How Incumbent Firms Strategically Transform from Product-Focus to Ecosystem Leadership

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Table of contents

List of figures

List of tables

Abstract

The emergence of ecosystems in a sector represents a significant and potentially disruptive challenge for product-focused incumbent firms. The existing literature explains the emergence of new ecosystems mainly as a disruptive process of technological change that challenges the original, product-focused activities. Therefore, we know relatively little about how incumbents prevail when ecosystems profoundly transform entire sectors, but do not replace the product business. I use an in-depth, longitudinal case study of a machine manufacturer to explore how incumbents cope with emerging ecosystem-based competition. I find that the focal incumbent created an ecosystem in a process of continuous change following a logic of continuity, thereby transforming and complementing the original product-focused business. I also show how the focal firm changed over multiple strategic cycles, engaging in in-house solutions and customized orchestration before successfully shifting to an ecosystem logic. My main theoretical contribution is a process model of accumulated learning that highlights historical embeddedness and continuous organizational learning as important, yet under-recognized drivers in ecosystem creation.

Keywords: incumbent, ecosystem, ecosystem emergence, strategy process, strategic change, organizational learning, accumulated learning.

Die Entstehung von Unternehmensökosystemen in einem Wirtschaftssektor stellt eine bedeutende und potentiell disruptive Herausforderung für produktfokussierte Unternehmen dar. Die bestehende Literatur sieht die Entstehung von Ökosystemen als einen radikalen, technologischen Wandel, der produktfokussierte Aktivitäten bedroht. Daher wissen wir relativ wenig darüber, wie Unternehmen ihr Kerngeschäft hin zum Wettbewerb in einem Ökosystem verändern können, wenn das Produktgeschäft bestehen bleibt. Ich nutze eine longitudinale Einzelfallstudie eines Maschinenherstellers, um die Prozesse, wie etablierte Unternehmen mit den Herausforderungen des Ökosystem-Wettbewerbs umgehen, zu analysieren. Ich habe herausgefunden, dass der Maschinenhersteller sein Ökosystem in einem Prozess des kontinuierlichen Wandels, der in einer Logik der Kontinuität das Produktgeschäft transformiert und ergänzt, entwickelt hat. Ich zeige, wie der Maschinenhersteller sich über mehrere strategische Zyklen hinweg verändert hat, von einer In-House-Lösung zu kundenspezifischen Angeboten und schlussendlich zur Führungsrolle in einem Ökosystem. Mein wesentlicher Beitrag zur Theorie ist ein Modell des akkumulierten Lernens, das die historische Einbettung und das kontinuierliche organisationale Lernen als bedeutende, aber unterschätzte Treiber von Ökosystementstehung identifiziert.

Schlüsselwörter: etablierte Unternehmen, Ökosysteme, Ökosystementstehung, Strategieprozess, strategischer Wandel, organisationales Lernen, akkumuliertes Lernen.

Preface

This dissertation is the essence of years of work on how companies can remain successful when faced with the emergence of digital ecosystems. I have presented various stages of the research project at conferences in Berlin, Houston, and Paris, where it received the “Best Paper Proposal” award of the Strategy Process Interest Group. The objective of this dissertation is to distill the most relevant and interesting insights of this work for researchers and practitioners.

My supervisors Günter Müller-Stewens and Torsten Schmid helped me countless times with their invaluable feedback and an open ear for discussions. I am incredibly grateful for their support in the research process, and during the entire Ph.D. program.

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1 Introduction

A critical challenge for product-focused incumbent firms is how to cope with potentially disruptive ecosystems. Incumbents often struggle because the emergence of ecosystem-based competition can entail two conflicting strategic priorities. On the one hand, emerging ecosystems can disrupt the original industry with new value propositions co-developed and co-offered by multiple partners (Adner, 2017; Jacobides, Cennamo, & Gawer, 2018), as ecosystem leaders gain control over client relationships and key technologies (Ansari, Garud, & Kumaraswamy, 2016; Snihur, Thomas, & Burgelman, 2018). This threat requires incumbents to adapt with radical changes, up to the point of self-disruption of the activity system. On the other hand, the original product-focused activities may remain relevant and valuable, even after ecosystem-based competition emerges. This forces incumbents into a position where they may have to engage in a difficult change process towards ecosystem leadership and, at the same time, grapple with the profound consequences for their existing product businesses. For incumbents facing disruptive ecosystem leaders, like Amazon or Netflix, it is an ironic twist that these firms start to enter the product businesses they set out to disrupt. Still, this is a compelling example for a potential symbiotic – rather than conflictual – relationship of product and ecosystem.

Existing research explains ecosystem emergence and the appropriate response of incumbents primarily as a process of disruptive change driven by new technologies. It shows that new ecosystems often entail fundamental changes in industry boundaries, economic relations, and client preferences (Christensen, McDonald, Altman *et al.*, 2018; Kumaraswamy, Garud, & Ansari, 2018; Teece, 2018). Firms establishing and leading an ecosystem can disrupt existing industries and gain control over customers and profits (Jacobides & Tae, 2015b). New entrants often prevail over incumbents in the context of ecosystem emergence when ecosystems cause disruptive changes (*e.g.*, Ansari *et al.*, 2016; Snihur *et al.*, 2018). Incumbents can fail to initiate the adequate changes because they remain locked in existing beliefs (Burgelman, 2002; Tripsas & Gavetti, 2000) and activity systems (Albert, Kreutzer, & Lechner, 2015; Siggelkow, 2001).

Nevertheless, literature shows that some incumbents successfully established new ecosystems and thus averted the threats of disruption by ecosystem leaders. The main strategies observed thus far include the use of experimentation (Cozzolino, Verona, & Rothaermel, 2018) or bottom-up initiatives (Burgelman, 2002) to identify ecosystem technologies prior to competitors, and structural separation to shield new activities directed to ecosystem competition from the existing product business. For example, Gawer and Phillips (2013) show how Intel created a new logic, separated from its historical chip business, to support the development of its interface technologies, and thus reach the position of an ecosystem leader.

Some emerging findings point to the potential of a firm's existing activities to engage in a process of continuous change towards ecosystem leadership, complementing the predominant focus on disruptive change. For example, Cozzolino *et al.* (2018) observed that the core business may maintain a residual value for profit generation even after a new ecosystem emerges. Dattée, Alexy, and Autio (2018) find that incumbents were leveraging their existing market power and client base when experimenting with and establishing a new, technology-based ecosystem. More generally, Bergek, Berggren, Magnusson *et al.* (2013) show that incumbents can master even radical, turbulent change by transforming their core business in a process of creative accumulation. The incumbents they observed did not only develop new technologies, they also continuously adapted their existing technologies and integrated them with technologies into new solutions for clients (Bergek *et al.*, 2013).

However, due to the focus on disruptive, technology-based change in existing ecosystem research, we have only a limited understanding of how incumbents deal with ecosystems that do not replace the product business but profoundly transform entire sectors. Current research underestimates the fact that ecosystem emergence is often not an imperative of disruptive technological innovation, but the result of a historically and socially embedded change process (Dattée *et al.*, 2018). It is driven by the participating actors (Jacobides *et al.*, 2018) whose actions influence, amongst others, when and how ecosystems emerge. Therefore, a fine-grained understanding of the processes within incumbents, not only at the ecosystem level, is required to develop a more nuanced and contextualized understanding of ecosystem emergence (Christensen *et al.*, 2018; Danneels, 2004). Incumbents require nuanced theory that takes the long-term dynamics and structural characteristics of the sector into account (Christensen *et al.*, 2018; Danneels, 2004; Jacobides *et al.*, 2018). Therefore I ask:

"*How can a leading incumbent transform its product-focused organization with the creation of an ecosystem?*"

In order to gain insight into the research question, I use an in-depth case study of a machine manufacturer that has successfully transformed its product-focused strategy over time to reach an ecosystem leadership position. I engaged in a longitudinal, historical analysis of the firm's transformation in the context of changes in the sector (Vaara & Lamberg, 2016). I introduce an activity systems lens (Siggelkow, 2002) to analyze the case, because it helps to understand at a detailed level the elements that underlie an organization's competitive advantage and influence its change dynamics (Johnson, Melin, & Whittington, 2003; Porter, 1996; Siggelkow, 2001).

I find that ecosystem creation was part of a continuous strategic change process of the focal incumbent, rather than a radical response to technology-driven change. The emerging ecosystem did not replace the original product, but complemented and enhanced strategic transformations that had begun before the ecosystem was established. The focal machine manufacturer engaged in a process of accumulated learning, which enabled the gradual, active change of its activity system towards a position of ecosystem leadership. In three cycles of change, the incumbent moved from a machine differentiation to a solution provider strategy, engaging in in-house solutions and customized orchestration before successfully shifting to an ecosystem logic. In each of these cycles, four sub-processes of accumulated learning were at play. (1) Reacting to perceived issues, managers introduced new core ideas to update strategic beliefs and (2) intervened in the activity system. These interventions, taken with bounded rationality, resulted in unintended consequences. Mid- and lower level managers started to modify the deliberate activities to resolve these misfits, and thus initiated (3) local learning dynamics. These learning dynamics in several activities started to form an (4) accumulating learning pattern, decoupling the intended strategy from the realized activities. These patterns laid the foundation for updated strategic beliefs in the next cycle. These multiple cycles transformed the historical core business over time, integrating – rather than opposing – product and ecosystem in the process.

With these findings, I contribute to ecosystem literature by introducing a complementary view of ecosystem emergence as continuous change. This provides a contextualization of existing studies that almost exclusively focus on ecosystems around new technologies in nascent and dynamic industries (Jacobides *et al.*, 2018). By highlighting the organizational and sectoral changes that precede the advent of the ecosystem, I embed the ecosystem emergence process historically. I thus demonstrate how an ecosystem can be used in a logic of strategic continuity, and emerge from strategies adopted prior to the explicit ecosystem creation. I also contribute to the literature on organizational learning and change in activity systems. The process of accumulated learning complements established perspectives on adaptive strategic change to ecosystems via experimentation and structural separation, as it highlights and details the potential of proactive transformation of an incumbent's core business (Bergek *et al.*, 2013; MacKay & Chia, 2013). In particular, I point to the potential of strategic beliefs to enable changes (Bettis & Prahalad, 1995; Tripsas *et al.*, 2000) by drawing on similarities between new and current activities, when some core ideas of the product business are applicable at the ecosystem level without losing their value.

In the next section, I will provide an overview of literature on ecosystem creation and incumbent's change processes in this context. I then detail my research methods for the in-depth case study, before presenting the results of analysis. I structure these results into a chronological description of the ecosystem creation process and a section elaborating on the process of accumulated learning. In the discussion section, I detail how the findings contribute to the research on ecosystems as well as on organizational learning and change. Finally, I detail how managers can apply the findings of my case to practice.

2 Theoretical and empirical background

2.1 Ecosystem emergence as a disruptive change

Business ecosystems enable new value propositions for clients by re-aligning the structure of activities in a sector, often based on digital technologies (Adner, 2017; Yoo, Boland, Lyytinen *et al.*, 2012). Structuring activities in an ecosystem is an alternative to traditional modes of economic interaction, such as value chains or markets, and enables complex and new value propositions (Jacobides *et al.*, 2018). The focal value proposition of an ecosystem consists of interdependent activities which the partners provide independently, integrated with the help of a coordination mechanism (Adner, 2017). The coordination mechanism for these interdependent activities can be a technological platform, but other mechanisms of coordination that rely on rules and processes are equally possible (Jacobides *et al.*, 2018). Ecosystems are used be the when the activities of different actors in a technological system are interdependent (Adner & Kapoor, 2010; Adner & Kapoor, 2016; Kapoor & Lee, 2013) or when multiple partners align their activities around a focal innovation objective (Davis, 2016). For the purpose of this study, I will use the definition of Adner (2017) of an ecosystem as a structure of interdependent activities in a sector. This contrasts with the view of platform ecosystems, where the ecosystem definition rests on the participation of buyers and sellers in a technological platform (*e.g.*, Eisenmann, Parker, & Van Alstyne, 2011; Gawer, 2014; Rochet & Tirole, 2006).

