a summary of the key problem areas and demonstrating how these problems can be addressed through the application of meta-rules.

2.1 Contextual factors affecting knowledge transfer

Prior research identifies a wide range of contextual factors which influence the success of university–industry knowledge transfer (Bruneel et al. 2010; Perkmann et al. 2013; Galán-Muros and Plewa 2016), these include different policy interventions and practical issues governing the transference of knowledge to different regions and across large distances. Prior literature often focuses on macro-context, where legislative provisions for knowledge transfer are governed by national policy (Bruneel 2010; Carayannis and Campbell 2011; Bozeman et al. 2013). Furthermore, an emerging body of research explores micro-level factors such as academic motivations (Perkmann et al. 2013; Alexander et al. 2015) and the suitability of competencies and skills of knowledge transfer managers (Alexander and Martin 2013; Cunningham et al. 2018). Interestingly, the ‘meso’ environment, or the point of contact between university and industry, which encapsulates the complex relationships existing between internal and external stakeholders is largely unexplored (McAdam et al. 2016). Here, KTOs have emerged and serve the purpose of a mediator, bridging relationships between internal (university), and external (regional and national) stakeholders (Howells 2006; Markman et al. 2007; Perkmann

and Schildt 2015) However, it is widely reported that KTOs often lack resources (Alexander and Childe 2013) and power (Sharifi and Liu 2010) to manage the complexity engendered by the multiple and sometimes contradictory strategic aims of universities, misaligning them with external stakeholder expectations (Miller et al. 2014; Bozeman et al. 2013).

2.2 Organizational factors affecting knowledge transfer

The transfer of knowledge is by its very nature a complex (Szulanski 2000) and difficult process (Kane et al. 2005). Policy suggests that university–industry knowledge transfer is rarely easy, or smooth (PACEC 2009, 2012). A key issue in implementing knowledge transfer mechanisms is the perceived bureaucracy and inflexibility of universities (PACEC 2009, PACEC 2012, Galán-Muros and Plewa 2016). Research by Pache and Santos (2010) and Miller et al. (2014) specifically highlights the internal organizational tensions resulting from multiple demands being placed on subject faculties and on individual academics within them. Nevertheless, this rigidity appears ill-suited to the fast-paced world of industry. Therefore, there is a need for decision-making to be capable of ‘agile’ responsiveness to industry contexts (King 2015; Sull and Spinosa 2007).

Organisational factors have also been found to affect the motivation and willingness of academics to engage in knowledge transfer (Siegel et al. 2003; Perkmann et al. 2013; Miller et al. 2016). Knowledge transfer activities do not always fit within the norms of traditional universities where reward and promotional mechanisms are often focused on publications, funding, teaching and technology commercialisation activities (Miller et al. 2014). Furthermore, KTOs experience challenges in navigating and applying knowledge transfer processes across different subject faculties where KTO staff need to decide which processes to follow and which to disregard if contradiction occurs (Wilson 2012). Eppler and Mengis (2004) suggests challenges of this nature can lead to ‘decision paralysis’ since decisions cannot be made without reference to a higher authority.

2.3 Stakeholder factors affecting knowledge transfer

In prior research, a reoccurring theme limiting university–industry knowledge transfer is the divergence in stakeholder expectations with regards to timing and speed of action in knowledge transfer management (Yusuf 2008; Perkmann et al. 2013). The speed under which industry need knowledge transfer outcomes can place a KTO under considerable internal pressure (Markman et al. 2005; PACEC 2009, 2012). It can also lead to problems in providing consistent KTO staffing levels (Sharifi and Liu 2010) given the considerable variation in project durations across the diverse KTO project portfolio. For example, consultancy projects can last 1 or 2 weeks, joint supervision (with a research qualification) 3–5 years, and knowledge transfer through collaborative new venture creation and spin outs can take over 5 years. There is often little precedent to create and implement best-practice in knowledge transfer processes and structures due to it being an immature profession that lacks requirements for formal qualifications and training (Wilson 2012).

2.4 Key barriers to establishing knowledge transfer mechanisms

From a review of the literature it is evident that the effectiveness of university–industry knowledge transfer is limited by strategic and operational challenges (Weckowska 2015;

Swamidass and Vulasa 2009; Litan et al. 2007). To ensure fulfilment of diverse internal and external objectives, KTO managers need to be able to align strategies across multiple departments, at various levels which often span organisational boundaries (Debackere and Veugelers 2005). This requires the use of various knowledge transfer mechanisms and capabilities which can be difficult to coordinate and manage (Weckowska 2015). Thus KTO staff require complex cognitive capabilities and effective processes in order to be able to undertake all this with limited resources, in a timely manner, avoiding information overload or decision paralysis (Halford et al. 1998; Eppler and Mengis 2004). However, this is often not done effectively, whereby KTO administrators and managers are often unable to find solutions to internal process mismatches, or procedural tensions within a reasonable time scale or passively choosing to delay projects often beyond the point where action was required (Alexander 2012). This then causes disharmony between internal and external stakeholders reducing both academic and industry stakeholders from engaging in knowledge transfer activities in the future (Rothaermel et al. 2007). The challenge of managing strategic alignment of goals across multiple levels of internal and external stakeholders is often the root cause of perceptions of bureaucracy and inflexibility reported by both academics and industry (Siegel et al. 2003; PACEC 2009; 2012; Rothaermel et al. 2007).

Despite recognition of these challenges within prior literature, there lacks a solution as to how this can be resolved to improve university–industry knowledge effectiveness (Cunningham et al. 2018; Ferguson et al. 2005; Kehm and Lanzendorf 2006; Paradeise et al. 2009; Christopher 2014). To help understand this context, it is important to note that knowledge transfer occurs between partnering (relational) and contracting (transactional) institutions with Perkmann and Walsh (2008) suggesting that universities struggle to operationalise and sustain this relationship. Multiple forms of governance are available to organisations, but this does not necessarily help in understanding how each aid knowledge transfer management (Weckowska 2015). There is a notable absence of ‘one size fits all’ type frameworks since antecedent factors may vary across university contexts and types of knowledge transfer (McAdam et al. 2016). Thus, for example whilst building trust requires a secure and enduring partnership, trust is of lesser significance for transactional knowledge transfer relationships (Bradach and Eccles 1989) as the degree of explicitness allows the knowledge content to be carefully prescribed in transactional knowledge transfer contracts, terms and conditions. Nevertheless, it is evident that institutional strategy, governance, departmental competences and services should align but research and practice to date has not found a solution. We put forth the solution of mapping knowledge transfer activities into a framework for decision-making, in order to enable a uniform approach to knowledge transfer implementation which accounts for varying modes (transactional, relational) of implementation. All this can be done through meta-rules as a decision making framework.

3 Introducing meta-rules

Various definitions of meta-rules exist, with the simplest being ‘rules governing the content, form, or application of other rules’ (OED 2008). According to Davis (1980) meta-rules support the human sense-making process in complex situations and can help actors take robust and justifiable decisions by achieving a heightened level of ‘situational awareness’. Meta-rules can re-order, replace and even suspend governing principles (Weischedel and Sondheimer 1983) and thus have particular utility in instances where policy application is problematic without being circumscribed by the content (or suitability) of the policy

itself. In this way they may be compared to grammatical syntax which dictates the order of sentence components rather than sentence content (Dubois et al. 2011).

