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Could an incumbent firm develop a radically new medical technology with an old organizational capability?

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ABSTRACT

Our case study addresses how an incumbent firm from the pharmaceutical industry develops a radically new medical technology. We engage with the question as to whether such a radical innovation could be developed by relying on existent patterns of actions (existing organisational capability) or whether such novelty also requires doing innovation differently (new organisational capability). We argue that a sharp conceptual distiction between sustaining existent and developing new organizational capabilities is inadequate for describing organization of a radical innovation within an incubent firm. We propose that developing a radical innovation in a nascent innovation ecosystem requires multiple modifications across many systemic processes that constitute organisational capability for innovation. Hence, many small and interdependent innovations in organisational processes, practices and structures can make a big difference for developing radically new technology. Radical technological innovation goes hand in hand with management innovation. We argue that the nascent innovation ecosystem necessitates a careful balancing between legitimacy-seeking and advantage-seeking actions, which guides managers when adapting organisational capability for innovation. When complexity of an innovation ecosystem increases, broader changes across multiple systemic processes for innovation are required. A degree of continuity between existing and new organisational capabilities for innovation increases the internal acceptance of radical innovation.

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Medical technology; radical innovation; organizational capability; case study

Introduction

Medical innovation often takes a form of a radical technological breakthrough with significant strategic and organisational consequences for incumbent firms (Andriani et al., 2017; Cardinal, 2001; Rothaermel, 2001). Moreover, realising a radical medical innovation requires navigating complex innovation ecosystems (Denicolai & Previtali, 2020; H. Chesbrough, 2020).

From the perspective of an incumbent firm, a radical technological innovation is defined as a major discontinuity from the incumbent's extant knowledge resources and its position within existing innovation ecosystems (Hill & Rothaermel, 2003; Jacobides et al., 2006). An innovation ecosystem is a network of interconnected, yet independent,

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heterogeneous participants who are organised around a focal firm and committed to the development of new value through innovation (Adner & Kapoor, 2010). Managers at an incumbent firm, therefore, face two strategic challenges. First, they need to adapt internally (Eggers & Park, 2018) in order to explore novel technological and market domains, often distant to their existing competency (Breschi et al., 2003; Rosenkopf & Nerkar, 2001) and overcome inertial forces of the core business (Garud & Munir, 2008; Tripsas & Gavetti, 2000). Second, they need to shift attention towards external partners to coordinate collaborative searches (Laursen & Salter, 2006) and shape the direction of a new innovation ecosystem (Rindova & Courtney, 2020). Managers from incumbent firms are broadly advised to structurally separate explorative and exploitative searches, allocate sufficient resources for intensive collaboration in innovation ecosystems and create an organisational environment supportive of entrepreneurial actions (Burgelman, 1983; Foss et al., 2022; H. W. Chesbrough, 2003; Kapoor & Klueter, 2015; Mudambi & Swift, 2014; Tushman & O'reilly, 1996).

The above advice comes close to suggesting that incumbents need organisational capability for 'how to get a radical innovation done' (Dosi et al., 2000). Those with a history of radical innovation are highly likely to possess identifiable processes by which they systematically develop and deliver radically innovative products to the market (Eisenhardt & Martin, 2000; Winter, 2000, 2003). The radicalness inevitably signals a discontinuity with existing technological or scientific trajectories (Dosi, 1982) or business models (Ansari et al., 2016), but it is much less clear to what extent it also indicates the inadequacy of existing organisational processes for innovation (Garud et al., 2013). The question of whether developing a radical technology at an incumbent firm could be decoupled from changes in how to organise for innovation is especially intriguing, because the extant literature on dynamic capabilities leads us in two opposite directions.

The dynamic capability perspective suggests that existent systemic processes for innovation could be deployed to create something radically new (DiStefano et al., 2014; Teece, 2012; Tripsas, 1997). If a set of capabilities exists, these enable incumbents to adapt to any kind of technological changes (Eggers & Park, 2018). For example, if new product development capabilities (Brown & Eisenhardt, 1997), embedded in deliberate processes of experiential learning (Zollo & Winter, 2002), exist within an incumbent firm, then it is possible to argue that it could develop a radical technology without changes in underlying organisational capabilities.

The alternative argument, however, suggests that radical advances in technology almost inevitably trigger requirements for incumbents not only to innovate their products but to change *how* they organise for innovation (Dougherty & Dunne, 2011; Greve & Taylor, 2000). Rosenbloom (2000) argues that it was necessary for the firm, NCR, to radically revamp its organisational capabilities to respond to the disruptiveness of digitalisation. Therefore, developing a radically new technology may also require to *innovate the innovation process* and so, radical technological innovation is accompanied with a degree of management innovation (Birkinshaw et al., 2008). Moreover, scholars assert that without such a management innovation the existing organisational capabilities more likely act as core rigidities (Leonard-Barton, 1992) by supporting cognitive inertia of relevant decision makers (Bettis & Prahalad, 1995; Danneels, 2010; Tripsas & Gavetti, 2000).

This leads to our research question: *Does developing radically new technology also require doing it differently or could any such technology be created by relying on existing organisational capability for innovation?* To engage with this research question, we selected an established pharmaceutical company with a strong record of innovation and focused our attention on a group that develops a radically new technology. The emerging domain of bioelectronics for medical applications potentially displaces current clinical practice and existing pharmaceutical business models for certain therapies. The team leading the development of this innovation needs to explore technological domains that are distant to the firm's core scientific expertise (Bhardway et al., 2006; Katila & Ahuja, 2002) and to search in a *de novo* innovation ecosystem (Dattee et al., 2018).

By studying development of a radical medical innovation with a high level of discontinuity with an incumbent's legacy business model, its core expertise and its existent innovation ecosystem, we intend to make three contributions. First, we complement the literature on incumbents' adaption to radical technological change (Eggers & Park, 2018; Hill & Rothaermel, 2003) by arguing that established firms could radically innovate if they create and orchestrate a nascent innovation ecosystem. Second, we contribute to ongoing debate on the dichotomy between old and new organisational capabilities (DiStefano et al., 2014) by suggesting that innovating a capability for managing innovation (Birkinshaw et al., 2008) is characterised by maintaining a degree of continuity between old and new processes and structures. Third, we advance the literature on *de novo* innovation ecosystems (Dattee et al., 2018) by arguing that the growing complexity of a nascent ecosystem needs to be matched by multiple changes across systemic processes at the focal firm that support orchestration of the ecosystem.

Theory background

To engage with the research question, we reviewed selected literature on dynamic capabilities (DiStefano et al., 2014; Helfat & Peteraf, 2003) and nascent innovation ecosystems (Hannah & Eisenhardt, 2018; McDonald & Eisenhardt, 2019).

Sustaining old versus developing new organisational capability for radical innovation

The literature on organisational capabilities has always been more comfortable with explaining gradual change (Helfat & Winter, 2011; Nelson & Winter, 1982) than with clarifying the emergence of novelty. Importantly, this incrementalism addresses the magnitude of change in an organisational capability and not necessary the level of novelty in a product or technology that is developed by deploying this organisational capability. The intellectual legacy of the evolutionary framework emphasises habitual and experiential learning (Nelson & Winter, 2002; Winter, 2013; Zollo & Winter, 2002) and hence it is assumed organisational capability predominantly changes through selective reactivation or minor modification of past patterns. From this evolutionary perspective, changes to the organisational processes and the actual practice of what managers and their organisations do and how they get it done (Birkinshaw et al., 2008) are hardly ever radical.