Ecosystem creation is a question of aligning multiple partners, whose activities become increasingly interdependent, **around a value proposition** (Adner *et al.*, 2010; Kapoor *et al.*, 2013). In this view, an ecosystem emerges when the “alignment of actors […] becomes an issue” (Adner, 2017: 42) to deliver a value proposition. Alignment issues arise when there are complementarities between the activities in the ecosystem, be it in production or consumption (Jacobides *et al.*, 2018). One or multiple actors drive this alignment in an ecosystem, taking the role of an ecosystem leader (Adner, 2017). Creating an ecosystem establishes a new system of economic relationships (Davis, 2016; Jacobides *et al.*, 2018) to manage the inter-firm interdependencies (Adner *et al.*, 2010; Adner *et al.*, 2016; Kapoor *et al.*, 2013). Such ecosystems are not an aggregation of dyadic relationships, like in a supplier or wholesale system, but qualitatively different multi-partner arrangements (Davis, 2016).

The emergence of ecosystems can be a disruptive threat to incumbents (Ansari *et al.*, 2016; Snihur *et al.*, 2018). During ecosystem emergence, the economic relevance of activities in a sector shifts, leading to a re-distribution of value among ecosystem players (Hannah & Eisenhardt, 2018), potentially away from leading incumbents. Firms that create the ecosystem and achieve a leadership position, coordinating the interdependent activities around the value proposition, typically capture a large share of the ecosystem's value (Jacobides *et al.*, 2015b). Other actors assume the role of ecosystem complementors, which are often at a disadvantage in terms of value capture (Zhu & Liu, 2016). This can cause a disruptive reconfiguration of relations between actors in an industry (Kumaraswamy *et al.*, 2018). For example, the ecosystem technology of TiVo, an entrant in the television sector, compromised the direct access of incumbents to end customers and thus ruptured a critical relationship (Ansari *et al.*, 2016). Furthermore, during ecosystem emergence, activities across industry boundaries converge (Teece, 2018). For instance, in the mobile banking ecosystem, banks, telecom providers, and hardware producers have to coordinate to deliver the value proposition. Firms that were dominant in their industries struggled with occupying a less central role when they formed ecosystem relationships with leading incumbents from other sectors (Ozcan & Santos, 2015). Hence, the emergence of an ecosystem has an impact on the performance outcomes in a sector, both in terms of which activity is creating most value for the system as well as for which organizations capture the value (Jacobides *et al.*, 2015b).

Finding an appropriate reaction to the disruptive threat of ecosystems is complicated by ecosystem dynamics, *i.e.*, changes of the structure of the emerging ecosystem caused by the interactions and tensions between multiple partners (Ansari *et al.*, 2016; Hannah *et al.*, 2018). Systems of interdependent activities are *ipso facto* complex systems, making the future behavior hard to predict (Albert *et al.*, 2015; Rivkin, 2000). This is particularly true in an ecosystem context, where actors are impacted by activities over which they have only partial control (Albert *et al.*, 2015; Amit & Zott, 2001). In the US solar ecosystem, for instance, the key control points shifted from finance, to sales, and eventually to installation within a timeframe of several years (Hannah *et al.*, 2018). To cope with the dynamics of the emerging ecosystem, incumbents are forced to modify (1) their strategy, *i.e.*, what activities to perform, and on (2) and the underlying activities, *i.e.*, how to perform (Levinthal & March, 1993). However, incumbents face multiple constraints to learning and change on both these levels.

(1) The **strategic beliefs of an incumbent**, focused on its core product market, can **create a co-evolutionary lock-in** that constrains the development of activities that would lie outside the current strategy (Burgelman, 2002). Multiple studies have observed that entrants can benefit from such strategic inertia and myopia of incumbents to establish disruptive ecosystems. New entrants frame a disruptive vision towards clients and partners in the emerging ecosystem, challenging the historical strategy of the incumbent (Gurses & Ozcan, 2015; Snihur *et al.*, 2018). Persistent strategic beliefs from the core business guide an incumbent's response facing ecosystem threats and constrain the change that would be required to adjust (Tripsas *et al.*, 2000). Snihur *et al.* (2018) show how Siebel, a software incumbent, failed to realize the extent of the threat posed by an entrant's ecosystem and persisted with its prior strategy as a vertically integrated provider. Siebel eventually responded with an ecosystem technology of its own, but was too late to stop the adoption dynamic that favored the entrant's ecosystem. While stable

strategic beliefs and the associated activity choices are required to exploit the current business (Burgelman, 2002), they can lead to local search and flawed learning in times of change (Levitt & March, 1988). An incumbent like Siebel can fail to grasp the scope of the ecosystem and respond with local changes of its activity system only, resulting in an incomplete change (Siggelkow, 2001). The interdependencies of an ecosystem make it difficult for incumbents to respond quickly by substituting only parts of their activity system, for example with an acquisition (Lavie, 2006). Failed strategic responses to ecosystem challenges can also be the result of a bias in the perception of how activities can be leveraged in times of change (Danneels, 2011). Response strategies of incumbents are further influenced by how entrants frame their ecosystem. Ansari *et al.* (2016) show how TiVo, a start-up firm, navigated co-opetitive tensions with incumbents to navigate the emergence process. Using flexible strategizing and continued adjustments, TiVo highlighted the long-term benefits for the industry and engaged with multiple incumbents, ultimately leading to a disrupted ecosystem due to incumbents' myopic behavior. Entrants like TiVo, unconstrained by a historically anchored strategy, can quickly adjust their strategy to occupy the bottlenecks that emerge in the process of ecosystem creation (Hannah *et al.*, 2018).

(2) The **extant activity system of an aspiring leader can prove a burden in the ecosystem creation process**, even if incumbents adapt their strategy as a response to emerging ecosystems (Cozzolino *et al.*, 2018; Snihur *et al.*, 2018). An established activity system, tightly integrated to support the status quo (Siggelkow, 2002), constrains the ability to implement strategic change (Albert *et al.*, 2015; Siggelkow, 2011). Organizations tend to reinforce their activity system over time (Miller & Friesen, 1980). The weight of historical core activities can overpower new and innovative activities in terms of resources and managerial attention (Leonard-Barton, 1992). Hence, ecosystem initiatives of incumbents can suffer from a lack of speed and determination, and are sometimes put on hold when the demands of the core

business are pressing (Cozzolino *et al.*, 2018). Conflicts between the historical and the ecosystem logic are a further source of failure in an incumbent's change process (Cozzolino *et al.*, 2018; Gawer *et al.*, 2013). A company with legacy activities might has trouble to be accepted as a neutral broker of the ecosystem (Gawer *et al.*, 2013; Nambisan & Sawhney, 2011; Wareham, Fox, & Giner, 2014) and therefore fail to reach a leadership position (Garud, Jain, & Kumaraswamy, 2002).

In certain cases, incumbents can prevent the emergence of an ecosystem that is not in their favor (Ozcan *et al.*, 2015) or regain control after the ecosystem has shifted (Jacobides, Macduffie, & Tae, 2015a). This, however, is only possible for large and dominant incumbents with a high degree of control over the industry. And even in such cases, myopic decisions can result in unintended industry change over time (Ansari *et al.*, 2016; Jacobides, 2005). Many studies observe that incumbents are at a disadvantage when ecosystems emerge in a sector and risk disruption by new entrants (*e.g.*, Ansari *et al.*, 2016; Snihur *et al.*, 2018).

2.2 Incumbents' change processes during ecosystem emergence

Recent research shows that **incumbents can successfully adapt to or even lead the sector-wide transformation towards ecosystems**, overcoming the challenges of disruptive ecosystem innovation (Christensen & Bower, 1996; Kumaraswamy *et al.*, 2018). In the few studies on ecosystem creation by incumbents, a few patterns are recognizable. Incumbents can identify ecosystem-enabling technologies and drive their development as an ecosystem leader, collaborating with partners in the process. To this end, they have to overcome the strategic inertia and myopia by establishing ecosystem initiatives outside the current strategy, and then avoid conflicts with the core business during the ecosystem creation process.

Successful incumbents first **identified technologies** that require an ecosystem approach for its implementation or commercialization. The identification of these technologies involves **emergent or deliberate initiatives outside the core business**. The insight for an ecosystem technology can stem from emergent bottom-up initiatives by lower and middle level managers outside the current strategic priorities. Intel's ecosystem technologies, *i.e.*, interface standards like USB and PCI, emerged from an "under the radar initiative" that initially was not supported by top management (Burgelman, 2002: 348). The promising performance of the initiative eventually led Intel's management to recognize the technology and the development of the ecosystem as a strategic priority. In other cases, managers consciously put in place structures that favor experiments with ecosystem technologies. Confronted with the advent of internet in the media sector, an Italian incumbent was the "opposite of myopic" and started multiple internal experiments on how to use internet technology and avoid disruption (Cozzolino *et al.*, 2018: 1182). When the experiments became more salient and ecosystem competitors entered the space, the incumbent shifted from internal ecosystem experiments to alliances and acquisitions. These examples align with the view that continued experimentation can avoid a negative selection of the inertial core business by the environmental forces (Nelson & Winter, 1982). The origin of these initiatives is generally bottom-up, driven by operating and middle managers (Floyd & Lane, 2000), constituting low cost probes into the future (Brown & Eisenhardt, 1997).

After identifying the ecosystem technology and recognizing its potential, successful incumbents continued to support the ecosystem initiative by establishing a **resonance dynamic between internal and external resource commitments, unconstrained by the rigidities of the original business**. Gawer *et al.* (2013) show how Intel transitioned from a product to an ecosystem leadership position. Intel avoided the inertia of the legacy business through separation of the ecosystem activities, by differentiating and transitioning between the historical product logic ("job 1") and the ecosystem logic ("job 2"). Through internal practice work, Intel built the new identity required for ecosystem leadership. Once internally established, incumbents created momentum for the ecosystem with outside stakeholders, leading to a reciprocal commitment of internal and external resources to the ecosystem (Dattée *et al.*, 2018). Strategic and operational flexibility was key to successfully manage the interactions with partners and remain in control of the process. Dattée *et al.* (2018) show how multiple incumbents managed to create new ("de novo") ecosystems to support their innovative technology developments. Starting from generative technologies, the incumbents adapted their framing of the technology's benefit to create momentum with internal and external stakeholders, while keeping the leadership position through control points, such as intellectual capital.

Incumbents avoided conflicts with the core business that could hamper the emerging resonance dynamic by **clearly separating the ecosystem from the core business**. Intel successfully engaged in external legitimacy work to establish a reputation as an ecosystem leader that has the interests of the sector in mind, establishing a contrast with the competitive threat of its traditional business to partners (Gawer *et al.*, 2013; Perrons, 2009). Such conflicts between the traditional core business and the ecosystem logic can cause the failure ecosystem initiatives (Cozzolino *et al.*, 2018; Garud *et al.*, 2002). Prior research has pointed out that novel initiatives have to be separated from the current strategy, but can later be integrated in the organization (Burgelman, 1983). Some ecosystem initiatives result in mixed models that combine ecosystem logic with elements from the old business model (Cozzolino *et al.*, 2018), while other firms transition from their historical product logic to an ecosystem logic (Gawer *et al.*, 2013).

These strategies for incumbents focus on **adapting to potentially disruptive technological changes**, for instance digitalization (Teece, 2018; Yoo *et al.*, 2012), **with ecosystem creation.** Often, however, the disruptive impact of ecosystems does not originate from a new technology to which incumbents fail to adapt, but from a change in the relationship structure between incumbent, clients and partners (Kumaraswamy *et al.*, 2018). Incumbents can adapt to an ecosystem, thinking it is not a menace to their dominant industry position (Ansari *et al.*, 2016), displaying myopic behavior in their adaptation (Jacobides *et al.*, 2015a). We therefore need a better understanding about the historical embeddedness of ecosystem emergence that goes beyond establishing an ecosystem around a new technology, towards understanding how the internal dynamics of incumbents drive the creation of ecosystem structures in a sector.