Originating in the computer intelligence field, the application of meta-rules in the management field is limited. They have been applied in complex adaptive systems, in the study of multi-level control parameters for entrepreneurial activity (Fuller et al. 2004) and as a way to understand and to derive unambiguous strategies (Davies et al. 2006). According to Davis (1980), meta-rules focus on a ‘discriminant dimension’ which preserve the object being studied, allowing them to operate in a ‘simplistic (or degraded) mode’. Furthermore, meta-rules have been used to guide project management practices (Bredillet 2010), and facilitate the practical and critical decision making process in the French Navy (Gaultier Le Bris 2014). Thus, they can help understand complex situations by creating an overarching rule or regime against which conflicting processes and procedures can be referenced. Furthermore, meta-rules can be a tool through which organisations can learn and alter processes accordingly, which offers potential value for knowledge transfer governance. Whilst meta rules have not been applied in the context of university knowledge transfer, we put forth that their use will enable KTOs to simplify the inherent complexity of university–industry knowledge transfer co-ordination, resource allocation and strategic alignment (Weckowska 2015; Miller et al. 2014) by constructing rules, based on an overarching frame of reference for action (or the ‘big picture’).

To help understand the applicability of meta rules we draw upon Brady’s (1987) seminal research which proposes that meta-rules are developed based on the following principles. First, problem areas are identified and used to deconstruct the phenomena into smaller segments. As the phenomena are likely to be of intangible nature, for instance conflicts over decisions, agreements, and objectives, it is necessary to problematize them at various levels of abstraction. Next, problem areas are prioritized (and re-prioritized) within each of these levels of abstraction, ideally in the order that they need to be solved. Then a review is made of the resources allocated to tasks (at each level of abstraction) according to priorities already identified with reallocation of resources focused directly on the most important problems. Finally, and if required, the application of ‘meta-rules’ encourages reflection on the effectiveness of practices which may lead to the development of new rules (in the form of institutional policies and processes) in order to overcome any ambiguity, or conflict caused by preceding rules. Therefore meta-rules can facilitate organisational learning where organisations amend rules and develop new rules in order to strive to optimum strategic alignment and balancing of priorities across different levels and stakeholders. In effect, meta-rules can be used to facilitate an action-learning process within organisations (Revans 1982) and lead to a system of double loop learning as opposed to single loop learning (Argyris and Schön 1996).

The adoption of ‘meta-rules’ can enable organizations to adopt a consistent approach to the administration of knowledge transfer flows across university–industry networks, without succumbing to the dangers of routine standardization. Although the presence of standardized and routine processes can allow efficiency of operation, it can inadvertently prevent efficacies and improvements through learning specifically, by restricting university–industry interaction to a set of ‘core’ activities, and limiting the scope for recognition and utilization of new opportunities (Sull and Spinosa 2007; Sull et al. 2015). The meta-rule approach reflects Alvesson and Willmott’s (2012) call for “communicative rationality”, where an individual’s rationale can be achieved with the successful practice of communication, and enables the creation of a framework (at the ‘meta’ level), which allows KTO’s to examine conflicting or competing claims and make a rational decision on how to manage scarce resource allocation. Consequently, we suggest that meta-rules can be used

to aid the decision making of university managers at all levels of an organisation, can help to develop organisational learning processes and develop KTO employees tacit knowledge and skills.

To further illustrate the potential of meta-rules, three steps are undertaken. First, three organizational levels are defined and used to frame the focus for each meta-rule. Next, existing frameworks and models published in prior research are utilised in order to show how meta-rules can be derived and used by KTO staff and university managers. Finally, these frameworks are referenced against practical examples to help understand how individually tailored meta-rules could be applied to organisational contexts and institutional strategies.

3.1 Organizational levels and associated meta-rules

Three organizational levels have been identified in order to frame university–industry knowledge transfer; the corporate level, the departmental level and the project level. Each level of abstraction will now be explained identifying the barriers to knowledge transfer at that level. Literature is then used to develop a possible meta-rule. The implications of meta-rules at each level is also explained.

3.1.1 The corporate level

For the purposes of our study, universities are considered to be in two categories: research-intensive and applied (O’Kane et al. 2015), with the assumption that differing strategic priorities exist for each (Guerrero et al. 2015; Siegel and Wright 2015). Universities must set an appropriate high-level knowledge transfer strategy and ensure that it aligns with their own research-intensive or more applied mission, values and goals (Siegel and Wright 2015; Andrews 1987). Perkmann and Walsh (2008) suggest that research intensive universities favour longer-term ‘relational governance’ mechanisms with external stakeholders, regardless of the opportunity cost in developing such relationships (Siegel and Wright 2015). Academic reward and performance mechanisms in these institutions are based on publications and research income which often demotivates academics from getting involved in activities which are resource-intensive, or do not guarantee rewards in the short- to mid-term (Miller et al. 2016). Applied universities however, utilise more transactional governance, which leads to high numbers of short term projects, yielding high-value but short-term monetary gain. Consequently, there is a tendency for applied universities to offer their full range of standardized knowledge transfer activities in all instances of institutional interactions with industry, rather than adjusting knowledge transfer offerings to the specific context (Alexander and Martin 2013). This suggests that universities are not effectively aligning their strategic intentions to their knowledge transfer strategies resulting often in only single loop learning (Cunningham and O’Reilly 2018; Liu and Hsiao 2017; Kruss and Visser 2017). The short-term collaborations in which applied universities most frequently engage in suggests that achieving strategic harmonisation across different stakeholders or different departments as quickly as possible would be a priority in order to commence knowledge transfer; and unless this governance intention is acted upon by departments and the staff then organisational learning is effectively hampered.

Conversely, the need to foster long-term partnerships would suggest that institutional factors such as culture and cognitive differences, such as lack of clarity in long-term policy

Core Competence	Ranking of Channel (from Relational to Transactional)											Characterisation																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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Fig. 1 Modes of governance and knowledge transfer channels

intentions, may be significant for more research intensive universities (Wit-de Vries et al. 2018).

To aid development of context-specific meta-rules at the organisational level, which will in turn help direct knowledge transfer activities at lower levels, relational and transactional ‘governance modes’ of knowledge transfer can be used (Alexander and Childe 2011). Figure 1 draws on research by Alexander and Childe (2013) to show how each mode of governance is associated with varying knowledge transfer activities.

Identifying the mode of governance can enable the development of the first primary meta-rule and associated secondary meta-rule in order to direct sub-organisational activities. This first meta-rule can be seen in Table 1 which provides an overview of all the associated meta-rules at each level. The meta-rule 1 and associated sub-rules (1a, 1b) in Table 1 could be used to aid a university in identifying which knowledge transfer activities are a priority, which will direct activities and facilitate better resource allocation, and which will enable service alignment at lower levels. In turn, this can improve feedback (knowledge transfer from the organisation to the individual, team, unit, etc.) through double-loop learning and enable feedforward flows (knowledge sharing from the individual, team, unit, etc. to the organisation) (Vargas et al. 2016). Thus if a university values long term partnerships with industry, then greater priority should be given to relational knowledge transfer activities.