This accumulative sustainment of existing organisational capability is then sharply contrasted with situations where firms are confronted with a major external disruption that potentially makes their organisational capabilities obsolete (Danneels, 2010; Henderson & Stern, 2004; Peteraf & Reed, 2007; Rosenbloom, 2000). Bresman (2013), for example, suggests that in high-velocity environments, groups engaged in radical innovation cannot simply learn from the experience of others. In this context, existent organisational capabilities prove to be mostly inadequate and so managers at incumbent firms face not only technological and market uncertainties but also organisational uncertainties of how to develop new ways to innovate. This sharp dichotomy between sustaining existing organisational capabilities for innovation versus developing entirely new ones leads to two different implications for managers at incumbent companies. First, they should replicate (Szulanski, 1996; Winter & Szulanski, 2001) existing organisational capabilities and learn 'as they go' without any major and purposeful changes in practices, processes and structures for innovation. Alternatively, a management innovation (a departure from the existing ways of how a firm innovates) is seen as a prerequisite for a radical technological innovation (Foss et al., 2013; Mol & Birkinshaw, 2009), and that processes, practices and structures must first be created and then enacted to facilitate the systematic deployment of organisational searches characteristic of radical technological innovation (Karim, 2009). Hence, a more nuanced and subtle understanding of change in organisational capability for radical technological innovation would be relevant for both innovation theory and practice.

Radical technological innovation and collaboration in nascent ecosystems

The relevance of studying the dichotomy between using existent versus developing new organisational capabilities is further amplified if external knowledge searches unfold in complex innovation ecosystems characterised with ambiguous structures, uncertain interdependencies between actors and fast-paced dynamics (Ansari et al., 2016; H. Chesbrough et al., 2014). The strategic focus shifts from internal adaptation towards managing inter-organisational interfaces and interdependencies.

It is recognised that radical technologies develop in innovation ecosystems with complex collaborative arrangements among sets of actors across industries that aim at creating and capturing value from the innovation (Adner, 2017). Such innovation ecosystems are typically orchestrated by a focal actor (Gawer & Cusumano, 2014) that possess a key technology or other resources (Jacobides et al., 2018). The collaborative nature of external knowledge search within an innovation ecosystem induces a managerial challenge that requires the cultivation of cooperation and coordination capabilities in order to support search activities performed by multiple organisations (Gulati et al., 2012).

The challenge of managing collaboration with external partners is further compounded if an incumbent firm needs to search for relevant external knowledge within a nascent ecosystem or has to create one (Santos & Eisenhardt, 2009). A nascent innovation ecosystem is a business environment in an early stage of formation, characterised by amorphous industrial structures, unclear product definitions and a lack of dominant logic to guide strategic decisions and actions (Santos & Eisenhardt, 2009). Hannah and Eisenhardt (2018) suggest that firms in nascent ecosystems need to balance

competition and cooperation. They are well advised to use joint R&D to resolve technological uncertainties. Similarly, Dattee et al. (2018) argue that strategically sharing IP may be essential to moving the ecosystem forward. However, in such an ambiguous, uncertain and dynamic environment it is often difficult to even identify innovation partners, let alone build productive collaborative arrangements from scratch.

The extant research on nascent ecosystems has mostly focused on creating new markets by shaping meaning (Rindova & Courtney, 2020), exercising soft power to build favourable relationships and acquiring resources to control as much of the new market as possible (Santos & Eisenhardt, 2009). The focus has been on skilful entrepreneurs navigating nascent structures in order to legitimise and frame radical technology (Lounsbury & Glynn, 2001; Snihur et al., 2022). However, we still know surprisingly little about how managers deploy, alter existent or develop entirely new organisational capabilities when shaping a new innovation ecosystem required for developing a radically new product.

Methodology

A single-case study research strategy (Sigglekow, 2007) was used in order to gain in-depth insights into the organisational capabilities required for an established pharmaceutical firm to develop a radical new technology. We selected a company and a very particular radical innovation initiative that made the phenomenon of interest transparently observable (Pettigrew, 1990). Our research was focused on *how* the focal innovation group and its managers deploy and change existing innovation processes, engage with members of the innovation ecosystem and assure their venture is accepted internally.

Empirical setting

Pharmaceutical companies have a recognised track record of technological innovation through the discovery of new molecules, and their subsequent development via clinical trials to commercialisation (Christensen et al., 2009). Within the industry, common core capabilities exist to manage relationships and alliances within the innovation ecosystem (Hagedoorn et al., 2006), manage the R&D portfolio (Girotra et al., 2007), and manage product development (Nerkar & Roberts, 2004; Pisano, 2000).

The case firm has a history of organisational experiments to change its R&D structures and processes. It had moved from traditional functional structures to smaller and interdisciplinary R&D units with greater decision-making autonomy and has also changed its investment decision-making approach for R&D. A deliberate effort was made to make the science-driven innovation process more 'entrepreneurial' by requiring company scientists to pitch for research money to an investment board of executives and venture capitalists. 'Give them an investment and then three years later hold them accountable and assess their progress' is how the company's R&D Chairman described the change in approach in a Wall Street Journal interview.

We focused our data collection on a group developing a radically new technology in the emerging field of bioelectronics, hereafter identified as 'Novel Medical Device' (NMD). In medicine, many current treatments for organ or chronic diseases involve

either invasive surgery or long-term treatment with drugs. The NMD technology uses a minimally invasive bioelectronic device to treat disease by targeting the electrical signals in the human nervous system, thereby reducing or eliminating the need for major surgery or chronic drug therapy.

The NMD group started modestly, with two staff. By the end of our research, the group had grown to a team of 35 staff, with over 30 external R&D collaborations, a $50 M venture fund invested in six start-ups and a major joint venture (JV) and investment of over $600 M with a major digital technology company.

Data collection

The field research initially focused on a retrospective investigation of how the firm had developed its broader innovation capabilities. This was achieved by using archival documents, observations and open-ended interviews to increase contextual knowledge. These interviews helped us to better understand the internal context in which the NMD group operated. It also provided us with the in-depth understanding of the existent organisational capabilities for innovation.

The research then focused on the NMD R&D group where interviews were conducted with managers and external collaborators, providing direct and contemporaneous access to senior leaders actively involved in managing the innovation initiative. Other data sources included public information and internal company documents which were used for analysis.

The case research concluded at the formation of a major joint venture, which represented an important milestone, signalling commitment and a strategic intent to pursue the innovation initiative. Recognising that the radical innovation was taking place within the context of a nascent innovation ecosystem, interviews with a range of institutional stakeholders were also conducted in parallel (identified as 'environment' interviews), thereby providing context and an understanding of the key issues that could influence the focal firm. The research data sources are summarised in Table 1. The initial case firm interviewees are denoted as RD1-RD6, and the NMD group interviewees as NMD1-NMD8 in Table 2.

Analysis and conceptualisation

Our research started by mapping existing systemic processes for innovation and determining if they were deployed for the radical innovation. Our analysis followed the method of Gioia et al. (2012), with first and second order coding being used to identify aggregate themes (Figure 1). What we learned prompted us to think not only about the magnitude of change but also about the structure of this change. We therefore focused on understanding the limitations for deploying existing systemic processes for developing radical technology, leading us to identify the nascent nature of the innovation ecosystem as a key driver for change in organisational capabilities. We investigated changes within the systemic processes that were a response to particular challenges. Through our field research, we realised how the perception of change in organisational capabilities potentially affects internal acceptance, and so, investigated other elements that influence internal acceptance.

Table 1. Research data sources.