Furthermore, in many instances, the **core business of an incumbent remains relevant after the transition towards an ecosystem** – think of hotels and rating platforms, books and amazon.com, news content and Google, etc. In all of these cases, a residual value in the core business remains even after an ecosystem emerges (Cozzolino *et al.*, 2018). The emergence of an ecosystem, in these cases, will not replace an incumbent's product, but lead to a shift in profit pools away from product-focused industries to ecosystem leadership positions (Jacobides *et al.*, 2015b). As the potential impact of emerging ecosystems becomes more complex, the complete shift from product to ecosystem logic as well as the separation of ecosystem initiatives from the core business might not be the appropriate strategies.

2.3 Ecosystem emergence as continuous change

New findings in the ecosystem literature suggest a potential complementary view to predominant focus on disruptive technological change, which can help to develop a more fine-grained and contextualized understanding of ecosystem emergence. **When the core business remains relevant during ecosystem creation, incumbents have to transform their original activities and integrate them into the ecosystem.** By separating the current activity system from the new ecosystem initiatives, incumbents forgo the potential to leverage their historically dominant position to shape the change processes towards an ecosystem. Dattée *et al.* (2018) have observed that incumbents were using market power and access to clients to drive ecosystem creation. Such interrelations indicate a potential to combine the historical product and the new ecosystem activities in a process of continuous change, avoiding a radical shift. Bergek *et al.* (2013) show that incumbents can master radical, turbulent change by transforming their core business in a process of creative accumulation. The incumbents they observed had the innovative capacity to evolve their existing technologies and develop new technologies, but also integrated the existing and new technologies into solutions for clients (Bergek *et al.*, 2013).

To succeed in this continuous transformation of the activity system, **incumbents have to shape the change processes in the sector proactively**, before and after ecosystem emergence. Ecosystems do not emerge spontaneously and inevitably, but require deliberate effort by participants to **create the conditions** that make ecosystems the most attractive form of inter-organizational coordination (Jacobides *et al.*, 2018). This means that institutional and sociological aspects, such as power, cognition, and framing, will play an increasing role to influence the process of ecosystem emergence (Dattée *et al.*, 2018; Thomas, Autio, & Gann, 2014). Hence, even if the ecosystem emergence is a complex process, it is not completely outside of the actors' control. Incumbents do not only have to adapt to the technological changes in their sector, they can actively participate in and shape the ecosystem emergence process.

This resonates with an emerging view that highlights the **complex interplay between a firm's strategic actions and its environment**. On the one hand, companies do influence their environment, instead of only adapting to population-level selection forces. On the other hand, this influence does not exclude unintended consequences and chance events outside a firm's control

(MacKay *et al.*, 2013). Companies can cope with such dynamics in a process where "internal decisions and external events flow together" (Quinn, 1978: 7) to determine the strategic direction. Following this view, incumbents have to engage in a constant process of learning, rather than adaptation or rational choice, to cope with internal and external changes over time. Such a strategy process is not a transition from a starting point to an end point, but a continued activity where "each act of insight is but an intermediate step which opens up new opportunities and challenges" (Kumaraswamy *et al.*, 2018: 1030) for the future.

Research indicates that **both the strategic beliefs and the current activity system of an incumbent contain a potential to transform the core business**. Strategic beliefs are sufficiently flexible to support a wide range of activity system configurations. Researchers have observed this "'**adaptive ability**,' so long as changes in the underlying logic are not necessary" (Bettis *et al.*, 1995: 11, emphasis added). The dominant strategic beliefs in an organization can therefore guide the development of future activities (Greenwood & Hinings, 1988), instead of being a source of inertia (Bettis *et al.*, 1995; Tripsas *et al.*, 2000). In addition to strategic changes, changes in the activity system over time can lead to a change in strategic belief of an incumbent. When local activity system changes lead to a de-coupling of the activities from the strategic belief, a modified strategic belief can be installed in an organization (Greenwood *et al.*, 1988). Contradictions, conflicts and change dynamics that modify the activity configurations of an organization have an influence on the strategic beliefs that serve as an interpretive scheme for managers (Ranson, Hinings, & Greenwood, 1980).

These potentials for active strategic change indicate that an incumbents' product-focused core business is not only inertial and constraining, but can enable continuous strategic change to cope with emerging ecosystems – even if not fully under the control of management. However, we know little about the processes that allow incumbents to pursue such continuous changes to their core business to drive the creation of an ecosystem. This longitudinal case study begins to shed light on these continuous transformation processes that complement and contextualize our knowledge about disruptive changes caused by ecosystem emergence.

3 Methodology

3.1 Research design

For my analysis, I draw on an in-depth, single case study (Siggelkow, 2007) to inductively build and extend theory. There is limited knowledge about the longitudinal process of ecosystem emergence in an established industry (Jacobides *et al.*, 2018; Kumaraswamy *et al.*, 2018), which calls for an inductive, empirical approach to the research question. I selected the context of the automotive supply chain for my in-depth field study, where the focal company, identified under the pseudonym CASTER, has successfully defended and extended its market leading position over 20 years. The long term success of CASTER in highly competitive and dynamic industry makes a theoretically interesting case study (Eisenhardt & Graebner, 2007; Yin, 2013). I had established contact with the firm during a consulting project, and the close relationship with the CEO enabled me to access the organization for my research project.

I started with an initial open-ended research question, focusing on how CASTER moves from a machine focus to a cell solution focus. I then observed in real time the strategic initiatives towards this end. I used the principles of research that situated the strategic development of the focal company in space and time, following examples such as Siggelkow (2002), Burgelman (2002), Danneels (2011), and MacKay *et al.* (2013). The initial interviews made clear that CASTER's transformation was a long-term process, so I complemented my real-time analysis by tracing back the solution strategy to its roots. I followed guidelines from historical analysis (Maclean, Harvey, & Clegg, 2016) to triangulate the critical events in their historical embeddedness (Vaara *et al.*, 2016; Van de Ven & Poole, 1990). I also realized that multiple perspectives from different actors in the sector were necessary to understand the case. My focal unit of analysis remains CASTER's organization, but I triangulated the internal view with outside perspectives from clients and partners. I also conducted deep dives to understand the internal strategic initiatives and projects in detail.

I drew on an activity system lens to conceptualize the change process of the incumbent and the evolution of the ecosystem (Porter, 1996; Siggelkow, 2011). Activity systems have been used to describe various types of change processes, from strategic renewal to punctuated equilibrium change (Siggelkow, 2001, 2002). The focus on activities as the level of analysis in the change process corresponds to current ecosystem definitions that also center on activities (Adner, 2017). An activity systems lens goes beyond macro categories like differentiation or competences, to enable a deeper understanding of change processes (Johnson *et al.*, 2003).

3.2 Data collection

My data collection focuses on the period from 2001 to 2018, the last three years being a real-time study and the previous years covered retrospectively. My contacts with the CEO enabled unconstrained access to employees and archival material. To develop the thick description of the case, I drew on interviews, participant observation, and internal documents. I conducted 29 formal interviews with CASTER's top and middle management, lasting between 30 and 90 minutes. I recorded and transcribed the interviews, except for a few where I did not get the permission to do so, and took field notes after each interview. I participated in 9 strategy workshops during which I interacted informally with more than 60 employees from all functional divisions. In addition, I collected internal presentations, documents, manuals, and other archival material.

Complementing these internal perspectives, I conducted 7 interviews with managers of different organizations in the sector, in particular clients and technology partners. I also attended the main sector trade fair where I had the chance to interact and conduct shorter, informal interviews with a large number of industry participants. I analyzed the articles from specialized industry press, company websites, and also searched financial databases. To analyze the strategic changes prior to my period of study, CASTER's internal annual reports were particularly revelatory. These reports were compiled for internal use only and thus contained frank assessments of CASTER's situation at the time. I complemented these reports with interviews of former top managers and historical archival material such as strategy presentations and public records.

Interviews and archival material were both in German and English, and I kept the original text throughout the data collection and analysis. For presentation and ease of reading purposes, I translated all quotes used in this dissertation to English.

3.3 Data analysis

The data analysis combines more established extended case methods for analyzing strategic change processes in the evolution of single firms and their industry (*e.g.*, Burgelman, 1991; Danneels, 2011). In a first step, I explored the research question with open-ended interviews to identify the main themes underlying CASTER's long-term success and the strategic shift from machine to solution provider. I started with the coding of the initial interviews using the atlas.ti software package, which helped me to identify recurring themes and interesting aspects of the case. It became clear that CASTER's transformation towards a solution provider was a historically embedded, evolutionary process that required a rich understanding of long-term developments at the level of the organization and the sector.

In a second step, I built a detailed timeline of events within CASTER and in the sector. This timeline included information about strategic changes, organizational structure, R&D projects, client portfolio, partnerships, and financial data for CASTER. This allowed me to trace the origins of the solution provider strategy back to the year 2001, which marks the starting point of my detailed analysis. I also analyzed data on the economic situation, market growth, macro trends, competitor moves, and market shares in this detailed timeline. This list helped me to build a detailed, longitudinal narrative of the case that I complemented with further interviews. My research covered almost three years in real time, which allowed me to track the development of several strategic projects in detail. The start of this analysis came shortly after CASTER decided to offer cell solutions as an orchestrator and I concluded my work after the introduction of the technological platform, at the cell level, that CASTER established as a leader with the help of ecosystem complementors.

In a third step, I identified the activity systems lens as particularly useful to analyze and explain the strategic change process. I iterated multiple times between data and theory to come to this conclusion (Langley, 1999; Siggelkow, 2007). I created activity systems and discussed them with the management team. I identified CASTER's core activities (following Siggelkow, 2002), which are highly interdependent with other activities and influence organizational development. I created multiple activity systems to reflect different points in time. To choose these points in time, I combined the activity system analysis with the results from the case timeline, which revealed different phases of the cell solution development. An activity system configuration characterizes each phase, and changes in CASTER's strategy mark the transitions. I analyzed how the activities as well as the positive or negative interdependencies developed over time. This helped me to describe in detail the changes that occurred. The comparison of different activity systems led me to the literature on learning and change, as it reflected the emerging explanations for the developments in the case. I went back to discuss my observation with some of my interview partners. Four sub-processes of the strategic change emerged, which lead me to conclude that CASTER's case reflects a model of accumulated learning.

In a final fourth step, I used the tools of process analysis (Langley, 1999), in particular the visual mapping technique, to combine and refine the concepts of my learning model. The cycles in the process of accumulated learning became clearer, as did the iterations between strategic beliefs and the activities. Table 1 shows an overview of the collected data, and how it contributed to the case analysis.

Phase	**Data sources**	**Contribution to analysis**
Real time analysis (2016-2018)	29 interviews with CASTER top and middle management 7 interviews with other actors in the sector Participant observation in 9 strategy workshops (1 day each) Trade fair visit and participant observation in meetings Relevant archival material (see historical analysis)	Develop map of current activity system Analyze and track key strategic initiatives Identify sectoral and environmental dynamics
Historical analysis (2001-2015)	178 pages of internal annual reports 253 pages of internal archival material 1662 pages of public annual reports 246 pages of specialized reporting (press, analysts, consultants) 113 pages of competitor and partner documents 3 interviews with former CASTER employees	Develop map of historical activity systems Compile timeline of critical events Write historically embedded thick case narrative

Table 1: Data sources and use in the case analysis.