Table 1 Meta-rules at various levels of abstraction

Level	Meta-rule	Situation awareness	Tools and indicators
Organisational (university level)	(1) What is the strategic mission? (a) What governance to employ (relational vs. transactional)? (b) What knowledge transfer activities are a priority?	To differentiate the dominant mode of governance to direct the knowledge transfer offerings	Modes of governance and knowledge transfer channels (Alexander and Childe 2013)
Department (KTO) level	(2) What knowledge transfer activities to offer? (a) Is there clarity both internally and externally as to the types of knowledge transfer activities are available? (3) What core competencies are needed in the KTO? (a) What training needs to be provided for staff working on particular programmes of activity?	To direct resources into knowledge transfer activities which align with the governance model specified at the organisational level To align resources and the core competencies needed of KTO staff to the strategic mission and the knowledge transfer priorities of the university (meta-rules 1 and 2 above)	University Strategy and Operational Planning (Fig. 2) Types of knowledge transfer activity (as above) Modes of governance and knowledge transfer channels Model of four competencies (Fig. 3)
Project level	(4) What type of knowledge will be transferred? (a) Do KTO staff have the correct capabilities?	To align competencies and sufficient resources to project according to the type of knowledge being transferred.	Visualisation framework (Fig. 4) University Strategy and Operational Planning (Fig. 2)

Channel of Knowledge Transfer (Alexander and Childe, 2010)	UK Transfer Office			French Transfer Office		
	Activity (L/M/H)	Past Trend ($\uparrow \leftrightarrow \downarrow$)	TTO Operational Plans ($\uparrow \leftrightarrow \downarrow$)	Activity (L/M/H)	Past Trend ($\uparrow \leftrightarrow \downarrow$)	TTO Operational Plans ($\uparrow \leftrightarrow \downarrow$)
Cont. Research & Consultancy	H	$\uparrow$	$\uparrow$	M	$\leftrightarrow$	$\uparrow$
Collaborative Research	M	$\uparrow$	$\uparrow$	M	$\leftrightarrow$	$\leftrightarrow$
Shared Facilities	L	$\leftrightarrow$	$\leftrightarrow$	L	$\leftrightarrow$	$\leftrightarrow$
Training & CPD	M	$\downarrow$	$\leftrightarrow$	M	$\leftrightarrow$	$\downarrow$
Professional Journal Publications	M	$\leftrightarrow$	$\leftrightarrow$	L	$\leftrightarrow$	$\leftrightarrow$
Joint Supervision	M	$\leftrightarrow$	$\leftrightarrow$	L	$\leftrightarrow$	$\leftrightarrow$
Student Placements	H	$\leftrightarrow$	$\leftrightarrow$	L	$\leftrightarrow$	$\leftrightarrow$
Joint Conference	H	$\uparrow$	$\leftrightarrow$	L	$\leftrightarrow$	$\leftrightarrow$
Secondment	L	$\leftrightarrow$	$\leftrightarrow$	L	$\leftrightarrow$	$\leftrightarrow$
Networks	H	$\uparrow$	$\uparrow$	L	$\leftrightarrow$	$\uparrow$
Patent or Licence	M	$\downarrow$	$\leftrightarrow$	H	$\uparrow$	$\uparrow$
Spin-Outs	L	$\downarrow$	$\leftrightarrow$	M	$\uparrow$	$\uparrow$
Joint Venture	L	$\leftrightarrow$	$\uparrow$	L	$\leftrightarrow$	$\leftrightarrow$

Fig. 2 University Strategy and Operational Planning (Alexander and Martin 2013)

3.1.2 Departmental level

Interoperability across organizational levels allows for the alignment of meta-rules therefore having identified meta-rules at the corporate level, we can use them to inform meta-rules at the department level. Since different organisational levels do not exist in separation, organisational learning is needed to ensure meta-rule application at the corporate level can be effectively disseminated to the departmental level. Indeed, decisions at a department level depend upon decisions at both an organisational and departmental level (Vargas et al. 2016; Hall 1995). KTOs must control and manage knowledge transfer by strategically aligning resources across all organisational levels (such as executive, legal, contracting, IP management, finance, debt, recovery and so on). Nevertheless, without the presence of ‘meta-rules’ at the corporate level, the knowledge transfer contact between internal departmental stakeholders with industry can succumb to the failures discussed above (Craneﬁeld and Yoong 2007; Perkmann and Schildt 2015) and encounter familiar collaborative barriers through cultural or organisational contexts and temporal issues (Wit-de Vries et al. 2018; Albats et al. 2018). Therefore, by aligning strategic aims at the corporate level and then selecting knowledge transfer activities that fit these strategic aims, operational planning at the departmental level for current and future priorities is possible. This can allow universities to move away from a default position where full, standardized knowledge transfer

offerings are always made and towards more context-specific knowledge transfer decision-making capabilities consistent with meta-rule protocols. Figure 2 presents key findings from Alexander and Martin (2013) to illustrate how two KTOs ranked the priority of their knowledge transfer activities between low, medium or high (L, M or H) and then considered past and future plans in terms of increasing, constant or reducing ($\leftrightarrow$, $\uparrow$ or $\downarrow$) their offering. Such an approach can be an ‘enabling instrument’ (Vargas et al. 2016) which can enable knowledge transfer across departments over time, as well as organisational learning through the codification of emergent, tacit knowledge and the development of its internal capability (Bellini et al. 2018; Eveleens et al. 2017). This enabled the KTOs in Alexander and Martin’s (2013) research to map out their activities and reference them against their institutional strategic mission. Interestingly, although both institutions in this research were seeking research growth with a vision for long-term research partners, their offerings differed significantly. They had clearly set a strategic direction but not adopted this intent operationally, or encouraged staff to learn how to undertake activities to reinforce this strategic aim.

To further illustrate failure caused by strategic and operational alignments, Fig. 3 draws upon research by Alexander et al. (2012) to present two case examples of common challenges when there is ambiguity over the types of knowledge transfer activities to offer which can result in a missed opportunity for a long term partnerships.

From the literature, it is evident that clear definitions of departmental activities are needed and will help greater strategic alignment and interoperability between programme and project level activity (third level of abstraction). This all leads to the development of a meta-rule at a department level. For example, in a research-intensive university that wants to prioritise relational governance relationships with external stakeholders, meta-rule 2 and in particular meta rule 2a (as shown in Table 1) could help the KTO to focus on offering activities that are more relational, for instance collaborative research, networking, joint PhD supervision and joint conferences/papers.

A further additional problem facing KTOs is recruiting staff with the requisite capabilities to manage knowledge transfer projects. Martin and Pujol (2008) present a simplistic competency model which they suggest identifies the four core competences² that staff working in the role of technology and knowledge transfer brokerage require. These are shown in Fig. 4, where competency 1 refers to the ability to set up and manage research projects, competency 2 is offering knowledge sharing and support services for enterprises, competency 3 is boundary spanning through human resources (HR) and competency 4 is patent and entrepreneurship.

Martin and Pujol (2008) also identified the potential channels that these competences align with. The aim of their work was to establish an operational alignment between activities offered and the competences of the staff, which in turn reinforce further alignment between corporate strategy and department level services. Recruitment selection or organisational learning opportunities therefore exist when selecting, or training staff in the respective competencies (as identified in Fig. 4) to match the priorities for service offerings. This will aid problems of scarce resource allocation (McAdam et al. 2012; Miller et al. 2014) and help to overcome problems reported in the literature regarding KTO staff not possessing the correct skills to serve industrial needs (Chapple et al. 2005; Sainsbury 2007; Wilson 2012; Alexander and Martin 2013). As the problems of capability is not resolved

² Derived from the literature surrounding dynamic competences and capabilities originally presented by Teece and Pisano (1994).