Data sources	Details	Aspects studied
Case Interviews (within innovation ecosystem)	28 interviews in total: 24 with 11 senior R&D managers and NMD leaders over the studied period, and 4 interviews with 3 senior leaders in external collaborations. Totalling over 36 hours (ranging from 45 mins to 120 mins).	Identification of patterns in capability change; manifestations of managerial agency for deploying and modifying systemic processes, engagement with partners in the emerging ecosystem and framing the purpose of the venture internally.
Internal strategic documents	R&D Investment Strategy documents, NMD White Paper, NMD Manifesto and Business Plan, Project Update Reports and Investment Board review papers.	Identification of patterns in broader capability change; and existing innovation performance.
Observations	R&D Senior Leadership Meetings (2), R&D Business Management Meetings (3), Product Investment Board Meetings (2), New Venture Capability Review (1).	Internal acceptance of the innovation venture and identification sources of internal acceptance.
Published cases, articles on the case firm	Published HBR case (not referenced due to anonymity) and other journal articles (e.g., WSJ and FT).	Existing innovation capabilities and organisational processes in biomedical domain, strategic changes in organisational structures for innovation.
Company Public Documents	Annual Reports (15), R&D Pipeline Reports (2).	Company trends and performance data.
Company Website	Open Innovation (OI) News Releases.	Public information on the new venture and associated initiatives
Business Press and Industry documents	18 Public News Items, company press releases, public reports (e.g., NIH) and papers related to the technology venture (published in journals including Nature, Scrip etc.)	Dynamics of proposed technological innovation and engagement with the emerging ecosystem.
Environment Interviews	38 interviews with senior leaders in Regulatory bodies (e.g., MHRA), Biotech start-ups, Investors and Venture Capital, Health Providers (e.g., NHS), Health Payers, Innovation Incubators, Government Agencies etc. Totalling over 33 hours.	To provide a deeper understanding of the dynamics in the wider environment in which the innovation ecosystem was evolving. Understanding the limitations of the existing systemic processes.

Table 2. Case firm and NMD group interview summary.

Informant code	Informant title	Number of years at current company (or in industry)	Number of interviews	Hours interviewed
RD1	Senior Vice President (R&D)	21	1	1.5
RD2	VP External R&D	22	1	1.5
RD3	Director of Technology Innovation Group	10	1	1.5
RD4	Senior Vice President (R&D)	26	1	2
RD5	Director R&D Group	15	1	1
RD6	Vice President R&D Group	12	1	1.5
NMD1	Vice President and Head – NMD	10 (15 in industry)	7	9
NMD2	Business Development – Director NMD	10	6	7
NMD3	Head of Venture Funding – NMD	3 (11 in industry)	2	2.5
NMD4	Director and Head of Research group – NMD	18	2	2.5
NMD5	Director and Head of Technology group – NMD	1 (6 in academia)	1	1
NMD6	Academic Partner – NMD (Prof)	26 |(in academia)	1	1.5
NMD7	Incubator Partner – NMD	4 (25 in industry)	2	2
NMD8	Incubator Partner – Entrepreneur	3 (20 in industry)	1	1

As issues or topics arose, we explored these to better understand the actions of managers. The use of contemporaneous interviews and a range of documented data reduced the risk of bias caused by prior knowledge of the outcome of the observed process (Van de Ven, 1992). During the interviews, notes were taken

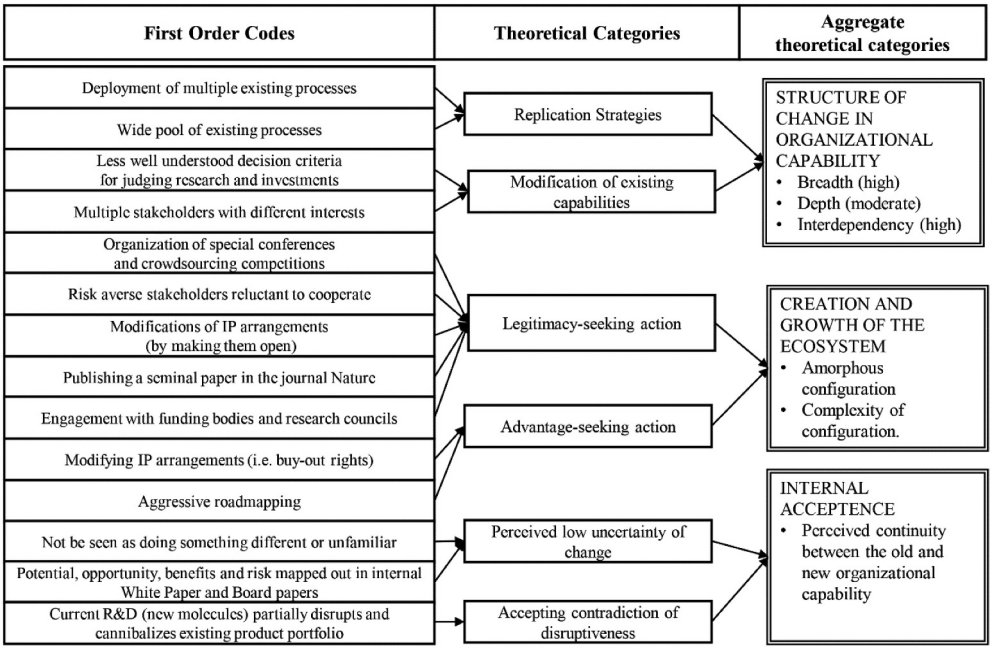

Figure 1. Data structure for developing theoretical inferences from raw data.

and the interviews recorded (where permitted). The data were then subject to further analysis and coding to identify patterns (Miles et al., 2014), with the aid of NVivo CADQAS software, to help address research reliability. To improve rigour, we looked to obtain data from multiple sources (i.e., from different interview respondents or documents) to help corroborate findings and address internal validity (Gibbert et al., 2008).

Findings

The studied firm has taken a leadership position in bioelectronics for medical applications, as explained by the NMD Head: 'We are still the only big pharma company investing substantially in this area'. It also moved from early exploration into full development of bioelectronic medical devices, as indicated by the R&D Chairman in an interview with the Financial Times '. . . expect [JV] to begin clinical trials on bioelectronics medicines for three different diseases within 18 months'. Key events in the evolution, from the initial identification of innovation opportunity, through the formation of the NMD group, the identification and engagement of academic collaborators and technology start-ups, the creation of an open innovation challenge and a corporate venture fund, to the development of the innovation ecosystem and the eventual formation of the $600 M joint venture with a global digital technology partner, are summarised in Table 3.

Table 3. Summary of main events for NMD group.

Year	Summary description of key events
Start of the project	Internal White Paper written outlining the business case for opportunity in bioelectronics.
Year 2	Agreement reached to form new R&D Unit for exploring the opportunity. Appointed trusted, highly capable internal leader and senior level sponsorship. Following corporate sign-off, informal governance and approval put in place.
Year 3	Begin search for potential R&D collaborators and partners. Expanded search using initial academic contacts as starting point to 'snowball' and reach other researchers. Initial academic R&D collaborations (ca 15) put in place. Hosted a conference with collaborators to identify wider technology and ecosystem needs. Announced Innovation Challenge an open innovation (i.e., crowdsourcing) with $1 M funding. Set up corporate Venture Fund with $50 M capital, to invest in 'pioneer' companies.
Year 4	Published papers in major journals to support funding and investment case, and to help build ecosystem interest and legitimise it and their role within it. Continued to build academic research collaborations. Engaged US research funding bodies and policy makers. Expanded to Innovation Challenge address conference output and technology gaps, with $5 M funding. Expand internal team to 5 with external 'technical expert' recruits.
Year 5	Open Innovation challenge approach revised and shortlist candidates selected and funded. 30 collaborative R&D projects underway with academia. Venture Funding invested in 3 start-ups. Created a new Investment Board with 3-year business plan and agreed budget. Engage European R&D funding bodies and policy-makers. Further internal team expansion (to 15) and re-organisation.
Year 6	Engaged Asian R&D funding bodies. Expand ecosystem to include Asia Pacific R&D collaborators. Expand internal team to 35. 50 collaborative R&D projects underway with academia. Venture Fund invested in 6 start-ups. Creating a recognised 'technical' domain via special topics at academic conferences. Formation of first major Joint Venture with Digital Technology partner (with $600 M funding). Preparation underway for first clinical study.