4 Transforming from product focus to ecosystem leadership

CASTER is a globally leading machine manufacturing company, headquartered in central Europe. CASTER produces die-casting machines, used to produce aluminum parts, mainly for the automotive industry.[1] CASTER has ca. 400 employees, revenues of ca. 300 M€ (rounded figures of 2018), and is an independent business unit of a diversified technology conglomerate. During my period of study (2000-2018), CASTER successfully defended and expanded its leading position in the industry. It managed to grow at an average of 4% per year during that time and maintained margin levels that are among the highest in the industry. In addition, the company expanded geographically from a leading position in Europe (#2 globally in terms of market share) to a global leadership position (#1 globally). This long-term success is especially remarkable given that none of CASTER's competitors have been able to maintain its position over such a long time.

As I will show, CASTER maintained and expanded this initial position as a regional market leader for premium machines by transforming its activity system, from a product-focused strategy towards solutions, co-designed and co-offered with multiple partners in an ecosystem. I found, in particular, that the ecosystem was the result of an ongoing process of accumulated learning, where gradual changes in the strategy and learning in the activity system interacted. Over multiple cycles, CASTER discovered the ecosystem as part of the implementation of its solution provider strategy. This change process resulted in a transformation of the core business, which despite profound changes unfolded in a logic of continuity rather than conflict. I will elaborate on the transformation process by structuring my analysis into 3 phases of the activity system that emerged during the data analysis.

[1] Around 80% of die-casting parts are used in the automotive industry.

4.1 Moving from product focus to a new playing field

4.1.1 Differentiating as a premium machine supplier

Die-casting machines inject liquid aluminum under high pressure into a mold, enabling large scale production of aluminum auto components, such as motor blocks, gearboxes, or chassis parts. The production run sizes for these automotive parts are large batches, from 10’000 to over 1 million pieces, making quality and cost efficiency critical success factors for the foundries that manufacture these parts. At the start of my analysis in 2000, CASTER’s main client group were medium-sized European aluminum foundries. These firms competed via auctions to win contracts for relatively commoditized aluminum parts from car manufacturers (original equipment manufacturers = OEMs) and Tier 1 suppliers. These small foundries faced high price pressure and strict quality controls in the hierarchically organized automotive supply chain. OEMs and Tier 1 suppliers produced some aluminum parts in-house and hence occasionally purchased CASTER’s machines.

The production system around the machine is called a die-casting cell and enables the transformation of aluminum alloy into an auto part, from melting to finishing (see figure 1). Components of a die-casting cell, in addition to the machine, include an alloy melting furnace, a mold in the shape of the auto part, robots, trim presses, and many others. At the start of my analysis, manual labor was a critical part of the die-casting process, as the components of a die-casting cell operated relatively independent from each other and were hardly automated. A worker loaded the machine with molten aluminum, initiated the injection, another worker used tongs to remove the hot part, another worker sprayed the mold to cool it down, etc. The foundry manager optimized this process with the objective to lower the cost per aluminum part. The manager purchased each required component individually, using specialized suppliers (shown in figure 1 as component producers).

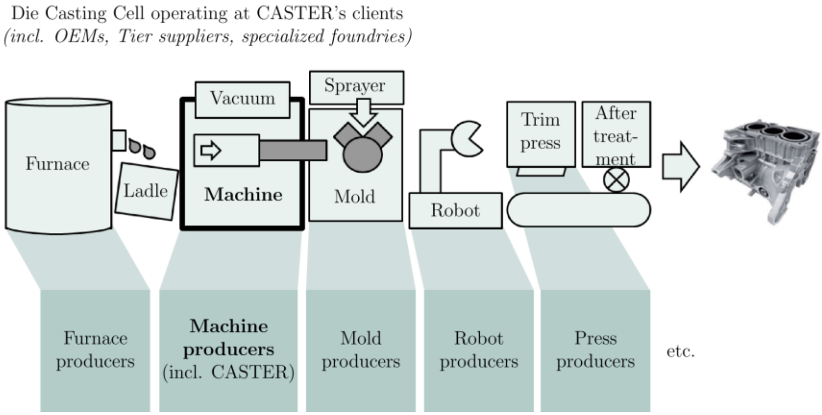

Figure 1: Schematic representation of a die-casting cell and the industries of component producers (non-exhaustive).

CASTER **specialized in the production of premium die-casting machines**, the largest and most expensive component of the cell. In the die-casting machine industry, CASTER was the market leader in Europe, and globally held the number 2 position behind a Japanese competitor. Most of CASTER's competitors focused on a cost leadership strategy to convince clients with low machine prices. CASTER was the largest company following a differentiation strategy. Priced at a significant premium compared to competitors (+20% and more), CASTER's products excelled at criteria like machine speed, pressure, and injection quality. Premium machines enabled CASTER's clients to increase their operating efficiency, which allowed them to invest more upfront. The value proposition driving the high margins of the differentiation strategy was reducing clients' cost base – using CASTER's machine helped clients to reach faster production times, less defective parts, and lower energy use.

4.1.2 Learning from increasing client service activities

CASTER's differentiation strategy rested on a self-reinforcing activity system where **engineering and client relationships played key roles** (depicted in the machine level of figure 2). CASTER's R&D focused on engineering machines with high performance characteristics, and in particular on the machine control system that allowed the precise injection of aluminum. CASTER had introduced a revolutionary injection technology in the late 1980s, which built its reputation as a premium machine manufacturer. CASTER's main R&D activities were the engineering, design, and assembly of the machine and the injection system. The production of the metal machine parts themselves was partly outsourced to a partnering firm. The position as a technologically advanced supplier helped CASTER to build and maintain long-term and trust-based partnerships with its clients. CASTER's client interactions were not only limited to machine service interventions, but also included support for a whole range of production problems. CASTER regularly faced client requests to improve die-casting operations and solve day-to-day problems. CASTER was proud of *"not leaving the client alone"* (Sales), even if the problem was not directly linked to the machine. The geographically focused client base helped to maintain and improve these relationships, because CASTER's sales and service technicians were close to their client counterparts. As CASTER responded to client requests, the **nature of client relationships changed to frequently include problems outside of the machine** (depicted in blue in machine level of figure 2). More and more clients moved from requesting emergency interventions only to more preventative service and training, to draw on CASTER's technological expertise (internal annual report 2001).

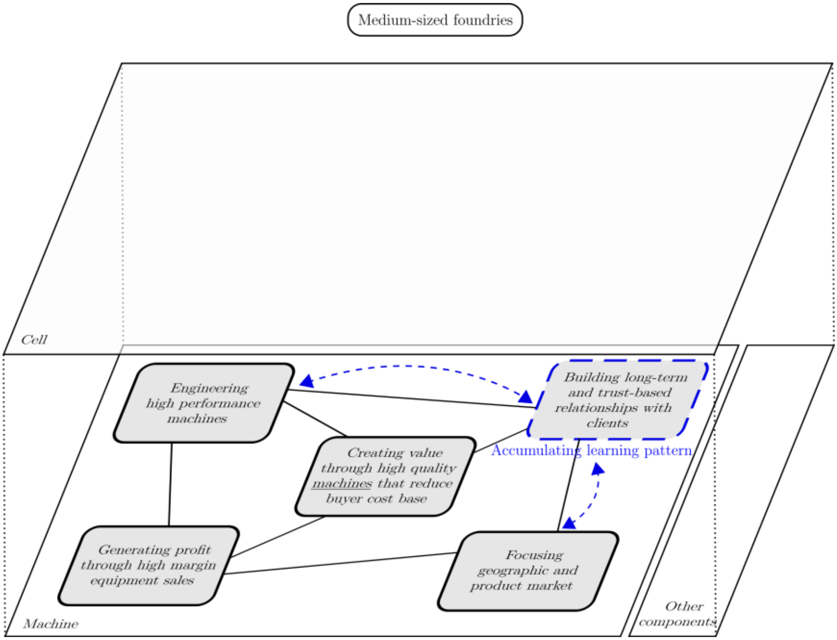

Figure 2: CASTER's activity system for the machine differentiation strategy (core activities only).

4.1.3 Pressure in the machine business

CASTER started to face **increasing competition in the machine industry**. First, a slowdown in the market for passenger vehicles resulted in more pressure for CASTER's clients, who reduced orders for die-casting machines and/or became more price conscious. The growing market for die-casting machines, dominated by sellers who struggled to fulfill client orders on time, slowly became a more competitive arena where clients had significant bargaining power. "*This was a seller's market, not a buyer's market like today. Who could produce faster could sell faster*" (Head of Sales). The slowdown in growth triggered intense price competition between machine producers. Second, innovation efforts by lower-cost competitors increasingly narrowed

CASTER's lead in machine performance. With new product generations, competitors were able to emulate some of the features that made CASTER's machine technology unique. It became harder for CASTER's sales team to justify the significant price premium for its machines. **CASTER's management team grew wary of an excessive dependence on machines, and started to look for strategic options** that relied less on machine sales.

4.2 Implementing a solution provider strategy

4.2.1 Re-focusing the strategy on the cell level

CASTER's management realized that a **strong source for future differentiation lay in optimizing the entire cell for the client**, not only providing a machine (arrow from machine to cell level in figure 3). They based their decision on the accumulated knowledge from client interactions and their belief that the R&D team could develop cell solutions superior to most clients' status quo. An awareness for the bottlenecks in the die-casting process had become engrained in CASTER's knowledge. "*When I joined the team [in 1998], I already felt very strongly, that the die-casting [unit] deals with much more and identifies with much more than only with the machine*" (former CEO). CASTER's management regularly interviewed the managers of clients to understand their challenges and their performance metrics. "*We conducted many interviews [with clients] globally and what we heard all the time was: number of good parts per unit of time*" (former R&D head). This privileged access was because the machine was among clients' largest equipment investments and CASTER was an important supplier. These close interactions helped CASTER to identify a new performance metric for their innovation projects – client productivity, instead of machine specifics. The CEO at the time pushed his team to think of the clients' needs and not only about technical features. "*I think this was a body of beliefs where managers, in particular [the CEO prior to my tenure], put the client value at the foreground very early on.*

[…] and with that, the whole management team – how shall I put it? – we all inhaled these beliefs" (former CEO). The option to mitigate industry pressure by shifting to a cost leadership position, reducing machine prices and manufacturing costs, did not seem feasible for CASTER's management. The Central European cost base, in particular labor cost, was a major impediment to such a strategy. Plus, CASTER did not have all manufacturing competence in house. "*If we are honest, an Italian or a German competitor, or a Korean, they are more or less as good [in terms of welding metal into machines] as we are*» (former CEO).

CASTER initiated activities to implement a strategy focused on the cell level, drawing on its engineering competence. The R&D team started, in 2000, to engineer an optimized cell process that would increase cost efficiency of a die-casting cell by 20 to 25% when completed (activity 1 in figure 3). "*This was the first time that we investigated the [entire die-casting] process from a scientific angle*" (former R&D head). To achieve these improvements, CASTER's R&D team looked to modify components adjacent to the machine and to optimize interactions between components, starting with thermodynamic simulations and calculations, and then moving to laboratory tests. Engineering this optimized cell processes included gaining knowledge about components, other than the machine, and new technical domains, including mold production, vacuum technology, and spraying methods. CASTER cooperated with a number of partners to develop knowledge regarding these new technical domains; the most important partner being a company in Germany manufacturing the molds for the aluminum parts. CASTER and this firm cooperated in a technology center to work on new concepts for mold design. Other partners, like chemical companies who produce fluids to spray the injection mold, were also involved. CASTER did work with these partners bilaterally to improve certain components where the R&D team did not have the required competencies.

A top-down, patriarchal management style helped to initiate and fund the cell R&D projects. CASTER's **management supported the cell optimization projects mainly based on the innovative potential of the idea** and their personal conviction, not the business plan. *"The [group owner] is a […] machine engineer too. I talked with him and he said: 'If you are convinced, try it. Do it.' And never the question: When do I get the money back that I invest?*" (former R&D head). The objective of the research projects was to find technological solutions to improve the die-casting process, and the issue of a detailed business plan did not come up.