Department Level	Project Level
A senior executive from a prestigious MNE enjoys a strong relationship with a key academic researching the optimisation of complex distribution networks. The institutional strategy is for long term, multi-level and centrally anchored partnerships with a number of strategic partners. They have identified the MNE as a targeted partner. Intellectual property has arisen from the research which is protectable and as such there are a range of options available to the institution to develop further knowledge transfer (c.f. table 1 above) with the MNE. The knowledge transfer office is tasked with moving the relationship to the next level – but which mechanism to choose? The academic favours consultancy for the benefits it provides, the IP team favour a patent and license sale, the contracts team a new piece of contract research etc. The academic is also under pressure to develop more postgraduate research and also to publish his work in academic refereed journals. The project chosen involved a lucrative patent sale, however no further research was undertaken nor any subsequent intellectual property registered following the transaction. Upon completion of the patent sale both industrial and academic partner felt that more could have been achieved in terms of further work and research. At interview they acknowledged they were unsure of the possible routes to engagement and also unsure if their home organisations preferred one or the other – and were ultimately guided by the advice of the IP management team. At the time of the interview the relationship remained a homogenous one and the MNE is not a long term institutional partner.	One case study project consisted of key academics working on an industry-based problem to determine how existing capabilities for seabed hydraulic flow-lines and systems could be adapted for power transmission within marine renewable energy farms. According to the participants, most of the knowledge that transferred during the early stages of the project should reflect the upper third of the framework (in a tacit state) which they, in turn, considered highly valuable. They recognise only a small amount of time was spent shaping the problem (codifying it) and this led to high levels of tacit knowledge being transferred during intense periods where engineers and academics worked collaboratively alongside each other, regularly meeting to exchange ideas etc. In contrast whilst considering another project the interview respondents suggest firmly that it is predominantly explicit knowledge that was transferred during their project. The project to develop a novel mode of patient information, stored at the bedside of an in-patient whilst in hospital, resulted in the design of a modular display card with the ability to configure regular messages and instructions using an in-moulded flip-card system. When considering the framework, knowledge was heavily codified by both parties at the outset of the project, with the exchange of a “client brief” and subsequent “supplier brief” before agreeing a price and set of deliverables. This was done without a meeting or hospital visit. Only when the scope was defined and the price accepted that meetings took place and “in-use” study visits were carried out. Emails, exchange of photographs and telephone calls were the main mode of knowledge exchange therefore the knowledge transferred was mostly explicit. The project participants were able to reflect that earlier meetings and a focus on the transfer of tacit knowledge could have improved both the process of transfer and the outcomes of the project – although this project was not considered to be a failure, but participants recognise that considering the role that tacit knowledge plays in the this activity could have improved things.

Fig. 3 Practical Examples of Department & Project Level deployment of Meta-rules

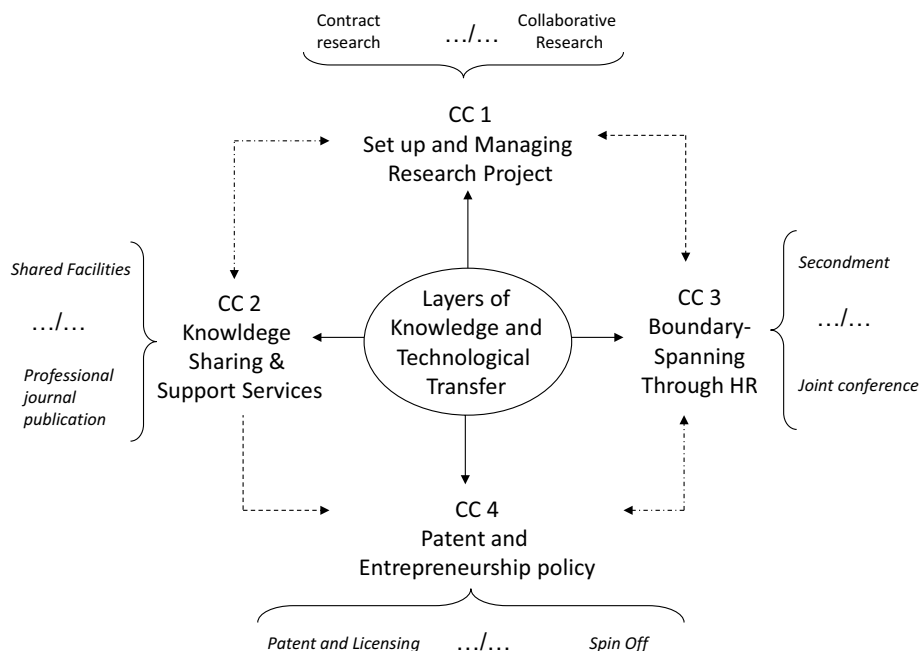


Fig. 4 The four main core competences of a Transfer Office (Martin and Pujol 2009)

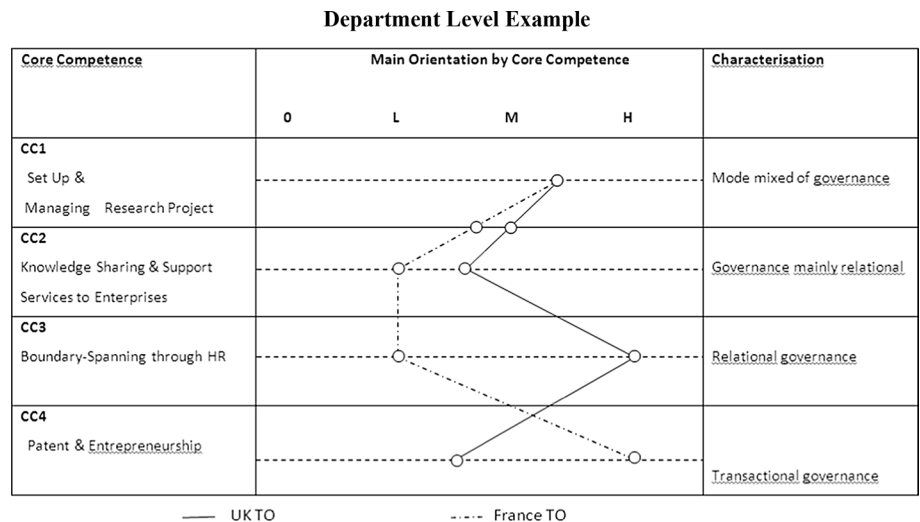


Fig. 5 Department Level Analysis (Alexander and Martin 2013)

by meta-rule 2, we derive a departmental meta-rule, meta-rule 2, shown in Table 1. To help explain the development of this meta-rule we revert back to Alexander and Martin (2013) whose research found that the competencies required by KTOs vary according to the priority the KTO gives to particular knowledge transfer activities. For example, in their