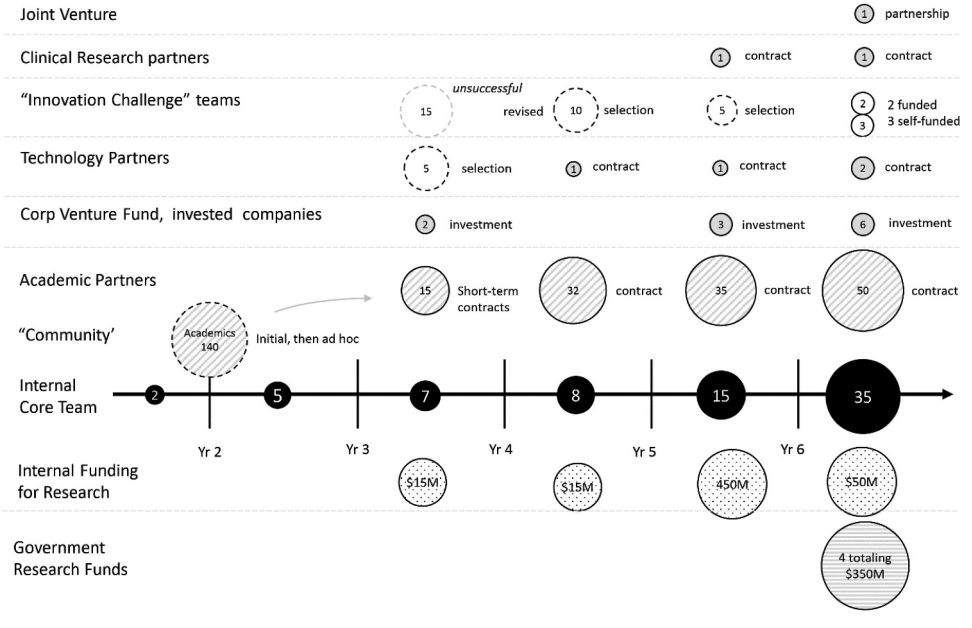

Figure 2. Growth of the nascent innovation ecosystem around the focal firm.

Balancing legitimacy- and advantage-seeking actions in the emergent innovation ecosystem

The bioelectronics field was emerging, with limited institutional support in terms of government research funding, venture funding and service organisations. A representation of the evolution of the innovation ecosystem is presented in Figure 2, showing its growth over time in terms of types of partners and collaborators and numbers of each. Unsurprisingly, the nature of the relationships between the focal firm and other actors differed for different actors, and in some instances varied over time with a particular actor, thus adding to the diversity and complexity of relationships being managed.

The early innovation ecosystem system was characterised by the lack of institutional funding. A member of Venture Capital community asserted: 'The main challenge is risk. With convergence of technologies, you are bringing together technical, integration and business model challenges – but you do not want risk in all three. That would not be investible'. Similarly, another interviewee [HS Med Tech Campus] identified the investment and risk issues: 'Investor community remains a challenge as VCs tend to specialise. Angel investors are limited in numbers and see this as having long timelines and higher risks'.

This presented several challenges to the NMD group, for example, the legitimacy of the emerging scientific field itself, the role of the firm within it, and the need for establishing a competitive position to enable future value capture. To help overcome these challenges and establish their position, the NMD group undertook several actions, which motivated the changes to their systemic processes (see Table 4).

Their initial actions were targeted at identifying academic collaboration partners and establishing company-funded research projects to build evidence and their network and to reduce uncertainty. A member of NMD team described the nature of their initial relationships as 'a low-key facilitator of ideas, rather than trying to dictate the terms of engagement. Our objective is to add value, and we do that in two ways: by encouraging more scientific diversity in the field, and helping prioritise a few practical outcomes through funding and partnerships that animate a spirit of co-ownership.' The NMD built partnerships in an exploratory way, making bigger commitments as knowledge, confidence and trust increased: 'For academic [partnerships] it was exploratory, there were many. We tried several to see what floats and then built with a few. As you know, the ones we started with were not the ones we have today'. To support researchers and start-up partners, a specialist research organisation was contracted to provide development support services, which was analogous to an existent internal capability model used to support traditional 'biotech' partners. To induce cooperation in the emerging ecosystem, the group funded conferences to share research outcomes and identify systemic challenges. One output of these conferences was the creation of a position paper in a major scientific journal (Nature) and a co-authored (with early ecosystem academics) paper and roadmap (Nature Reviews Drug Discovery), thus enabling the field to be more widely recognised in the broader scientific community.

Importantly, the nature of the early relationships was often simple, short term and focused on specific scientific goals to mitigate risks. As the ecosystem developed, different partnership approaches were employed and their nature moved to longer-term value

Table 4. Legitimacy-seeking and advantage-seeking actions.

Legitimacy-seeking action		Advantage seeking-action	
Description	Example quote/evidence	Description	Example quote/evidence
Research Contracts share IP rights with academic R&D collaborators.	• '[collaborators] concerned … whether our IP position was genuine. … we said that everyone would retain their IP. And there was a lot of scepticism about whether we were genuine about that' *{NMD2}*	Positioned as a 'hub' in network, and providing funds, support services and influencing research direction.	• '... what's turning into reality is that we are the downstream partners. So we can propose joint research with academics to apply for this funding … we believe that these funding programs can not only feed new ideas or new disease opportunities in to our development pipeline. But it's also a way for us to get more leverage in the early research'. *{NMD1}*
Funding start-ups via new corporate Venture Fund.	• 'Through our $50 m venture capital arm, [NMD] Venture Capital, we are investing in start-ups and technology platforms that aim to advance the development of bioelectronic medicines'. *[NMD website]*	Renegotiated Collaboration IP positions to take full ownership (in return for royalties, funds) for later value capture.	• 'Much of the value we've created has come from partnerships we've created with academics. The real balancing act this year has been to leverage the IP we've jointly created and use this … in a constructive way … we look to take control, via buy-out or licencing or royalties so we have exclusivity and ownership'. *{NMD1}*
Open access of IP from Open Innovation Challenge to research community.	• 'Acceptance of the prize will require, that the ... winner … release all relevant research data and information into the public domain. This … will allow other investigators, including those at [NMD], the right to utilise the work for future research purposes while permitting the … winner … to retain commercial rights'. *–[NMD website]*	Hold right to exploit and capture value from Open Innovation IP for commercial use.	• 'So we have said we will allow the winner to retain the IP, but with conditions. Those are: they must make it broadly accessible to the community. [NMD] has the 1st option to licence it for research and clinical, commercial use'. *{NMD3}*
Develop paper for major scientific journal, to position the field and their role to attract other researchers and funding	• 'Realising the vision of a new class of medicines based on modulating the electrical signalling patterns of the peripheral nervous system needs a firm research foundation. Here, an interdisciplinary community puts forward a research roadmap for the next 5 years'. *[Nature 2014]*	Joint Venture formed with major digital technology partner.	• 'So the driver was – how do we rapidly access the technology and engineering capability to build a game changing device'. *{NMD1}* • 'It's a big initial investment, so you want to be able to capture the value. So the deal needed to allow us to be able to capture the value'. *{NMD1}*
Special sessions at existing academic conferences to present collaborative R&D findings	• 'we have now started to publically disclose the outcomes and output from all that funded work, through a number of channels' *{NMD2}*		

creation. Whilst government research funding was not immediately available, the NMD group also directly funded academic research and, importantly, entered into contracts that shared the rights to any intellectual property (IP) created. This had a positive impact on researchers in the field: 'They are like a catalyst and have open up new possibilities, provided a new purpose. I was almost ready to retire . . . but this research provides a new perspective'. [NMD6]. Investment was provided to start-ups (biotech and specialised technology firms) in the form of a new corporate venture fund, addressing an identified limitation in the institutional funding. Consistent with their existing venturing approach, most relationships were managed 'hands-off', but the nature varied depending on the capability of the funded partner. Their open innovation challenge (funding a mix of start-ups, university research consortia, etc.) addressed systemic and platform technology gaps. Importantly, the IP so generated was to be made freely available to the whole research community; an act that helped to overcome initial suspicion of their involvement from the start-up and academic community. Managers at NMD recalls: 'They [potential collaborators] were concerned whether our IP position was genuine. We said that everyone would retain their IP and there was a lot of scepticism about whether we were genuine about that'.