4.2.2 Initiating in-house activities to provide the cell solution

Providing optimized cells to clients became a strategic priority for CASTER. CASTER communicated its new focus on the cell level internally and externally. The slogan chosen to rally the organization to this new strategic priority was to become a "cell solution provider". Instead of only differentiating via machine technology, CASTER wanted to position itself to offer clients a solution that optimized the entire die-casting cell. CASTER's management initiated the new activities at the cell level drawing on the success formula for the machine business. The main value proposition of the optimized cell processes was to enable clients to considerably lower their cost per part. CASTER wanted to rely on in-house activities to provide the optimized cell, engineering all required components and processes internally.

CASTER decided to commercialize its cell innovations by **selling a complete in-house cell to its clients**, combining its optimized cell process, a control system, and the necessary components (activity 2 in figure 3). CASTER's management was convinced that selling complete cells would be a powerful value proposition to its customers, based on the experiences with the machine business. "*We championed the philosophy: We have the software, we have the [component] options, which we sell […] And eventually every client profits from purchasing these options, from the fact that it is not a bricolaged* *solution built in a rush, but a properly developed, properly documented one*" (former CEO). CASTER felt that clients would not be willing to pay for an optimized cell process that was purely conceptual. Even if CASTER would provide a blueprint for an improved cell, the client still had to bear the implementation risks. Managers believed strongly that clients would not accept this kind of solution. *"We could only sell a mold concept to the client and then we had to say: 'Dear client, this is a mold concept. But the implementation has to be done by Maier, Müller, Huber… mold producers.' That is of course/ The client wants everything out of one hand. He is not willing to pay much for a mold concept and after that still bearing the risks during the implementation*" (former CEO). To minimize the implementation risk, CASTER controlled its solution with a software system that steered the cell components based on the optimized die-casting process. It was an extension of the machine control system, integrated into the machine but modified to connect to peripheral components. Like its base system, it was proprietary to CASTER and not accessible to clients or other firms. *"And we simply said: […] here at CASTER you get [our system]. And we always got reproaches that [our system] was a black box, [because operators couldn't modify the source code readily]*" (former CEO).

CASTER also **started to engineer in-house components** that were compatible with its optimized cell process (activity 3 in figure 3). Management and R&D were convinced they could draw on their engineering skills to develop better products than the ones available on the market. *"And there we pondered: yes, can we build our own, more simple [components] in-house? And that's what we did"* (former CEO). These components included a robot, a sprayer, a furnace, a vacuum system, and a ladling unit, launched starting from 2003. CASTER contracted suppliers to re-design these components to include CASTER-specific features, but kept the intellectual property in-house or on an exclusive basis. CASTER commercialized and branded the cell components.

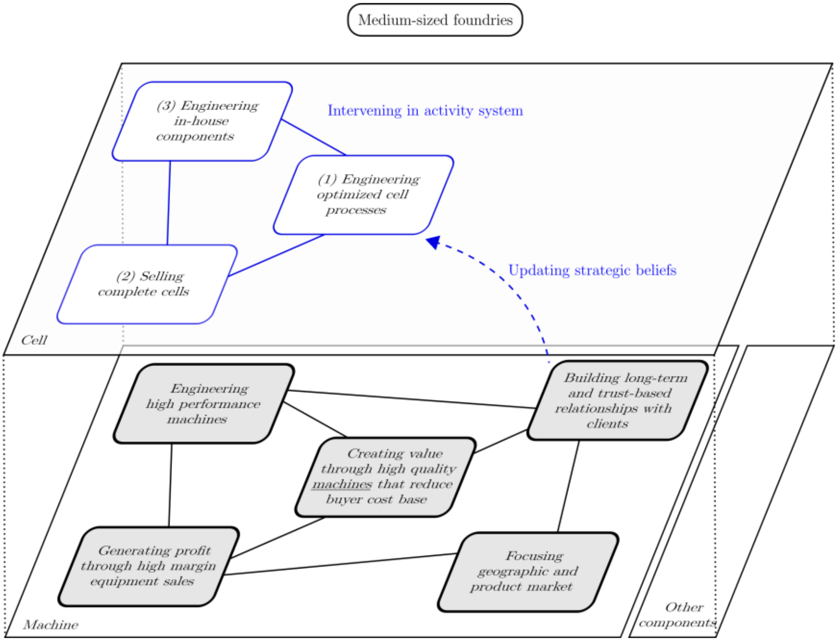

Figure 3: CASTER's activity system entering the cell level (core activities and new activities only).

4.2.3 *Struggling with client acceptance of the cell solution*

CASTER soon found that its assumptions about client needs that were the basis for its new cell activities were problematic, as **many of these cell activities encountered misfits** (red dotted lines in figure 4). CASTER's core client group (medium-sized foundries) was reluctant to invest in the in-house cell solution, because it would heavily impact core client activities. The long family history of the firms meant that the owner, experienced and technically skilled, was mostly reluctant to hand off responsibility of the process optimization to a supplier like CASTER. Even worse, purchasing a complete cell risked exposing parts of their competitive advantage and thus damaged the trust-based relationship with CASTER. While many cost drivers of the die-casting process, like the raw aluminum, are well known to OEMs, the selection and use of cell components, in particular, was not cost transparent and one of the core competences of CASTER's clients. "*Somehow this was the last spot where our clients could, I'd say, hide some profit (laughs) given their position as a supplier*" (former CEO). Skilled clients could 'tweak' certain cell components, by optimizing changing times or replacements, to generate better performance and escape the strict cost controls of OEMs. Higher standardization with an in-house cell by CASTER meant fewer opportunities to customize the cell operations. It also meant less differentiation potential, as several rivalling foundries use the same cell layout developed by CASTER. "*And if you would spread the [technological] advantage [...] over all the players, via a partner such as CASTER, we wouldn't have needed to invest in the first place, because we would lose our advance, our advantage*" (medium-sized client).

Like selling in-house cells, **the activity of selling integrated components did not develop as projected**. CASTER's in-house furnace, for example, was retreated from the market after less than a year. *"About half a year later we retreated from the market: it didn't work, we did not have experience in the field and it just simply didn't function"* (Product Management). The sprayer and some other components were discontinued as well. One reason was that the technical performance of the in-house components did not meet the standards that clients had become to expect of CASTER. The component improvements of CASTER were specific to its cell process and did not add value in all situations. Furthermore, clients also encountered quality problems with the in-house components, because CASTER's engineers did not have extensive experience in the domain. Furthermore, the agreements with suppliers for the in-house components proved to be problematic. CASTER had approached its manufacturing partners with very specific requests, and did not address the issue of future innovation in the partnership agreement. The suppliers of CASTER stuck to a fixed design, and any new features had to be included by CASTER's engineers. "*And then, two three years went by [...]: Our competitor included this and that additional feature, while we started lagging behind. Because this wasn't out core competence [to develop components]*" (Sales). Once the R&D team of CASTER had designed the core features required for the fully integrated solution, they had little resources and incentives to continue making incremental improvements to the components. These incremental improvements to the components, however, were important for the clients.

4.2.4 Learning from pioneering clients

CASTER had assumed clients were interested in lowering costs per part with the cell solution. However, **CASTER soon learned that the most interesting aspect of the cell solution were the new technological possibilities for additional value creation with the die-casting process** (learning in activity 1 in figure 4). For example, using process knowledge to optimize the cell enabled the manufacturing of larger and thinner parts. "*Well, it started with the insight that the [aluminum] parts become ever larger and ever thinner, and that is what we discovered [in the first cell project]"* (former R&D head). These parts had historically never been produced using a die-casting process. Examples are complex V8 motor blocks and thin-walled structural parts, like doors and trunk hoods. For these new types of parts, the process improvements that CASTER's cell research projects had developed were critical to be able to produce them at all. CASTER's engineers became convinced of the potential of these new parts. "*Important strategic parts [...] for future projects [...] are in particular aluminum motor blocks and structural parts in the automotive [sector]*" (internal annual report 2006).

CASTER **drew on its machine activities to initiate collaborations with pioneering clients** regarding these value enhancing cell solutions. Parallel to the introduction of the in-house cell, CASTER extended its geographic footprint and machine portfolio (new activity 4 in figure 4). CASTER bought a US-based competitor and established a subsidiary in China to serve clients globally. In addition, CASTER developed larger machines, with pressures much higher than previous equipment, which were attractive to OEMs and large automotive suppliers. CASTER's worldwide presence and complete machine range were important for these globally active, large clients, who became more and more important in CASTER's client portfolio. CASTER was able to win two large OEMs to test the cell solution to produce new complex parts. Trust from previous machine sales helped to initiate these collaborations and to convince the clients that CASTER's cells would perform as predicted and advertised. "*When you deliver something new, there has to be a certain relationship of trust. [As a client] you have to trust your supplier that he can do it. There is a huge investment at stake. You cannot simply say, let's try and see*" (former R&D head).

Encouraged by the better understanding of client needs and cell solution possibilities, CASTER promoted its new cell solution strategy intensively. CASTER organized symposia and other events touting its capabilities to develop cell solutions for new and complex parts. "*We also [traveled a lot]. We held a ton of presentations regarding structural parts. We went to clients. We went to symposia. And we really tried to become known as being a structural parts specialist*" (former R&D head). However, the **successful tests with the few pioneering clients did not result in a significant cell business**. Only a few more clients invested in the cell solution to produce new parts. Skepticism regarding the cell solution strategy started to mount. "*And the structural parts did not take off in the way how we had in fact projected it. Thus, we heard from top management: What are you telling us? These parts are not growing at all*» (former R&D head). CASTER started to sell parts of its cell solution separately, to still monetize on its investment in engineering and R&D. These parts included consulting from its engineers, cell simulations, cell trainings, and the individual sale of in-house components.

4.2.5 *Solution provider strategy starts to align with emerging client issues*

Over time, **CASTER started to address more clients interested in the idea of purchasing cell solutions** (emergence of new client group in figure 4). A first reason was the growth strategy of large Tier 1 and Tier 2 suppliers. Investing in cell solutions enabled these clients to produce complex and thin-walled parts. In this market segment price competition was less intense, and foundries were able to **engage in co-innovation with OEMs**. Instead of remaining commodity suppliers, larger foundries tried to establish themselves as module producers that take innovative responsibility for a small automotive module.[2] "*Because the client himself, say, over the years, has tried to increase his share of value creation across the whole value chain*" (former CEO). The global economic crisis, with its main impact in 2008 and 2009, accelerated this consolidation towards larger clients. Many smaller foundries exited the market or were acquired by larger firms (internal annual report 2010). To profit from the technological developments in the die-casting process, OEMs shifted more innovative tasks to these large suppliers. The R&D teams of the large suppliers worked with the OEMs to produce lightweight parts to be environmentally friendly yet cost efficient. "*In these domains, we work with OEMs to design the parts, because we know what can be produced and what not. And also how to make it cheaper by adjusting the part design*" (large client). OEMs also started to use more die-casting internally to produce parts, with the objective of reducing the weight of motor blocks and comply with stricter environmental regulation. Overall, this segment of CASTER's clients became willing to invest more in complex cell solutions. *"All of a sudden there was a willingness to pay on the market for lightweight parts and with that for aluminum solutions. And with that we could suddenly/ all these required features like vacuum, they*

[2] For a detailed analysis of the trends in the automotive supply chain towards modularity and co-innovation, see Jacobides et al. (2015a).

cost additional money at first. With this trend [clients] became willing to invest" (former CEO).

Second, **cell solutions filled competency gaps** of the clients. Many of CASTER's Chinese clients had only recently entered the die-casting market to benefit from the rapid growth in the Chinese automotive industry. They did not have prior experience in the die-casting sector and needed to build up expertise fast. Hence, CASTER's cell solution proved to be very popular among Chinese firms who did not want to engineer their die-casting cells from scratch. CASTER served the first purely Chinese client in 2008, but had been a supplier of foreign-owned foundries in China before. "*I would say that the reason that cell demand grew the way it did, or that our cell competence became more prominent, that obviously has a lot to do with China. [...] These clients wanted a technological solution, from which they knew that it is functioning and which somebody else has already implemented thirty times in a similar form somewhere in the world. And that heavily pushed us in this [cell] belief*" (former CEO). About 70-80% of contracts in China were not for a machine only, but for a cell solution (sales analysis).