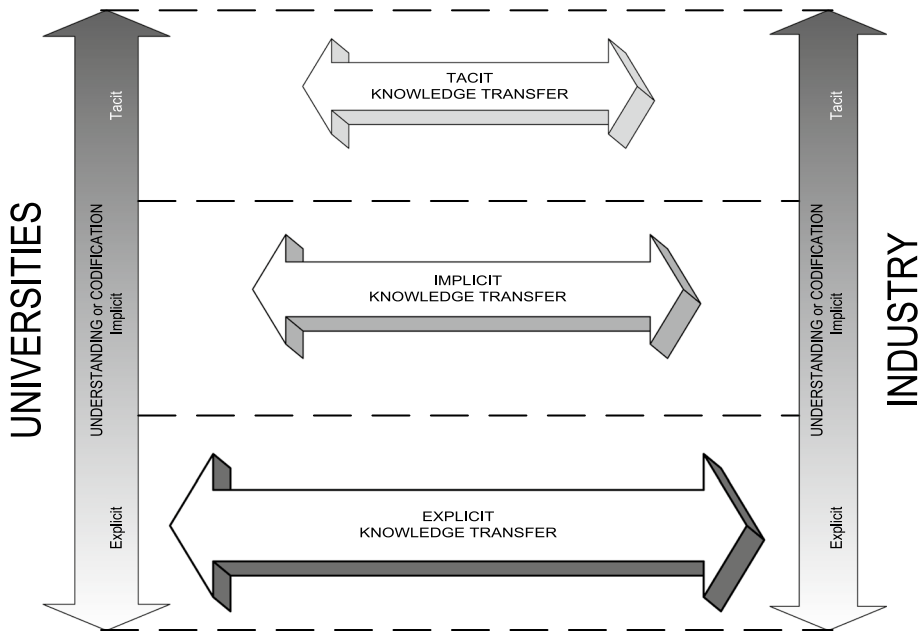


Fig. 6 The Visualisation Framework (Alexander and Childe 2011)

research they found that the UK KTO required its staff to have a broad range of competencies whereas a French KTO who favoured priority to patents, licenses and entrepreneurial activity required their staff to have different competencies. Their research is summarised in Fig. 5.

3.1.3 Project level

Extant literature emphasises the importance of considering what ‘type’ of knowledge is being transferred in each knowledge transfer project but recognises that individually-held, tacit knowledge is difficult to comprehend, codify and transfer (Howells 1996; Chilton and Bloodgood 2008). In those instances, it is the organisation’s absorptive capacity and cognitive dissonance which are key project level barriers to knowledge transfer (Cunningham and O’Reilly 2018; Xu et al. 2017). One potential way to draw attention to flows which are abstract or invisible in their ambiguity is to derive a “sensitising framework” (Epp and Price 2008; Wacker 1998). Alexander and Childe (2011) present a visualisation framework of university–industry knowledge transfer (shown in Fig. 6) which takes the categories of tacit, implicit and explicit knowledge and places these on a continuum between cognition and codification. For simplicity, their framework only takes two stakeholders into account; the university and industry and presents the exchanges of knowledge during a knowledge transfer activity. The framework shows two directional knowledge between the industry partner and the university.

Alexander and Childe (2011) suggest that the framework provides a visualisation of knowledge flows, making it a reference tool for planning. Figure 6 considers how tacit knowledge can be managed and allows the development of a fourth meta-rule, shown in Table 1. In this way the facilitation of knowledge flows can enable the codification of tacit

knowledge through feedforward and feedback mechanisms (Vargas et al. 2016) which aids organisational learning through creating a platform for project-level co-operation and knowledge acquisition (Liao et al. 2017). An important consideration here is the ‘epistemic’ and syntactical nature of meta-rules which highlight the order of organisational policy application (Dubois et al. 2011; Davis 1980). Consequently, the meta-rule framework can aid knowledge distribution from the corporate, through to the departmental and project levels and thus enhance organisational learning through multi-level knowledge flows.

4 Conclusions and implications

Existing research has presented a fragmented view of the challenges, barriers and motivator of knowledge transfer management in a university–industry context (Perkmann et al. 2013; Rossi and Rosli 2013). University–industry knowledge transfer continues to be of high importance in policy, research and practice (Witty 2013; Dowling 2015; Industrial Strategy 2017). Thus there is a need to make improvements in the way organizations make decisions in order to reduce conflicting priorities and fulfil diverse regional stakeholder needs in order to increase university–industry knowledge transfer effectiveness. This research proposes a practical yet strategically-aligned approach to address key problems in the governance of knowledge transfer through the introduction of meta-rules. This follows recommendations from Schultz and Hatch (2005) who identify that practical solutions are required to help build and extend theory. Furthermore, responds to calls by Cunningham et al. (2017) who identify the need for more theory building approaches to advance fields.

Our paper attempts to bridge the gap between management research and practice (Carter et al. 2008) and show how the adoption of meta-rules can help to solve every day managerial problems common to knowledge transfer organizations operating in collaboration with industry partners. By discussing university–industry knowledge transfer at three different organizational levels of abstraction (corporate, departmental and project-focused), identifying key challenges at each level and by considering existing frameworks, we propose a set of meta-rules intended to aid those practical knowledge transfer management problems. In turn, we suggest that meta-rules (as shown in Table 1) can aid the interoperability between each level of abstraction (organizational level) and facilitate the strategic alignment of departmental and organisational goals. Consequently, we demonstrate how meta-rules can help reduce the barriers limiting knowledge transfer (Pache and Santos 2010; Miller et al. 2014).

In this research, we identified that the presence of barriers can be inherent to the decision-making process and its application within organisations and not a result of any strategic or structural deficiencies. Consequently, we posit that universities already have the critical capacity and potential for learning (Bellini et al. 2018) but encounter barriers when they try to negotiate multi-level priorities internally or seek to reconcile existing, codified learning with tacit knowledge flows from new partnerships. Therefore, rather than suggest a radical re-think of internal university governance, we operationalize the ‘meta-rule’ concept and present examples of its potential to help solve problems in establishing and managing knowledge transfer flows in a university–industry context.

It is acknowledged that meta-rules present a simplified and practical approach to a complex problem. The levels of organizational categorization we adopt may appear mechanistic, yet this is a necessary requirement to overcome the procedural and stakeholder complexity (see, for example, Schultz and Hatch 2005; Sun and Pfahring

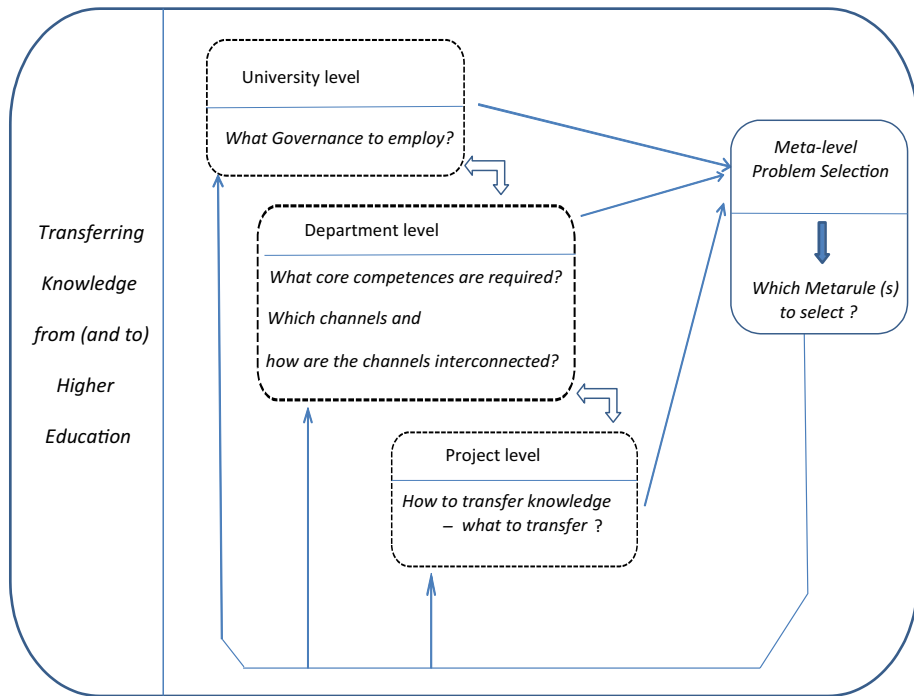


Fig. 7 University KT: structural characteristics

2014). Accordingly, we identify that developing meta-rules requires an understanding of the respective organizations' short, medium and long term goals, as well as their institutional strategy. This provides the necessary context against which the application of meta-rules aids decision-making. It is also necessary to consider the likely systems of governance within the respective institutional departments engaging in the knowledge transfer. Structural characteristics will have a material effect on the design of and choice of meta-rules, as will the levels of organizational categorization chosen. Meta-rules will therefore vary according to each university model, yet the examples provided can be tailored to other organizational contexts. A summary of the structural characteristics of knowledge transfer from which meta rules can be derived is shown in Fig. 7.