The firm's early intent was to establish a position to assess the potential of the new field. As the field and the firm's legitimacy were established, their role moved to that of 'advantage-seeking'. Their central role within the emerging ecosystem created a position of leadership and power with access to, and the ability to influence key research partners, technology companies and institutions. The corporate venture fund provided opportunities to invest, and appropriate value from those ventures. They also developed alliances with several biotechnology companies to help develop and create specific capabilities and technologies. But this presented some unforeseen challenges. The lack of domain knowledge (by the technology companies) and the risks they perceived acted as early barriers to their engagement: 'A surprising challenge was that the Tech companies were actually quite risk averse. They are doing something completely new. They all see potential in health applications, but are not sure how to play or where to engage. They worry about things like scale, . . ., and liability. But having someone like us on board is helping [NMD7]'.

The open innovation program reinforced their central role by providing funds but also enabled them to establish a position to commercially exploit the IP generated and the ability to take a 'first mover' position. However, NMD managers also admitted that the information they held was only selectively revealed, in order to build a stronger position and to give them strategic advantage as an early mover: 'But for later work, that's more commercial, we are more opaque. I'm happy for the competition . . . seeing this is just [. . .] working on a 'moonshot'. Their position was reinforced by the creation of a major joint venture with a global digital technology company and several hundreds of millions of dollars in funding. This accelerated their technical expertise and product development, whilst retaining control and a position to capture future value. Once this joint venture was established, they had created, and nurtured, a viable and developing innovation ecosystem.

Table 5. Managing relationships within innovation ecosystem.

Systemic processes supporting innovation in core domain (biomedicine)	Change in systemic processes created by managerial actions	Relevant quotes from the case {interviewee}
• Search for new scientific knowledge and academic partners by reviewing journals, investigating IP databases and attending scientific conferences.	• Systematic searches were tried, then supplemented by repeated engagement and networking to access a wider network and new knowledge.	• 'We started with a systematic search, but I'd downplay that, we aspired to it, but that's not how it worked out over time. That initial search led to us accessing three key individuals who we collaborated with to write the [. . .] paper. That provided a key to access more people. It was not so much that they opened up their Rolodex, as by working with them we had more credibility from those interactions and the paper, so we were perceived as serious and credible. That was key'. {NMD1}
• Engagement with a community of academics and researchers working in well-defined and established fields.	• Organised researcher events and special topics at established conferences and published journal articles to build the new community. • Increasingly, they moved from the role of integrator (helping make connections) to one of leadership.	• 'We decided to hold a conference and persuaded the National Institute of Health, NIH (amongst others) to be involved, that encouraged attendance (from academics looking for funding) at the conference, and from that we found our next wave of collaborators'. {NMD1} • 'On average every year we have had two network meetings where we bring all our funded PIs together. one of the things we have done, increasingly is go to these conferences and ask for a bespoke session. . . .'. {NMD2} • 'I think our initial deliberate role was to integrate the community. To bring all those people in the community together. That then organically morphed into an expectation that [NMD] will evolve from playing an integrating role into a leadership position'. {NMD4}
• Using Open Innovation (OI) or Crowdsourcing for problem-solving within a well-defined problem space, identified by the company (e.g., disease domain).	• Instead of defining problems themselves, stakeholders were used to help codify it. • Adapted their crowdsourcing (OI) processes (by funding the competitors) to ensure engagement and success • OI solutions made available to the research community free of charge.	• '. . . after the community identified the "problem" we went out and consulted to confirm we had identified the right problem and decision criteria, we also got the funders to endorse and confirm this was critical and finally we checked that the community would be prepared to participate'. {NMD4} • 'Acceptance of the prize will require, that the . . . winner (or the entity that owns or controls the relevant IP) release all relevant research data and information into the public domain, ... This public release of data and design will allow other investigators, including those at [NMD], the right to utilise the work for future research purposes while permitting the . . . winner (or the entity that owns or controls the relevant IP) to retain commercial rights'. – *[crowdsource selection criteria* {NMD website}
• Investing in start-ups and SMEs (biotech companies) through a combination of licencing agreements or venture funding that was financially focused.	• Created a new Venture Fund, specific to this field, to make investments in pioneer firms and platform technologies. • Unlike the existing fund, there was no firewall between the ventures and the internal R&D group.	• '... fund invests off of [NMD] balance sheet, and is effectively a $150 M evergreen fund, able to lead investments into start-ups, is stage agnostic, and once invested, behaves like a traditional financial investor following on our investments and well-aligned with other institutional VCs around the board'. - {VC Fund website] • 'So the approach we've developed gives an alternative. . . .. This approach reduces risks for both parties and from [. . .] viewpoint keeps the price down and allows [. . .] to engage with academics who don't want traditional R&D collaboration'. {NMD4}

(Continued)

Table 5. (Continued).

Systemic processes supporting innovation in core domain (biomedicine)	Change in systemic processes created by managerial actions	Relevant quotes from the case {interviewee}
• Access to a wider network of other pharmaceutical companies and supply chain partners to develop pre-competitive collaborative networks or joint ventures.	• Built alliances with firms outside their industry including start-ups and technology companies. • Set up a Joint Venture partnership with a major computer/digital technology company.	• 'We bring expertise, complementary research, tools, connections, and learnings, making the value to our partners both high and durable' –*[Internal Business Plan]* • 'I think we had not taken the leadership position it would have been difficult to be attractive to [TECH] for one. Secondly, it would have been difficult to make a case internally'. {NMD1} • 'This is an ambitious collaboration allowing [NMD] and [TECH] to combine forces and have a huge impact on an emerging field. Bioelectronic medicine is a new area of therapeutic exploration, and we know that success will require the confluence of deep disease biology expertise and new highly miniaturised technologies' – *[Press Release 2016]*.
• IP (patent) ownership and management and licencing focused on tightly defined domains (e.g., a specific molecule or formulation) and exclusivity.	• Employed different approaches to managing patents and IP; co-owned IP was created (in contrast to exclusivity). • Where the IP was critical to the growth of the ecosystem, an open approach was used (making IP freely available to other research collaborators).	• 'Our primary focus in 2015–17 is to build a broad portfolio of method of treatment and treatment parameter patents. This should be seen as our key "platform IP"…' – *[Internal Business Plan]* • '… our key "platform IP", which would be difficult to work around and of high commercial value, and we will seek to own it outright …), or have an exclusive licence (where invented by a collaborator or jointly by us and a collaborator)'. – *[Internal Business Plan]* • '… because we were all aligned on the view that the value came from the information that it generated. So the OI was the equivalent of trying to develop a PCR1 machine or a sequencing machine to catalyse the genomics field' {NMD2}
• Providing a dedicated support organisation to external alliance partners and collaborators.	• Partnered with a new clinical research organisation (CRO) to support their collaborators in areas needing 'translational' capabilities.	• 'These … will not be expected to build a world-class translational team each from scratch, but will instead draw on our strategic CRO partner […] across pre-clinical GLP, clinical operations and regulatory services. With nearly 50 years' experience in medical device services, […] has provided CRO support for over 200 […] projects '– *[Internal Business Plan]*
• Established public funding bodies (government and research agencies) financially support academic research community and projects.	• Leveraged position to engage funding bodies and help focus research funding interest. • Provided funding for specific academic projects that funding bodies did not.	• 'However, the [NMD] commitment and engagement with the broader community has triggered significant new interest in closing these gaps as exemplified by the 2014 pledge by the US National Institutes of Health (NIH) of a $248 m, 6-year program'. -*[Internal Business Plan]* • *Evidence of company funded projects in* Internal *Business Plan*: '… [NMD] R&D currently has 33 fully funded projects across 26 institutions in 9 countries'. *[Internal Business Plan]*