Competency gaps became an issue for established European and American clients as well. These clients faced an increasing lack of qualified personnel trained how to operate a complex die-casting cell. Many low-skilled employees could no longer be trusted to adjust and steer the cell appropriately, requiring more process automation with cell solutions. In addition, less and less client engineers could design a complete cell for the new complex and thin-walled parts. "*One driver that is pushing me towards automation and cell solutions is the lack of qualified workforce. When I cannot find the qualified operating personnel, I have to rely more on solutions by our suppliers instead of doing it in house"* (large client). *"Our clients have laid off foundry personnel during the crisis years and now have a deficit of qualified workforce"* (internal annual report 2010).

4.2.6 Learning to build customized solutions

CASTER had to adjust its sales approach to address the emerging clients groups interested in cell solutions (learning in activity 2 in figure 4). The cell solutions had to be customized, because most clients did not want to rely on CASTER's standard cell solution or in-house components. CASTER's sales team had to concede that the in-house solution was not meeting the demands of clients. *"A further insight resulted from many conversations with our clients: the market does not want the 'ultimate CASTER solution' […] but a solution, which is customized to the needs of the production, like for example, parts specifics, cost factors, etc. This means for us that we have to be flexible in our ways to find solutions; that we have to develop our solutions individually with the client"* (internal annual report 2010). **To win contracts, CASTER was obliged to customize most of its cells and work with components defined by the client.** "*Because when I realize that I basically have no chance [with the in-house solution] or maybe the client does not perceive a value added, that means I will only do partial integration [and use components defined by clients]*" (former CEO). Customized engineering work to develop such cells surged, to the point that CASTER's engineering team lacked personnel resources to complete contracts (internal annual report 2010).

This increasing client interest in customized cell solutions led the CEO of CASTER to order the **spin out of the engineering team from the R&D department, with the objective to support the cell solution business.** The engineering team now reported directly to the CEO and became one of CASTER's 6 functional divisions (internal documents). "*And with the increasing sale of cell solutions the share of engineering work grew and became more and more demanding. And then I eventually…/ we then spun out the engineering team*" (former CEO). The rationale behind the spin out was to support the cell solution activities by giving more independence to the engineering team. This team operated differently from the R&D team. While R&D projects lasted around 1-2 years and resulted in process or machine innovations, engineering projects used this knowledge to customize a cell in the time span of a few weeks or months. "*And the engineering has, I'd say, a stronger focus on the execution part with the client; to assess client requirements, to talk with them, bla bla bla: What kind of solutions can we develop?*" (former CEO). With the status as an independent department, the engineers would be able to react faster, and also have a direct voice in the management team taking strategic decisions.

The customization of cell solution was not limited to the engineering department, but required **challenging cross-functional collaboration among CASTER's departments.** To develop an offer for the client, the sales person had to work closely with the engineering team, but also with application engineers, and other specialists. The resources – and hence the cost – required to customize the cell solution were hard to estimate ex ante. "*There is a huge difference to before. The effort today in the offer phase is multiplied by a factor 15, at least, or even more. And you have to take all the disciplines [like robotics, automation, furnaces and many more] on board"* (Sales). Coordinating the different functional specialists to engineer cells according to customer requests led to long discussions between the involved teams, in particular during the offering process. The sales team was interested in closely adhering to client's wishes to facilitate the sale. However, the engineers were confronted with long customization work and preferred to adhere to in-house solutions. They struggled to give precise estimates of working hours and avoided to guarantee specifics of the solution they had not previously developed. "*And there the cells challenged us brutally, during the offer phase: large projects, having a reliable offer. That was a real challenge until the very end"* (former CEO). The divergent interests led to conflicts when offers had to be made to clients. "*Back then, we offered something. We managed to submit the cell offer, but there was always conflict: Yes, sales has promised this and that, but we don't know anything about it*" (Product Management). To decide on the specifics and price of a final offer, management mostly took top-down decisions that ended the long discussions between the different teams. *"And eventually, the head of sales and myself, we said: boom [these are the offer specifics], after a long back and forth"* (former CEO). They did not have better knowledge than the involved teams, but used their gut feeling and experience to estimate the appropriate middle ground between the positions of CASTER's teams and the client.

4.2.7 Learning to work with third party components

CASTER's strategic priority was to use in-house components for cell solutions, but **it learned that clients did prefer third-party components** and had to comply to sell (learning in activity 3 in figure 4). CASTER struggled over several years to reconcile these diverging objectives in its day-to-day business. "*But that took us a while […] until we were ready to say: „Jeez, at some point we have to accept the reality […] And so we will offer [the client] the customized solution, but he has [only] the full comfort when he purchases [in-house components] with us"* (former CEO). CASTER's engineers preferred to use in-house components, because these were the most easy to handle. Working with components produced by external firms, at clients' request, could be problematic. The engineers had a hard time determining *ex ante* if these components would be suited to meet the specifics of the cell solution. "*And there every component supplier, with whom we did not collaborate previously, is a priori a risk factor*" (Engineering).

To integrate the third-party components more easily in the cell solution, **CASTER worked bilaterally with the largest producers of these components**, in particular large robotics firms. They established working relationships that focused on a regular information exchange about the specifics of the software interface, *e.g.*, how CASTER's control system could access data from the cell component. "*We defined an interface with [several large complementors]. You can't avoid it, this is more or less a must, you have* *to do it. Because these are the main components, they have to be in there*" (Sales). This allowed CASTER to reduce the customization effort required internally when clients demanded these components for their cell solution. In many instances, however, CASTER was still forced to use components a client had chosen without collaborating with the supplier of this equipment.

Policies from the machines business constrained the customization of cell solutions. Corporate financial guidelines, for example, required every item sold to clients to have a minimum contribution margin. While such targets were appropriate for in-house equipment, it was not suitable for situations where CASTER had to integrate third-party components and had to act as a wholesaler for clients. Despite little value added on these third-party components, CASTER's sales team had to add a high margin for the client. This constrained the development of cell solutions because CASTER was not price competitive when it customized cells as a general contractor.

4.2.8 Customizing decouples activities from strategy

While the **cell solution activities moved away from the in-house approach** towards a customized solution (accumulating learning pattern in figure 4), the strategic plans of CASTER remained committed to it. In its strategic priorities, CASTER **considered over several years to reinforce its commitment to in-house components,** for example with an acquisition of a producer of molds. These investment plans were included in the budget and the strategic mid-term plan over several years, but **never acted upon.** Looking at it from hindsight, a manager stated: "*This was a phase where we did not really know, what we would actually like to be*" (Product Management). Some managers considered the resulting course of action as **erratic**, *i.e.*, without a clear strategic direction. "*Die-casting did have a sort of, I wouldn't say a reputation… but in many ways, whoever spoken to them last or whatever has been heard this month [led to the conclusion:] "Oh now we have to change it, now we have to move." […] And then something else would happen and all of* *a sudden another decision would come*" (CEO). The lack of strategic rigidity, however, also allowed CASTER to follow the wishes of its clients and learn from its initiatives.

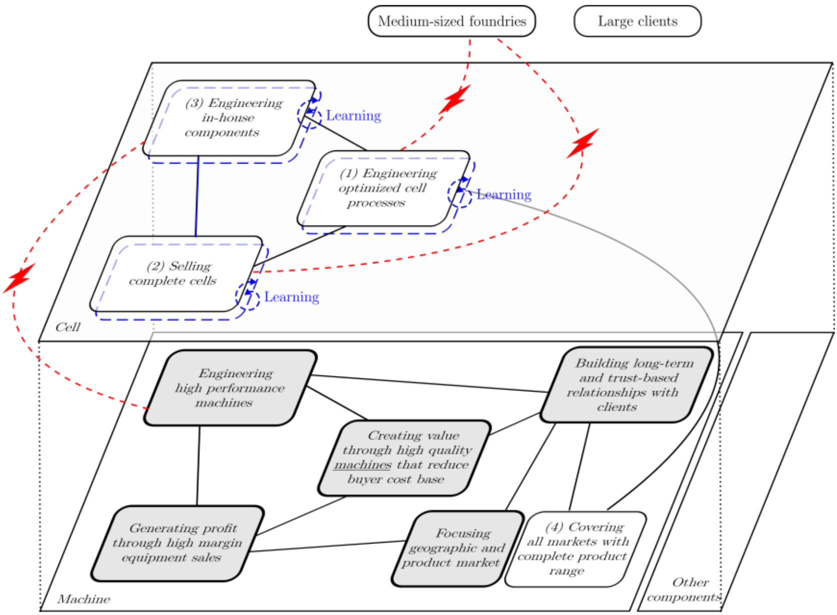

Figure 4: CASTER's activity system for in-house cells (historical core activities only, new activities in white, misfits represented with dashed lines).

4.3 Moving from an orchestration role to an ecosystem leader

4.3.1 Abandoning in-house activities

At the beginning of 2014, a **new CEO** from outside took the helm of CASTER and **initiated a strategy review** (updating strategic beliefs in figure 5). He started to hold monthly meetings with the management team to discuss the strategic assumptions of the past and their validity for the future. "*That was also for us a bit of a discussion as a part of the strategy [:] are we a machine* *supplier? Are we a solution provider? If we are a solution provider, what does that mean? Does it mean the whole cell, does it mean we have to buy peripherals or we have to be owners of peripheral supplies*" (CEO). As a result of these discussions, **the option to continue a complete CASTER cell, with in-house components, was shelved** (abandoning activities 2 and 3 in figure 5). This decision to not further invest in the development or acquisition of in-house components was based on a double strategic rationale. On the one hand, most of these components were sold regionally in relatively fragmented markets where CASTER felt it could not be competitive. *"We said, 'No, we're not going to become a peripheral supplier because the customers, one, it's relatively regional, there are some global players but even the global players are very small companies'"* (CEO). On the other hand, limiting the sale of these components to CASTER cells would make the necessary scale hard to achieve. CASTER drew on its market understanding and experiences with the in-house components to make this determination. In particular, the negative experiences with "frictions in the market place", *i.e.*, conflicts with clients and partners, limited the development of globally scalable in-house components (internal strategy documents). The decision was an explicit acknowledgement of reality and ended plans to acquire or integrate more components. The immediate operational impact was limited because some low complexity in-house components remained in the portfolio as not to alienate clients who had purchased them.

4.3.2 Continuing the solution provider strategy as an orchestrator

CASTER's CEO and management team **reconfirmed the commitment to the cell solution provider strategy** (internal strategy document 2014). The rationale was to maintain a differentiated position, because "*differentiation only with the machine is getting more and more difficult [...] As a differentiation for the future we see: Technology, Automation, Speed and Service*" (internal annual report 2014). However, CASTER decided to pursue the strategy with a new configuration of activities. The new objective was to orchestrate cell solutions for the client, without having all the components in-house (NEW core activity 5 in figure 5). "*So, we went through all those parts of this [strategy] process and said, 'Yes we want to be a solution provider but we do not want to own the peripherals. We want to be able to integrate for our customers'*" (CEO). CASTER did not abandon its historical focus on premium machines, but integrated it with the new orchestrator role. The slogan "***Marrying the […] Cell Automation to the machine***" (internal strategy document 2014) summarized this idea.

The continuity of the cell solution objective led managers and employees to quickly support the orchestration strategy, but caused uncertainty about what was novel and in need of change. "*I think the biggest conflicts with the solution provider was everybody said yes*" (CEO). The strategic objective to be a solution provider was rarely called into question, as it was the continuation of the historical strategy. But the changes in the activity system configuration towards an orchestrator role were complicated to communicate and implement. *"There was a question as to what was the solution provider,* ***to really the extent of it****. So people had a bit of different opinion of what that should be"* (CEO). The limited operational impact of ending the in-house cell left many employees and even some members of the management team doubting the clarity and the impact of the orchestration approach. After one strategy meeting the main takeaway was *"more questions than answers"* (internal strategy document 2014).