This research makes a number of key contributions. First it contributes to the growing debate on the strategic challenges of managing knowledge transfer activities (Perkmann et al. 2013; Witty 2013; Dowling 2015; Miller et al. 2016) and offers practical solutions through meta-rules could facilitate intra-institutional strategic alignment at the corporate, departmental and project level and resolve internal and external stakeholder tensions (Schultz and Hatch 2005; Carter et al. 2008). 'Meta-rules' will be of use to KTO managers to overcome challenges evident within each structural level of abstraction. In turn, the interoperability across the three levels of meta-rules can serve as a point of reference across institutional departments. Furthermore, meta-rules can help universities with resource allocation, identify competency gaps and allocate required training required. Second, we prove the efficacy of meta-rules to aid knowledge transfer

through illustrating its analytical abilities and application within a university–industry knowledge transfer context. The meta-rules presented in Table 1 are not prescriptive but are provided as examples to aid managers in deriving their own sets of tailor-made meta-frameworks. Third, this research identifies the importance of organisational context when presenting solutions to knowledge transfer problems at the organisational and sub-organisational level since variability between internal and external stakeholders and organisational goals will result in different meta-rules.

Fourth, this research contributes to literature on organisational learning by proposing a tool which encourages reflection and organisational learning in order to both identify and removing procedural obstacles which limit knowledge transfer whilst also facilitating the incorporation of tacit and explicit knowledge into existing governance structures. Consequently meta-rules can be used to help universities learn through experience, facilitating more effective strategic alignment and allocation of resources. Lastly, from a practical perspective, meta-rules can help KTO managers overcome ongoing challenges of reduced resources for knowledge transfer, whilst under increasing pressure to offer an increasing range of knowledge transfer activities to demonstrate their impact to society. Meta rules will help them to prioritise objectives and align resources across multiple levels.

This research identifies a number of future research directions will help overcome the limitations of this research. Our meta-approach seeks to simplify and not trivialize, yet we acknowledge that the need for interoperability between each corporate level may deter KTO managers from accepting that simplicity can be a source for clarity. The concepts we present are focused on theory building through utilising prior empirical research however, further research into the application of meta-rule principles in practice is required in order to help refine the design of meta-rules through long-term trial and error learning (Miner et al. 2001) across various university contexts. Further research should be mindful of not radically increasing the number of meta-rules to try to solve the interoperability problems as the institution grows, since this will lead to more bureaucracy and increased numbers of rules, which reverts back to the initiation identified problem.

This research avoided the application of a prescriptive analytical framework in developing our approach. The frameworks selected aid in illustrating our concept and to achieve an element of ‘situational awareness’ of the complex environment within which an organisation is operating (Davis 1980). Other frameworks exist (see, for example, Argote et al. 2003; Murray and Peyrefitte 2007; Plewa et al. 2013) which further research should explore to see if they aid the development and understanding of meta-rules.

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References

- Albats, E., Fiegenbaum, I., & Cunningham, J. A. (2018). A micro level study of university industry collaborative lifecycle key performance indicators. *The Journal of Technology Transfer*, 43(2), 389–431.
- Alexander, A. T., & Childe, S. J. (2010). Innovation: A knowledge transfer perspective. In M. Garetti, M. Taisch, S. Cavaleiri, S. Terzi, & M. Tucci (Eds.), *Advances in production management systems*. Poliscrypt: Como.

- Alexander, A. T., & Childe, S. J. (2011). A framework for knowledge transfer. In: *Advances in production management systems*, Stavanger, Norway.
- Alexander, A. T., & Childe, S. J. (2013). Innovation: A knowledge transfer perspective. *Production Planning & Control*, 24, 208–225.
- Alexander, A. T., & Martin, D. P. (2013). Intermediaries for open innovation: A competence-based comparison of knowledge transfer offices practices. *Technological Forecasting and Social Change*, 80(1), 38–49.
- Alexander, A. T., Miller, K., Fielding, S. N. (2015). Open for business: Universities, Entrepreneurial Academics & Open Innovation. In: Conn, S., Bitran, I., & Huizingh, E. K. R. E. (eds.), *XXVI ISPIM international conference: Shaping the frontiers of innovation management*, 14–17 June 2015 Budapest, Hungary. Wiley.
- Alexander, A. T., Neyer, A. K., & Huizingh, K. R. E. (2016). Introduction to the special issue: Transferring knowledge for innovation. *R&D Management*, 46, 305–311.
- Alexander, A. T., Pearson, S. R., Fielding, S. N., & Bessant, J. R. (2012). The open innovation era—Are university services up to the challenge? In I. Bitran & S. Conn (Eds.), *The XXIII ISPIM conference—Action for innovation: innovating from experience Barcelona, Spain*. New York: Wiley.
- Alvesson, M., & Willmott, H. (2012). *Making sense of management: A critical introduction*. London: Sage.
- Andrews, K. R. (1987). *The concept of corporate strategy*. New York: Irwin.
- Argote, L. (2011). Organizational learning research: Past, present and future. *Management Learning*, 42, 439–446.
- Argyris, C., & Schön, D. A. (1996). *Organizational learning II*. Boston: Addison Wesley.
- Bansal, P., & Clelland, I. (2004). Talking trash: Legitimacy, impression management, and unsystematic risk in the context of the natural environment. *Academy of Management Journal*, 47, 93–103.
- Bellini, E., Piroli, G., & Pennachio, L. (2018). Collaborative know-how and trust in university–industry collaborations: Empirical evidence from ICT firms. *The Journal of Technology Transfer*. <https://doi.org/10.1007/s10961-018-9655-7>.
- Benneworth, P., Pinheiro, R., & Sánchez-Barrioluengo, M. (2016). One size does not fit all! New perspectives on the university in the social knowledge economy. *Science and Public Policy*, 43(6), 731–735.
- Bozeman, B., Fay, D., & Slade, C. (2013). Research collaboration in universities and academic entrepreneurship: The state-of-the-art. *The Journal of Technology Transfer*, 38, 1–67.
- Bradach, J. L., & Eccles, R. G. (1989). Price, authority, and trust: From ideal types to plural forms. *Annual Review of Sociology*, 15, 97–118.
- Brady, F. N. (1987). Rules for making exceptions to rules. *Academy of Management Review*, 12, 436–444.
- Bredillet, C. N. (2010). Blowing hot and cold on project management. *Project Management Journal*, 41, 4–20.
- Bruneel, J., D'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy*, 39, 858–868.
- Carayannis, E., & Campbell, D. J. (2011). Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: Building on the quadruple and quintuple helix innovation concepts and the “Mode 3” knowledge production system. *Journal of the Knowledge Economy*, 2, 327–372.
- Carter, C., Clegg, S. R., & Kornberger, M. (2008). *A very short, fairly interesting and reasonably cheap book about studying strategy*. Thousand Oaks: Sage.
- Chapple, W., Lockett, A., Siegel, D., & Wright, M. (2005). Assessing the relative performance of UK university technology transfer offices: Parametric and non-parametric evidence. *Research Policy*, 34, 369–384.
- Chilton, M. A., & Bloodgood, J. M. (2008). The dimension of tacit and explicit knowledge: A descriptive and measure. *International Journal of Knowledge Management*, 4(2), 75–91.
- Christopher, J. (2014). Australian public universities: Are they practising a corporate approach to governance? *Studies in Higher Education*, 39(4), 560–573.
- Cranefield, J., & Yoong, P. (2007). The role of the translator/interpreter in knowledge transfer environments. *Knowledge and Process Management*, 14, 95–103.
- Cunningham, J. A., Menter, M., & Young, C. (2017). A review of qualitative case methods trends and themes used in technology transfer research. *The Journal of Technology Transfer*, 42(4), 923–956.
- Cunningham, J., Mentor, M., & O’Kane, C. (2018). Value creation in the quadruple helix: A micro level conceptual model of principal investigators as value creators. *R&D Management*, 48(1), 136–147.
- Cunningham, J. A., & O’Reilly, P. (2018). Macro, meso and micro perspectives of technology transfer. *The Journal of Technology Transfer*, 43(3), 545–557.