Incremental modifications across multiple innovation processes

Our initial findings consider the extent to which the NMD group modified systemic processes within the three main organisational capabilities for innovation, that is to manage relationships in the innovation ecosystem, manage the R&D portfolio, and to manage product development. The NMD group deployed many of their existing systemic processes and also modified them to address limitations to these processes resulting from the emerging nature of the ecosystem. They used a range of approaches to build relationships in the emerging ecosystem, to help build a new network and to engage a diverse and dispersed community. Several examples are provided below and a summary of existing systemic processes to manage ecosystem relationships, their limitations and the group's response are included in Table 5.

Their early approaches to searching for collaborators and knowledge were modified (in that they initially knew very few people in the field) and so focused more on relationship building and less on systematic searches for relevant IP and scientific knowledge. They also deliberately, and unconventionally, ran their 'Innovation Challenge' crowdsourcing process in stages with several competing teams (e.g., a team may include an alliance of academics and technology companies). These teams were brought together at each stage to share findings and create the potential for new teams to be formed for subsequent stages, with the aim of increasing the likelihood of success. Corporate Venturing (to provide investment in start-ups and early-stage biotechs) was already established in the firm, but the NMD group modified the venturing model from the outset, eliminating the existing 'firewalled' approach, to a model where there was a flow of knowledge and data between the NMD group and the invested company.

Management of the R&D investment portfolio evolved throughout the observed period. Initially, a conscious decision was taken to 'ring-fence' the initiative from normal R&D funding and then manage individual investment decisions through a single senior sponsor (a member of the corporate executive team). This process was continued until the risks were reduced, and the potential of the venture was established. At this point, they created an 'investment board' modelled on existing internal boards, but with greater external membership. This continued until the Joint Venture with a major technology company was established. A summary of existing processes to manage the R&D portfolio, the limitations and the group's responses are included in Table 6.

From the outset, there was a deliberate intent to work in a collaborative way; this provided increased flexibility and reduced risk whilst the ecosystem, and their technical competencies within it, were developing. But as there was a need to create their own competency, the internal team was gradually built, as that competence became core to the venture. A summary of existing processes to manage the product development, the limitations and the NMD group's responses are included in Table 7.

In summary, the NMD group engaged with many of the existing systemic processes, and indeed modified them to progress the radical innovation. Some existing processes, were initially, simply replicated, yet most underwent organisational changes as they proved to be inadequate to manage innovation processes in the emerging innovation ecosystem.

Table 6. Managing R&D portfolio.

Systemic processes supporting innovation in core domain (biomedicine)	Change in systemic processes created by managerial actions	Relevant quotes from the case
• Internal assessment of the opportunity and potential value by prediction of (path dependent) knowledge trajectories.	• Used external research evidence and evidence from related fields to build early support for the opportunity.	• 'We are now confident that [NMD] medicines will be able to offer precision treatments for a range of chronic diseases. This conclusion is based on a combination of clinical results, pre-clinical preliminary findings and a groundswell of foundational research'. *[Internal Paper]* • 'The therapeutic potential is proven in the clinic by devices for sleep apnoea, hypertension and rheumatoid arthritis, and [NMD] funded work uncovered a rich base of preclinical evidence for the impact on other chronic diseases, e.g., for type 2 diabetes, asthma, and infertility. We have also shown we can interface with select neural circuits'. *[Internal Paper]*
• Internal venture approach to R&D, requiring R&D leaders to make business cases for up to 3 years funding • Empowering small R&D groups to manage the approved innovation with minimal oversight.	• Initial investments were low and managed informally, following top level 'in principle' sign off. • As investments increased more formal structures were put in place to assess them. • Nascent nature of the technology required different investment decision criteria.	• 'There was a strong sense in [. . .] that we needed time to incubate. It's a new area and the work needed some protection, or air cover from the more restrictive constraints and normal decision making and governance'. *{NMD1}* • '... so, what I've been doing so far is going to [. . .] once a week, with a one pager, saying here is what we need, £100k to do this collaboration – yes or no? To build the portfolio'. {NMD1} • 'Now when we are talking about a few 10s of millions and of ramping up the investment, it's time for a more solid governance. And that will be a business plan, an investment plan, reviewed by the board'. {NMD1}
• Independent Investment Boards in place to manage resource allocation decisions across portfolio of projects.	• Formed new Scientific Advisory Boards with external experts to judge portfolio. • A new Investment Board (IB) was created, with both internal and external expertise – analogous to existing investment boards.	• 'So we knew that technologically it was different, that we'd need different criteria and that things like safety data would be different to a molecular medicine. So we'd also need to judge the portfolio using different criteria'. • '. . . although there is initially a lower promise and it's hard to compare, in the long term it has to deliver a viable portfolio and stack up against other investments'. *{NMD5}* • 'We need to have rigour in our capital allocation and ensure we have the right expert input. Hence the new Investment Board. We also have other structures like Disease Advisory Boards, . . . modelled on the (existing) approach' – *{NMD1}* • 'I guess what we are trying to do is avoid creating . . . .not too much dissonance'. *{NMD1}*

Table 7. Managing product development.

Systemic processes supporting innovation in core domain (biomedicine)	Change in systemic processes created by managerial actions	Relevant quotes from the case
• Well-defined processes to assess product potential and the plans to develop and commercialise the product. • Well defined and detailed development process, with substantial internal capabilities and facilities, complemented by an extensive and well-established external network of research partners (e.g., CROs)	• Recognised the need for different approaches but not fully enacted during research period. • Externally recruiting new Regulatory Head with relevant expertise. • Minimised internal investments and maximised the use of their growing network. • Development processes initially drew on external expertise. • Internally focused on biology and clinical, used external partnerships for all technical other activities.	• '. . . lack of referral pathways, and reimbursement codes are also well known obstacles. In general, it is fair to assume that commercial ramp-ups will be slower for [NMD] than molecular medicines'. *–[Internal Paper]* • 'The experimental work to date has by and large not been conducted at [NMD], but instead by ~ 100 researchers in the ~50 collaborations the team has led and integrated'. *[Internal Strategy Document]* • 'Investments internally at [.] will be held at a minimum during the exploratory years with all hands-on R&D taking place at partnering organisations and with the [.] team being lean and focused on evaluating, coalescing funding, and strategically integrating different strands'. *–[Internal Business Plan]* • 'So from Day one we were always going to play to our strengths which were- we could do the biology, do the clinical trials but we did not have the technology, although we could and did recruit people internally, but by and large it was always going to be done in bespoke strategic partnerships' *{NMD1}*
• R&D groups are small empowered, multi-disciplinary teams – with deep scientific expertise in their field.	• Balancing the external and internal challenges resulted in them deciding to recruit internally for the leader and a few key staff (to help manage the internal relationships) and externally for key technical roles.	• *[Internal Business Plan Exhibit OS2] identifies the leadership team consisting of 3 internal and 3 external recruits. p27,* • 'So I think he was trading off two things here. To make this venture a success we need to do two things – make the right scientific calls (and clearly the external candidates were better placed to do this), but we also needed to navigate the internal organisation. And the view was that they would not be able to do that as well'. *{NMD1}*

Building internal acceptance

The group appears to have developed a radical innovation by modifying a large suite of existing systemic processes. Expectedly, like most early innovations, there was a need to focus on de-risking and gaining credibility, via small early investments. More surprisingly, and counter to expectations for a radical innovation, internal resistance was not evident to the team, as summarised by the group's head [NMD1] who explained that: 'there has not been internal resistance, not that I've faced or that has been noticeable'.