To increase the understanding and commitment of the solution provider strategy and the orchestration approach, **the CEO initiated a strategy process that involved the middle and upper management levels**, including some third-level team leaders. He wanted to tackle the issue that "*the strategic thinking was quite often kept within a very small group of people […] I'd say there was a gap between had been defined and how involved the team was*" (CEO). In this project, cross-functional teams worked in a bottom-up strategizing approach to further understand clients and develop strategic initiatives within this strategic frame. After this project, a regular strategy working group was established that includes not only managers but also high potentials from all levels of the organization.

4.3.3 Organizing to support the orchestration activity

CASTER had to ensure that it could orchestrate cell solutions that work seamlessly for the customer consistently and on a global scale. This required cross-functional collaboration from all the departments involved in offering the cell solution, in particular combining the commercial and the engineering teams. To overcome the conflicts and uncertainties that had plagued the cell projects in the past, CASTER structured the sales processes in form of an "offer conference" (internal documents). These are meetings initiated by the sales rep, where members from various departments, like engineering, application technology, or product management, join their competencies to decide on the specifics and the pricing of a complex cell solution. CASTER also worked to better align its innovation projects so that their results would be compatible in a cell solution. "*For the [process project] the [cell computer project] is also critical. Because eventually, when we present the solution to the client, it has to be seamless*» (R&D). Regular project collaboration meetings were established to facilitate coordination. The product management department became responsible for ensuring the compatibility of the different elements of the portfolio.

These organizational processes and structures helped to establish cell orchestration as a core activity (linkages of the new core activity in figure 5). Historically, cell projects depended on the personal competence of the project leaders, and were thus regionally focused and difficult to scale. CASTER could draw on the experience with successful client projects and derive a process for cell solutions that could be implemented for a large number of clients, and globally transferred from the headquarter in Europe to the subsidiaries in Asia and the US. "*Standardized and more reliable […] And we appropriately implement the whole process on a day-to-day basis"* (Product Management). With these collaborative processes, CASTER could more confidently and professionally offer cell solutions to clients.

The insistence on structured collaborative processes, in combination with higher awareness of the orchestration strategy through the more open strategy process, slowly changed the deeply engrained mentality of focusing on in-house engineering in functional silos. This mentality was a barrier to the processes that support cell solutions, in particular regarding the heavier focus on clients and commercial aspects. "*That was a complete cultural change […] Prior, our project leaders were much more technically oriented, and today it is also about cost control and cost awareness […] All that was newly introduced*" (Engineering). Selling and pricing the solution component of a cell was a challenge to the sales reps. *"Our organization is used to selling hardware, selling machines"* (R&D).

4.3.4 Driving cell orchestration with modified client interactions

The orchestration activities reinforced a change in CASTER's **value proposition from machines that reduce clients' cost base to cell solutions that create value**, for instance by enabling new types of parts and filling competence gaps (modified core activity 8 in figure 5). CASTER leveraged its experience from projects with many different clients to position itself as a competent partner for new die-casting processes and technologies. Clients struggled with uncertainties about how digital technology, epitomized in the buzzword "Industry 4.0", would transform the die-casting process and how electric vehicles would impact the use of aluminum parts in cars. CASTER communicated about its ability to help clients with these challenges. "*The philosophy of CASTER is one of evolution, enabling die casters to take advantage of this new [cell] technology as it emerges*" (communication on foundryplanet.com, July 2018). The operations director of a European foundry describes the type of client interaction that has replaced the purchasing of machines. "*And then we gather together around the table [with the team of CASTER]: 'This is our problem that we would like to solve. Do you have any ideas on how we could approach this issue?' […] And CASTER is so competent, they don't only provide us the die-casting machine, they also install the complete cell. […] And CASTER is basically responsible for the functioning of the entire cell*" (medium-sized client).

In its interactions with clients, **CASTER tried to turn the discussion away from competition among its clients towards making the industry as a whole more competitive.** Clients look to CASTER to help them "*where we want to increase the pie*" (medium-sized client), *i.e.*, to enable new parts and increase the competitiveness of the die-casting process compared to other materials. These common challenges enabled a new form of client interaction, away from interviews to a true dialogue, where CASTER discussed different visions of the future. "*We try to turn the discussion around by saying, "We're not just selling you a machine. I mean we're all interested in the success of the die-casting industry. So their challenges are our challenges*" (CEO). One part of this approach is **openly sharing the strategy, innovation roadmap, and underlying assumption with clients**, similar to the more open internal strategy process. "*And it's interesting the way that some of the discussions […] have evolved is, one is we would go out and ask questions. So, you tell us what you're thinking. Now, […] we actually go to customers and share our strategy, not only about what we want to build as products but how we got to where we thought. And that opens up an incredible amount of discussion with our customers who are very, very eager to be able to take a look at it*" (CEO).

For some clients, the core activity of CASTER to engineer **high performance machines continues to decrease in importance compared to the engineering of high performance cell solutions**. "*The sale of complete die-casting cells continues to increase versus selling single machines. […]*

Nowadays our main business is selling complete die-casting cells and not so much single machine business anymore" (internal annual report 2015). The focus on superior cell solutions allowed CASTER to reach new customers that had not previously bought their machines. "*And this is the first time […] and somehow the client learned, with CASTER you simply get better parts […]. The complete solution is simply better and that is why CASTER became interesting for him*" (Engineering).

4.3.5 Learning from machine-independent innovation projects

The orchestration role had a direct impact on the innovation roadmap (internal documents), where **cell innovation projects became more independent from the machine innovations** (activity 6 in figure 5). CASTER developed, for the first time, a cell control system that was not integrated in the machine. The previous control systems all expanded and adapted the existing machine control system. The objective was to develop a system that is applicable to a large range of clients and, in the future, **could potentially function for a client who does not own a CASTER machine**. The system was meant to consolidate data from all cell components and steer them according to the optimized process parameters CASTER had developed. The first project leader drew on his experiences outside of die-casting to define the cornerstones of the project. "*My background is actually in the semiconductor business and when you enter this industry and see what the [die-casting] cells are doing, I'm thinking to myself, this is the Stone Age! […] That's how the project emerged […] I did the business plan, which is requirements, marketing, all that stuff*" (R&D). Members of the R&D team had championed such projects over several years before they were funded by management. *"That was a project for which we fought a long time, until we received a green light"* (former R&D head).

When the cell control system became a machine-independent innovation project, **the pressure increased to develop a standalone business case.** CASTER's revenue models for the control system and its applications were still heavily influenced by the history as an equipment provider. Most ideas circled around using the cell know-how to increase the price of the equipment sale. "*Purchase the components, smartly link them [with our cell control system], and re-sell it with an added value*" (Product Management). Regular revenue streams like licensing fees, common in software businesses, were initially not the priority. In one meeting we observed, this elicited an incredulous gasp from the department head of a partnering firm with an automation background. Confronted with this feedback, CASTER started to develop other revenue models, such as subscriptions or performance-based fees. CASTER also planned to commercialize applications based on the control system, like predictive maintenance algorithms or energy optimization (learning in activity 6 in figure 5).

The idea of new revenue models spilled over to machine innovation projects, where CASTER started to modify the design of its equipment. CASTER's developed a machine that is **modular**, so that it allows upgrades and changes over the course of the life cycle. This **lowers the purchase price and increases flexibility for clients**, who can upgrade a machine years later if a client order requires additional features. The idea of modularity and more flexible revenue models has impacted the process engineering projects, too. A new project to further optimize the production of thin-walled parts tried to limit changes to hardware components as much as possible and only work on the conceptual and thermodynamic improvements. CASTER has started to commercialize features developed in this project separately, like an infrared sensor or a cooling system, rather than insist on only selling the entire cell solution.

These machine independent projects faced challenges in the organization that was still heavily focused on equipment. "*We have capital* *equipment DNA*" (CEO). The intangibility of the projects made performance reviews more difficult and drew skepticism from managers used to working with machines. "*It is easy to show some screens […] I don't know how far they really are with the project*" (Application Technology). **This lack of tangibility and the unknown revenue models caused the projects to be disadvantaged in the resource allocation process** – both in terms of financial resources as well as time from collaborating departments. "*Not a lot of people believe in the project. […] We knew the objective, but nobody in the organization moved*" (Product Management). The increasing interest of employees, clients, and partners in all issues related to digitalization and 'industry 4.0' has alleviated some of these challenges.

4.3.6 Learning to integrate partners with a digital cell standard

Coordinating and professionalizing the **external collaboration with partners was key to integrate their components into the orchestrated cell solution** (activity 7 in figure 5). To support this activity, the product management department obtained more resources from management. *"If you have partners, they have their own ideas and strategies. And that has to align. That is why you need the product manager, who opens the doors […]. So that you know what to do"* (R&D). The task of product management was to be a contact point for these partners and coordinate the innovative work between the internal R&D team and partners.

CASTER's product management and R&D team realized soon after the introduction of the orchestration strategy that only an **industry-wide standard for interfaces** could allow a real orchestration of the cell (learning in activity 7 in figure 5). With this approach, CASTER's cell solution could include the full potential of components from third party producers. Common interfaces allow exchanging standardized data between cell components, instead of customizing the connection for each client project. This would allow

CASTER to more reliably and efficiently optimize cells based on its process know-how. CASTER could also gather more data to develop new and better cell solutions. Furthermore, such a standard would allow CASTER to harness the innovations of other component suppliers in its cell solution. *"The path with the [interface standards] enables that the [component] suppliers can continue to develop innovation, and we [...] are able to connect this to our cell"* (Application Technology). The ultimate objective was to be able to offer a "modular high performance cell" (internal documents).

To develop and establish widely accepted interfaces among cell components, **CASTER chose to collaborate with 8 large and technologically advanced component producers**, one per type of component. CASTER could draw on previous collaborations to establish contact with many of the firms required in the development of the standard. One of the partners was a large robotics firm with whom CASTER had collaborated in the past, other partners had been involved in customized client projects, etc. CASTER felt that only a small number of component producers had the competencies to collaborate in such an ambitious innovation project. *"We start on the technological side with a few partners and those are the most common ones, and we will collaborate with them"* (R&D). CASTER assumed that the rest of the industry, mainly smaller producers, would accept the standard set by the large and technologically advanced players.

The objective was to open the standard to the entire industry after the development phase. The main argument to convince partners to engage in the collaboration to develop interfaces with CASTER was an **exclusivity period**, during which the participating partners' components would be the only ones integrated in the system. The partners were eager to learn about CASTER's ideas for such a standard and potentially get a head start over their competitors. They also expected additional business from being part of the highly respected cell solution of CASTER.

The project, however, was challenged by concerns about intellectual property, which led to long negotiations before CASTER and its partners agreed on a collaboration. CASTER wanted to avoid a transfer of know-how about its machines and its cell processes to partners, clients, and competitors. Hence, CASTER tried to establish a **complex contractual framework before engaging in the technological collaboration.** *"The organization of CASTER works in a way we like to assure and safeguard everything, for example regarding these interfaces. This means you have to establish collaboration contracts, in order to avoid passing information to the outsid*e" (Product Management). CASTER, in its role as a technology leader, had always **considered partnering firms as technologically inferior.** This was aggravated by the fact that most of these firms were smaller than CASTER. "*And so you've got a big company, small company. You have dynamic and then we were-, we just really weren't very nice - we weren't really a nice company to work with. I don't say we were an awful company to work with. We just we didn't take care of the relationships that we needed to be able to build with these people. We used them because we needed them*" (CEO). However, the need to integrate partner's innovation into the cell solution, and to convince them to collaborate on interfaces, **required a fundamentally different approach to partnering.** "*If we are going to be a solution provider we have to change the way that we work with these peripheral [component suppliers] so much*" (CEO).