- Davies, A., Brady, T., & Hobday, M. (2006). Charting a path toward integrated solutions. *MIT Sloan Management Review*, 47, 39–48.
- Davis, R. (1980). Meta-rules: Reasoning about control. *Artificial Intelligence*, 15, 179–222.
- Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy*, 34(3), 321–342.
- Deetz, S. (2003). Reclaiming the legacy of the linguistic turn. *Organization*, 10, 421–429.
- D'Este, P., & Neely, A. (2007). Science and technology in the UK: 2006 census. In *Advanced Institute of Management (AIM) Research*.
- Dowling, A. (2015). *The dowling review of business-university research collaborations*. London: Department of Business, Innovation & Skills.
- Dowling, J., & Pfeffer, J. (1975). Organizational legitimacy. *Pacific Sociological Review*, 18, 122–136.
- Dubois, D., Prade, H., & Shockaert, S. (2011). Rules and meta-rules in the framework of possibility theory and possibilistic logic. *Scientia Iranica*, 18(3), 566–573.
- Easterby-Smith, M., Lyles, M. A., & Tsang, E. W. K. (2008). Inter-organizational knowledge transfer: Current themes and future prospects. *Journal of Management Studies*, 45, 677–690.
- Epp, A. M., & Price, L. L. (2008). Family identity: A framework of identity interplay in consumption practices. *Journal of Consumer Research*, 35(1), 50–70.
- Eppler, M. J., & Mengis, J. (2004). The concept of information overload: A review of literature from organization science, accounting, marketing, MIS, and related disciplines. *The Information Society*, 20, 325–344.
- European Commission (2017). *Europe 2020* [Online]. European Commission. http://ec.europa.eu/europ2020/index_en.htm [Accessed 07/07/2017].
- Eveleens, C. P., van Rijnsoever, F. J., & Niesten, E. M. (2017). How network-based incubation helps start-up performance: A systematic review against the background of management theories. *The Journal of Technology Transfer*, 42(3), 676–713.
- Ferguson, R., Paulin, M., & Bergeron, J. (2005). Contractual governance, relational governance, and the performance of interfirm service exchanges: The influence of boundary-spanner closeness. *Journal of the Academy of Marketing Science*, 33, 217–234.
- Fuller, T., Argyle, P., & Moran, P. (Eds.). (2004). *Meta-rules for entrepreneurial foresight*. Oxford: Blackwell.
- Galán-Muros, V., & Plewa, C. (2016). What drives and inhibits university-business cooperation in Europe? A comprehensive assessment. *R&D Management*, 46, 369–382.
- Gaultier Le Bris, S. (2014). *Improvisation vs (meta) règles: effets sur la fiabilité d'une organisation hautement fiable: le cas d'une équipe passerelle dans la Marine nationale*. Rennes 1.
- Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy*, 44, 748–764.
- Halford, G. S., Wilson, W. H., & Phillips, S. (1998). Processing capacity defined by relational complexity: Implications for comparative, developmental, and cognitive psychology. *Behavioral and Brain Sciences*, 21(6), 803–831.
- Hall, A. (1995). A structure for organizational learning. *The Journal of Technology Transfer*, 20(3–4), 11–19.
- Hobbs, K. G., Link, A. N., & Scott, J. T. (2017). Science and technology parks: An annotated and analytical literature review. *The Journal of Technology Transfer*, 42(4), 957–976.
- Howells, J. (1996). Tacit knowledge, innovation and technology transfer. *Technology Analysis & Strategic Management*, 8, 91–106.
- Howells, J. (2006). Intermediation and the role of intermediation in innovation. *Research Policy*, 35, 715–728.
- Industrial Strategy. (2017). *Industrial Strategy: Building a Britain fit for the Future*. Department for Business, Energy and Industrial Strategy.
- Kane, A., Argote, L., & Levine, J. (2005). Knowledge transfer between groups via personnel rotation: Effects of social identity and knowledge quality. *Organizational Behavior and Human Decision Processes*, 96, 56–71.
- Kehm, B., & Lanzendorf, U., (2006). Reforming university governance. *Changing Conditions for Research in Four European Countries, Bonn, Lemmens*.
- King, M. (2015). Why higher Ed and business need to work together. *Harvard Business Review* [Online]. <https://hbr.org/2015/07/why-higher-ed-and-business-need-to-work-together> [Accessed 20/03/2017].
- Kruss, G., & Visser, M. (2017). Putting university–industry interaction into perspective: A differentiated view from inside South African universities. *The Journal of Technology Transfer*, 42(4), 884–908.