This can in part be explained by senior sponsorship and the nature of pharma R&D, where there is a culture of being more open to radical innovations, typically from new classes of drugs which may completely displace the existing business, and which may be developed internally or by partners or by competitors. When asked to explain, the group head [NMD1], who had navigated the innovation externally and internally, stated:

> *I think there is also an element of familiarity. It's partly about giving Exec management comfort. . . . It also helps across the rest of the organisation. We don't want to be "seen" as too different. You should not underestimate the power of your peers. They can challenge, especially in R&D and we are all trying to access the same funding pot. So, there is a need for some familiarity, for people to be comfortable that the process, governance and arena is fair, it's different but seen to be fair. So, it isn't easier for us to get money than someone else . . . . The structures looked similar or familiar.*

The 'familiarity' therefore addresses both perceived uncertainty and 'fairness', whilst the radical innovation was developing something different, it was not seen internally to be treated differently. Furthermore, the creation of an advantage-seeking position was considered important to the internal acceptance, explained by another senior executive [NMD2] that if they '. . . had not taken the leadership position it would have been difficult to be attractive to [JV] for one. Secondly, it would have been difficult to make a case internally'. This combination of incremental but broad changes across multiple systemic processes, being seen as 'familiar' and advantage-seeking activities therefore appear to be key to securing internal acceptance.

Discussion

We began this paper by asking if an incumbent firm developing radically new technology also requires doing it differently or could any such technology be created by relying on existing organisational capability for innovation? In decoding this old-new dichotomy, we considered to what extent the development of a radically new technology could be decoupled from changes in underlying organisational capabilities for innovation. Our findings lead us to propose a conceptual model of structural changes in organisational capabilities for supporting radical technological innovation at an incumbent firm (see Figure 3).

We argue that a radically new technology will be accompanied with significant changes in the existent organisational capability for innovation. Hence, technology innovation goes hand in hand with management innovation. However, the new capability will have a degree of consistency and continuity with the old one and this requires a deeper look into the structure of this change. Two processes drive the changes in organisational capabilities for innovation (Altman et al., 2022). First, managers at an incumbent firm must create and

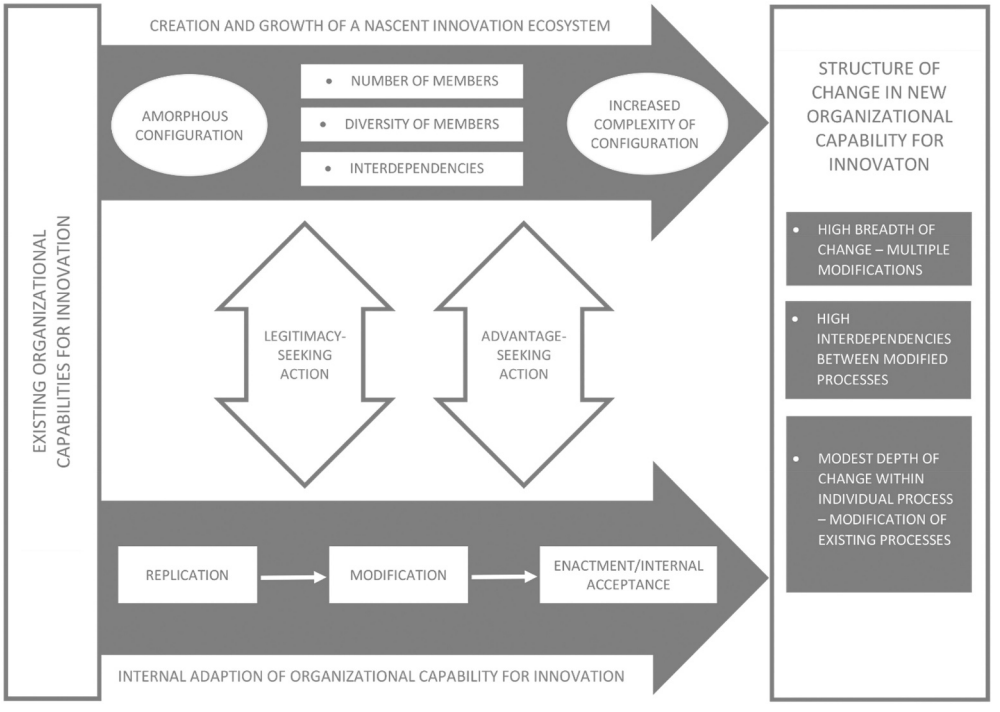

Figure 3. Model of structural change in organisational capability for managing radical innovation at an incumbent firm.

orchestrate a nascent innovation system which, in time, grows in complexity. Second, the creation and orchestration require concurrent adaptation of internal organisational capabilities for managing external searches. The adaptation of existing organisational capabilities is shaped by the need to legitimise a radically new technology and the strategic intent of a focal firm to position itself centrally to capture as much value as possible when the technology reaches the market. The increased complexity of the innovation ecosystem manifests in a greater number of collaborators, their diversity and the establishment of new interdependencies. This ecosystem complexity is mirrored by increased complexity of internal adaption as a focal firm needs to modify multiple systemic processes in their organisational capability for innovation. However, as this adaptation unfolds through a pattern of replication, modification and enactment, the new organisational capability has a degree of consistency with the old capability. In other words, many modifications within a complex organisational capability could lead to a significant improvement in the incumbent's ability to radically innovate.

Structure of change in organisational capability for radical technological innovation

Our evidence demonstrates that a sharp conceptual distinction between existent and new organisational capabilities (DiStefano et al., 2014; Teece, 2012) fails to adequately describe changes that are required when a group in an incumbent firm develops radically new

technology. Also, existing capabilities do not necessarily act as core rigidities (Leonard-Barton, 1992), underpin cognitive inertia (Tripsas & Gavetti, 2000) or hamper internal acceptance. The evidence broadly supports an argument that a radical innovation and accompanying search of distant knowledge domains within a nascent ecosystem increase the likelihood for existing organisational capabilities to be modified and, hence, organisational innovation (Birkinshaw et al., 2008) accompanies the development of a radical technology. This is, however, very far from suggesting existent organisational capabilities become obsolete and the new ones are characterised with a radical discontinuity. We argue that instead of categorising change in capabilities in terms of its magnitude or old versus new dichotomy, it is more productive to explore the structure of this change.

The literature on organisational capabilities and strategic resources (Black & Boal, 1994; Winter, 2003) allows us to conceptualise an organisational capability as a complex configuration of interrelated processes and strategic resources. Adopting this systemic perspective enables us to describe the structure of change with the dimensions of breadth, depth and interdependencies. The breadth of change indicates the number of systemic processes that require change in order to support searches in a new technological domain. The depth of change denotes a degree to which a particular systemic process needs to be altered for supporting the development of a radical innovation. The interdependency addresses the connectedness between these processes.