- Liao, S. H., Chen, C. C., Hu, D. C., Chung, Y. C., & Yang, M. J. (2017). Developing a sustainable competitive advantage: Absorptive capacity, knowledge transfer and organizational learning. *The Journal of Technology Transfer*, 42(6), 1431–1450.
- Litan, R. E., Mitchell, L., & Reedy, E. J. (2007). Commercialising university innovation: Alternative approaches. *Innovation Policy and the Economy*, 8, 31–57.
- Liu, T. -H., & Hsiao, Y. -C. (2017). Fitting cooperative mode in inter-organizational strategic alliance: A perspective from innovative and financial performances. *The Journal of Technology Transfer*. <https://doi.org/10.1007/s10961-017-9593-9>.
- Lockett, N., Kerr, R., & Robinson, S. (2008). Multiple perspectives on the challenges for knowledge transfer between higher education institutions and industry. *International Small Business Journal*, 26, 661–681.
- Markman, K. D., Lindberg, M. J., Kray, L. J., & Galinsky, A. D. (2007). Implications of counterfactual structure for creative generation and analytical problem solving. *Personality and Social Psychology Bulletin*, 33, 312–324.
- Martin, D., & Pujol, L. (2008). The technology transfer in the public domain, the role of human factors in licensing patents from universities. *Gérer & Comprendre*, 92, 66–77.
- McAdam, M., Miller, K., & McAdam, R. (2016). Exploring the micro foundations of triple helix relationships in University Technology transfer: A stakeholder salience and engagement perspective. *Studies in Higher Education*, 50–51, 68–78.
- McAdam, R., Miller, K., McAdam, M., & Teague, S. (2012). The development of University Technology transfer stakeholder relationships at a regional level: Lessons for the future. *Technovation*, 32, 57–67.
- Miller, K., McAdam, M., & McAdam, R. (2014). The changing university business model: a stakeholder perspective. *R and D Management*, 44, 265–287.
- Miller, K., McAdam, M., & McAdam, R. (2018). A systematic literature review of university technology transfer from a quadruple helix approach: Towards a research agenda. *R&D Management*, 48(1), 7–24.
- Miller, K., McAdam, R., Moffett, S., Alexander, A., & Puthusserry, P. (2016). Knowledge transfer in university quadruple helix ecosystems: An absorptive capacity perspective. *R&D Management*, 46, 383–399.
- Miner, A. S., Bassof, P., & Moorman, C. (2001). Organizational improvisation and learning: A field study. *Administrative Science Quarterly*, 46(2), 304–337.
- Murray, S. R., & Peyrefitte, J. (2007). Knowledge type and communication media choice in the knowledge transfer process. *Journal of Managerial Issues*, 19(1), 111–133.
- O’Kane, C., Mangematin, V., Geoghegan, W., & Fitzgerald, C. (2015). University technology transfer offices: The search for identity to build legitimacy. *Research Policy*, 44, 421–437.
- O’Shea, R. P., Chugh, H., & Allen, T. J. (2008). Determinants and consequences of university spinoff activity: A conceptual framework. *The Journal of Technology Transfer*, 33, 653–666.
- OED. (2008). *Oxford english dictionary*. Oxford: OVP.
- PACEC. (2009). *Evaluation of the effectiveness and role of HEFCE Third Stream Funding*. Cambridge: PACEC—Public & Corporate Economic Consultants.
- PACEC. (2012). Strengthening the contribution of English Higher Education Institutions to the Innovation System: Knowledge Exchange and HEIF Funding. In: HEFCE (ed.). Cambridge: PACEC.
- Pache, A.-C., & Santos, F. (2010). When worlds collide: The internal dynamics of organizational responses to conflicting institutional demands. *Academy of Management Review*, 35, 455–476.
- Paradeise, C., Reale, E., Bleiklie, I., & Ferlie, E. (2009). *University governance*. New York: Springer.
- Perkmann, M., King, Z., & Pavelin, S. (2011a). Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy*, 40, 539–552.
- Perkmann, M., Neely, A., & Walsh, K. (2011b). How should firms evaluate success in university–industry alliances? A performance measurement system. *R&D Management*, 41, 202–216.
- Perkmann, M., & Schildt, H. (2015). Open data partnerships between firms and universities: The role of boundary organizations. *Research Policy*, 44, 1133–1143.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D’Este, P., et al. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy*, 42, 423–442.
- Perkmann, M., & Walsh, K. (Eds.). (2008). *How firms source knowledge from universities: Partnerships versus contracting*. Cheltenham: Edward Elgar.
- Plewa, C., Korff, N., Johnson, C., Macpherson, G., Baaken, T., & Rampersad, G. C. (2013). The evolution of university–industry linkages—A framework. *Journal of Engineering and Technology Management*, 30, 21–44.
- Revans, R. W. (1982). What is action learning? *Journal of Management Development*, 1(3), 64–75.

- Robinson, S., Lockett, N., Bicknell, A., Francis-Smythe, J., & Arthur, J. (2010). Knowledge transfer: Deconstructing the entrepreneurial academic. *International Journal of Entrepreneurial Behavior & Research*, 16, 485–501.
- Rossi, F., & Rosli, A. (2013). Indicators of university-industry knowledge transfer performance and their implications for universities: Evidence from the UK's HE-BCI survey.
- Rothaermel, F., Agung, S., & Jiang, L. (2007). University entrepreneurship: A Taxonomy of the literature. *Industrial and Corporate Change*, 16(4), 691–791.
- Sainsbury, D. (2007). *The race to the top: A review of governments science and innovation policies*. London: HM Treasury.
- Schoen, A., de la Potterie, B. V. P., & Henkel, J. (2014). Governance typology of universities' technology transfer processes. *Journal of Technology Transfer*, 39, 435.
- Schultz, M., & Hatch, M. J. (2005). *Building theory from practice*. Thousand Oaks, CA: Sage Publications.
- Sharifi, H., & Liu, W. (2010). An exploratory study of management of university knowledge transfer offices in the UK. In: Research, A. I. O. M. (ed.) *Academic Publications*. London: Management School, University of Liverpool.
- Siegel, D. S., Westhead, P., & Wright, M. (2003). Assessing the impact of university science parks on research productivity: Exploratory firm-level evidence from the United Kingdom. *International Journal of Industrial Organisation*, 21(9), 1357–1369.
- Siegel, D. S., & Wright, M. (2015). Academic entrepreneurship: Time for a rethink? *British Journal of Management*, 26, 582–595.
- Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, 20, 571–610.
- Sull, D., Homkes, R., & Sull, C. (2015). Why strategy execution unravels and what to do about it. *Harvard Business Review*, 93, 57–66.
- Sull, D. N., & Spinosa, C. (2007). Promise-based management. *Harvard Business Review*, 85, 79–86.
- Sun, Q., & Pfahringer, B. (2014). Hierarchical meta-rules for scalable meta-learning. In *Pacific rim international conference on artificial intelligence* (pp. 383–395). Springer.
- Swamidass, P. M., & Vulasa, V. (2009). Why university inventions rarely produce income? Bottlenecks in university technology transfer. *Journal of Technology Transfer*, 34, 343–363.
- Szulanski, G. (2000). The process of knowledge transfer: A diachronic analysis of stickiness. *Organizational Behavior and Human Decision Processes*, 82, 9–27.
- Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: An introduction. *Industrial and Corporate Change*, 3, 537–556.
- Thornton, P. H., & Ocasio, W. (2008). *The Sage handbook of organizational institutionalism*. London: Sage.
- Vargas, N., Lloria, M. B., & Roig-Dobon, S. (2016). Main drivers of human capital, learning and performance. *The Journal of Technology Transfer*, 41(5), 961–978.
- Wacker, J. G. (1998). A definition of theory: Research guidelines for different theory-building research methods in operations management. *Journal of Operations Management*, 16, 361–385.
- Weckowska, D. M. (2015). Learning in university technology transfer offices: Transactions-focused and relations focused approaches to commercialization of academic research. *Technovation*, 41–42, 62–74.
- Weischedel, R. M., & Sondheimer, N. K. (1983). Meta-rules as a basis for processing ill-formed input. *Computational Linguistics*, 9(3–4), 161–177.
- Wilson, T. (2012). A review of business-university collaboration. In: Department for Business, I. S. (ed.). London.
- Wit-de Vries, E., Dolfsma, W. A., van der Windt, H. J., & Gerkema, M. P. (2018). Knowledge transfer in university–industry research partnerships: A review. *The Journal of Technology Transfer*. <https://doi.org/10.1007/s10961-018-9660-x>.
- Witty, A. (2013). Encouraging a British invention revolution: Sir Andrew Witty's review of universities and growth.
- Xu, L., Li, J., & Zhou, X. (2017). Exploring new knowledge through research collaboration: The moderation of the global and local cohesion of knowledge networks. *The Journal of Technology Transfer*. <https://doi.org/10.1007/s10961-017-9614-8>.
- Yusuf, S. (2008). Intermediating knowledge exchange between universities and businesses. *Research Policy*, 37, 1167–1174.