We propose that when an incumbent firm develops a radical technology the changes in underlying organisational capabilities could be characterised by many processes being altered (high breadth of change), yet the degree of change within these processes may be largely gradual (modest depth of change). Also, multiple gradual changes will likely be highly interdependent, which increases the complexity of adaption. An established firm with a history of technological innovation, such as the one in our research, will possess multiple systemic processes that support innovation capability. This large pool of already available processes is a necessary ingredient for a breadth of change. Here, managers involved in a radical innovation initiative deploy the existing systemic processes despite being aware that they explore a very distant domain, which is entirely discontinuous with their existent technology expertise. They attempt to replicate (Szulanski, 1996) innovation capabilities that proved to be adequate for conducting local searches in a familiar domain (e.g., medical biology) for exploring a technologically distant domain (e.g., bioelectronics for medical applications). This initial reliance on replication suggests that any accompanying organisational innovation will have continuity with the existing pool of systemic processes and hence depth of change will more likely be modest.

Nascent innovation ecosystem and modification of organisational capabilities for radical innovation

If replication strategy explains a degree of continuity between the old and new organisational capabilities for innovation, it says much less about the breadth of change, and its complexity. The evidence from our case study provides insights into what necessitates multiple modifications and what considerations inform managers when amending multiple systemic processes to create and orchestrate a nascent innovation ecosystem.

It has been widely accepted that the development of radical innovation requires managing relations in a complex ecosystem (Adner & Kapoor, 2010) and skilfully

balancing the need to induce cooperation with advantage-seeking competitive actions (Gnyawali et al., 2006; Hannah & Eisenhardt, 2018). The extant research has mostly investigated how entrepreneurial firms navigate existent innovation ecosystem (Ansari et al., 2016) or shape the nascent ones (Santos & Eisenhardt, 2009). What is less often studied is how a resource rich incumbent creates and orchestrates a nascent ecosystem that enables integration of highly dispersed expertise (Dattee et al., 2018). Such an emergent ecosystem has the characteristic of an organisational field in flux, with undefined boundaries and an amorphous network of organisations and individuals that are potentially relevant for exploring and developing a radical technology innovation (Meyer et al., 2005). Our case study shows that this emergent nature of the ecosystem and its dynamics are the main influential factors that necessitate multiple modifications in existent capabilities.

To induce cooperation in such an emerging field, they must first legitimise the new technology and the firm's position within the innovation ecosystem. For example, publishing a seminal paper in the journal Nature was clearly intended to signal to the academic community that the field of medical bioelectronics is scientifically legitimate. Intentional engagement with government funded research councils to support research in an emerging field is equally a legitimacy-seeking action to facilitate the growth of the ecosystem. On the other hand, the modification of an existent crowd-sourcing process with a unique IP-sharing agreement was clearly intended to signal to the sceptical community of academics and small technology companies that this company is a trustworthy partner willing to consider common interests. It is intriguing to observe that managers from a powerful and resource rich incumbent should behave as skilful cultural entrepreneurs (Lounsbury & Glynn, 2001) that utilise the existing firm's resources and also deploy framing strategies to legitimise the importance of an emerging field to multiple constituencies so as to induce and intensify cooperation. It is equally important to assert that these legitimacy-driven actions and accompanying framing strategies directly impact changes in systemic processes that constitute organisational capabilities for innovation.

As the ecosystem becomes better configured and more complex, these legitimacy-seeking modifications are quickly accompanied with more assertive advantage seeking-actions that aim at appropriating the future value of the innovation. The studied company was clearly in possession of numerous systemic processes for managing relationships in the biomedical ecosystem and the managers intended to replicate them within the emerging ecosystem of bioelectronics. They have, however, encountered multiple limitations that required changes in these systemic processes. We argue that these changes in organisational capabilities are needed because the systemic processes adequate for navigating an established ecosystem are imperfect for *building* a nascent one. Their existent systemic processes were far less productive in the emergent field where relevant IP is extremely scarce and dedicated conferences and academic journals did not yet exist. The replication of existing organisational capabilities for innovation may suffice if a firm transfers its existing systemic processes from its core domain to another *established* technological domain. We assert that the more nascent the innovation ecosystem for radical innovation, the higher the need for changes in systemic processes that constitute organisational capabilities at an incumbent firm. Moreover, when the configuration of a nascent ecosystem becomes more complex, broader changes

are required across multiple systemic processes for innovation. Consequently, these broader changes become increasingly interdependent, which increases differentiation between the new and old organisational capabilities for radical innovation.

Structure of change in organisational capability and internal acceptance of radical innovation

Our evidence enables us to infer that strategic actions within the innovation ecosystem and the identified change in organisational capabilities affect the prospect of the radical venture being accepted internally. Importantly, we were unable to observe any significant internal objections driven by cognitive inertia and dominant logic. We have identified some evidence suggesting that the notion of radical innovation is being embraced within the studied company and the pharma sector more widely. This potentially infers that if organisational values support embracing contradictions of discontinuous innovation (Smith & Lewis, 2011) then any internal opposition is far less likely.

Potentially more captivating is the evidence that links internal acceptance with the structure of change in organisational capabilities as well as with advantage-seeking actions within the nascent ecosystem. Informants from the group leading the radical innovation initiative agreed that it is of utmost importance '*not to be seen as any different*' to the other innovation groups that explore in the core domain of biomedicine. It is acceptable for the group to be *seen* as exploring a *radically* new technology and business model, but it is also important to conduct this exploration by using similar innovation processes as other groups. This inevitably triggers a parallel with Ansari's et al. (2016) assertion that disrupters are well advised to avoid framing themselves as being disrupters. Their example emphasises the importance of framing for the external audience. Our case study on the other hand indicates that being seen internally as innovating in a familiar way helps to avoid internal resistance or opposition. This suggests that what counts is not only internal framing and effective issue-selling but also the structure of change in organisational capabilities (high breadth, but modest depth) that creates an internal perception of low uncertainty related to the required organisational change. The replication strategy creates a perception that the group operates *per* existent organisational rules and procedures and that it is not treated favourably in comparison to other innovation teams. We also find evidence that assertive advantage-seeking actions that accompany legitimacy-seeking actions in the nascent innovation ecosystem help with building internal legitimacy and hence increase the internal acceptance of the initiative. We therefore propose that the likelihood for a radical innovation initiative to receive internal support in an incumbent firm increases if changes in organisational capabilities for innovation are perceived as continuous and consistent, and hence less uncertain. Managers leading innovation initiatives should be aware that doing something different (i.e., developing a radical technology) may not give a licence to do it in a radically different way.

Limitations of research

Reliance on a single case and close engagement with its idiosyncrasies inevitably limit generalised induction. Our focus on early stages of developing bioelectronics technology for medical use prevents us from investigating managerial actions and organisational

capabilities that become relevant when this technology enters the market. Perhaps more importantly, a lack of comparative cases raises the question if radical technologies could be developed in nascent ecosystems without any significant organisational changes (using old capability) or, on the other extreme, require radical and discontinuous changes in organisational capability? We would speculate that the latter scenario is likely if a focal firm faces a major disruption and development of a radical technology is part of a larger strategic transformation (Eggers & Park, 2018; Rosenbloom, 2000). The former scenario is plausible if, unlike in our case, multiple incumbents explore within the nascent ecosystem that may reduce the importance of legitimising actions. Alternative research designs (multiple case studies or quantitative theory testing) could shed further light into contingencies that affect the degree of organisational change.

Disclosure statement

No potential conflict of interest was reported by the authors.

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