CASTER planned to leverage the central position of the machine in the cell to maintain leadership status within its newly created ecosystem. "***We always have better cards [versus our competitors], because the main component - the machine - is critical.*** *The casting is done in the machine. This means that there is the data that I need in subsequent steps to analyze and track, to improve the process – all this data comes from the machine*" (Sales). Many clients echo this view. *"In the cell, CASTER supplies by far the largest, most complex and most important component […] It only makes […]sense, that* *the large one integrates all the other and not inversely, that's how it is done in practice"* (medium-sized client). Over the years, however, competitors' die-casting machines have become more and more similar to CASTER's machine. *"I have the feeling that our machine is currently not the best one on the market"* (Application Technology).

4.3.7 Starting to compete as an ecosystem leader

With the introduction of the standardized cell interfaces, **CASTER established itself as the leader of a multi-partner ecosystem** it created around its machine. A consensus has emerged in the die-casting industry that the competitive arena has shifted from individual component markets to the cell level. Several other cell ecosystems now vie for the leadership in this domain, sponsored by machine producers, component producers, and new entrants. "*There is a race to be the master of the cell, and no one yet knows who will be the future cell leader. It could be a [die-casting] machine company, a robotics company, or some big player like Siemens or GE*" (Robotics Producer). A **new range of competitors has emerged that offer rivaling cell solutions.** Most active in this respect are robotics producers who have built plant automation know-how they intend to leverage in the die-casting business and replace the central role of the die-casting machine. "*The central point in the automated die-casting cell is a […] robot in its foundry edition*" (Robotics Producer in case example). Some software engineering firms too have started to compete for contracts for cell automation. Whether CASTER will be able to grow its ecosystem to become the leading ecosystem in the industry will be a **question for the near and medium-term future**.

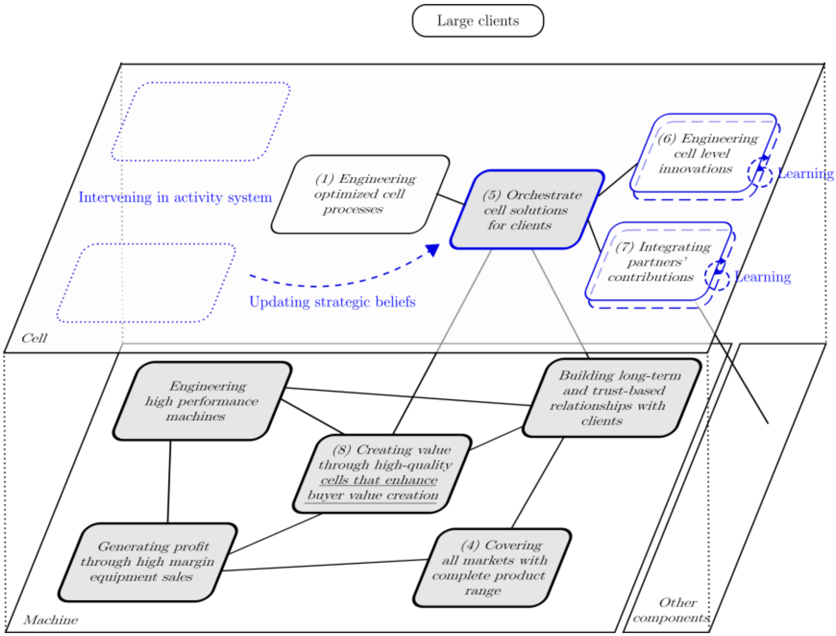

Figure 5: Activity system of CASTER as a cell orchestrator (historical core activities only, new activities in white).

4.4 Towards a process model of accumulated learning

I observed that CASTER has remained a central player in the die-casting sector despite profound changes, like a shift in performance metric from machine specifics to cell solutions, a change of client group from smaller foundries to large automotive companies, as well as the emergence of new competitors from outside the industry. CASTER managed to change its activity system continuously over time, complementing its machine business with an ecosystem leadership role. CASTER transformed its core business in a process of **accumulated learning**. The realized strategic course was the result of learning dynamics that altered the strategy and the activities over multiple cycles. These learning dynamics accumulated over time, *i.e.*, expanded and enhanced prior activities, rather than substituting for them. This led to a relatively gradual and nonconflictual change process that nevertheless transformed the core business. Over the period of my analysis, I observed three cycles of accumulated learning. Figure 6 depicts the resulting change model, including some examples of key changes in activities. Four sub-processes, which I will describe in detail hereafter, constitute the accumulated learning process.

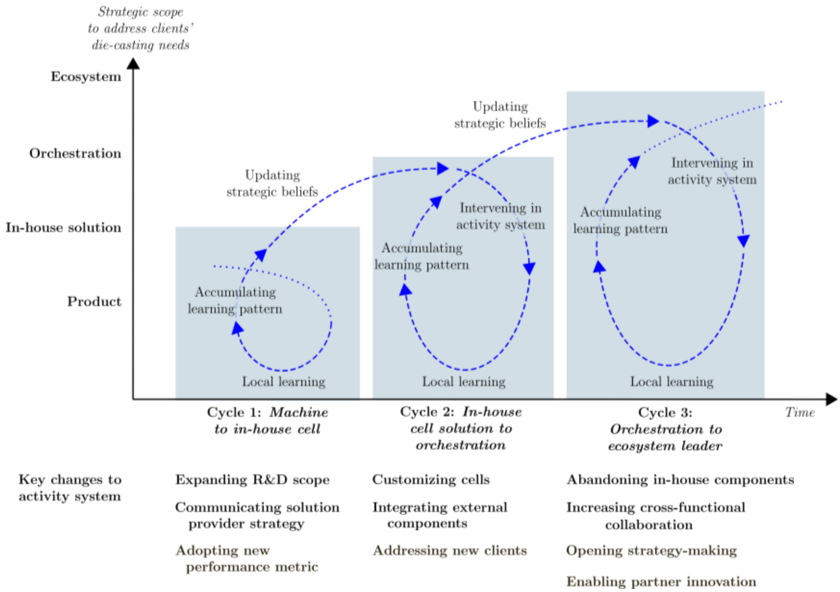

Figure 6: Process of accumulated learning at CASTER.

The first sub-process of accumulated learning is **updating strategic beliefs.** CASTER's management introduced or deleted core ideas to their strategic beliefs, to reflect perceived external trends and internal issues. The updated strategic beliefs, however, initially left past strategic assumptions and ideas unchanged. For instance, the cell solution idea left other strategic beliefs about revenue models and clients unchanged, and the orchestration idea left the cell solutions belief unchanged. This indicates that the updating of strategic beliefs was not a deliberate, rational reconfiguration of the entire belief system, but boundedly rational reactions of managers to accumulating issues. However, CASTER's management creatively modified and amplified their strategic reactions to these issues to take an active role.

The second sub-process is **intervening in the activity system** with the objective of implementing the updated strategic beliefs. Interventions created, reinforced, or deleted activities by modifying the resource allocation, for example through R&D projects or changes in the organizational structure. CASTER's management was convinced that these interventions would create and reinforce the positive interdependencies that characterize a successful activity system. However, it was only after these interventions that CASTER discovered the real impacts of the activity system changes. CASTER could not fully foresee the positive and negative interdependencies that arose.

The positive and negative interdependencies caused by the interventions in the activity system initiated **local learning** processes, as employees tried to deal with the fits and misfits that arose. They adapted the activities to create internal fits and mitigated conflicts with the historical activities. They also searched for new ways achieve external fit, by adapting the activities to the client needs they discovered. This search led to learning dynamics, when modified cognition and behavior of employees led to increased fit or reduced misfits. Learning dynamics altered the activities, away from the intended high-level choices of management.

In the fourth sub-process, these local learning dynamics in the activities started to form an **accumulating learning pattern.** Multiple activities changed over time to address fits and misfits, forming a pattern. These patterns resulted in realized activities that were decoupled from the intended strategic beliefs, at least partially. The acceleration in different customized projects for cell solution for thin-walled parts, for example, transformed the in-house component activities and modified the core value proposition of CASTER. Triggers, such as environmental pressures or personnel movements, initiated strategizing episodes that, based on the accumulated learning pattern, caused managers to question and update their strategic beliefs.

The combination of the sub-processes led to continuous change for CASTER that combined new strategic ideas with learning. "*It's gradual. I mean there was no master plan four years ago or five years ago […] There's a certain process, a certain idea that you have and you start to put it into place. Then there are, I say external elements which fortunately we have that either exhilarate for us or slow down for us or bring in some of the things*" (CEO). Table 2 provides a more detailed grounding of these four sub-processes in the context of CASTER's case.

Updating strategic beliefs
Integrating a new core idea, but leaving other strategic beliefs intact
(1) to (2) *"[Around 2000,] I'd say, all of this started: 'solution provider'. But that was more about/ those were catchphrases. Marketing really exploited that. But we still had the product and just said: 'solution provider''"* (Product Management)
(2) to (3) *"Marrying […] Cell Automation to the machine"* (internal document, 2014)
Strategically motivated changes
(1) to (2) *"I think this was a body of beliefs where managers, in particular [the CEO prior to my tenure], put the client value at the foreground very early on. […] and with that, the whole management team [...] we all inhaled these beliefs"* (former CEO)
(2) to (3) "*differentiation only with the machine is getting more and more difficult […] As a differentiation for the future we see: Technology, Automation, Speed and Service*" (internal annual report 2014)
Drawing on accumulated learnings
(1) to (2) *"When I joined the team […], I already felt very strongly, that the die-casting [unit] deals with and identifies with much more than only the machine"* (former CEO)
(2) to (3) *"There was not a need [to shake things up], neither operationally a crisis nor strategically a crisis. So we had […] the luxury of standing through the process"* (CEO)

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Intervening in activity system
Intervening in the activity system to support strategy (2) *"And there we pondered: yes, can we build our own, more simple [components] in-house? And that's what we did"* (former CEO) (3) *"Prior, our project leaders were much more technically oriented, and today it is also about cost control […] All that was <u>newly introduced</u>"* (Engineering) Discovering (unintended) interdependencies and consequences (2)*"About half a year later we retreated from the market: it didn't work, we did not have experience in the field and it just simply didn't function"* (Product management) (2)*"And this integration, this full [in-house] integration of peripheral components: One lessons learnt from that was that it sounded good at the beginning […] but <u>in retrospect, I have to say, that it was not really thought through</u>"* (former CEO) (3) *"If we are going to be a solution provider <u>we have to change the way that we work</u> with these peripheral [component suppliers] so much"* (CEO)
Local learning
Striving for fit and resolving misfits (1) *"We are not leaving the client alone"* (Sales) "*We saw an increase in framework agreements for preventative service, [client] education and consulting"* (AR 2001) (2) "*Jeez, at some point we have to accept the reality […] And so we will offer [the client] the customized solution*" (former CEO) (3) *"My background is actually in the semiconductor business and when you enter this industry and see what the [die-casting] cells are doing, I'm thinking to myself, <u>this is the Stone Age!</u> […] <u>That's how the project emerged</u>"* (R&D (3) "*We <u>had to correct all of their errors with our software</u>, and that was very complicated. And so we soon had the idea […] to develop a [modular] vacuum system. Eventually, we were able to get this approved"* (Application development) Initiating local learning dynamics (1) *"Well, it <u>started with the insight</u> that the [aluminum] parts become ever larger and ever thinner, and that is what we discovered [in the first cell project]"* (former R&D) (2) *"That is how it starts. <u>You begin somewhere small</u>, you think to yourself: this is the direction to take, you analyze the know-how that you need to be able to implement your ideas"* (former R&D)

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(2) *"And then we really started to move ahead with steam, and we started to address the topic of structural parts professionally"* (former R&D)
(3) *"The philosophy of CASTER is one of evolution, enabling die casters to take advantage of this new [cell] technology as it emerges"* (communication on foundryplanet.com, July 2018)
Accumulating learning patterns
Recognizing patterns in the local learning processes over time
(2) *"The understanding or the idea is actually older. That was a process, a development process where we said: Okay, at some point we started selling more and more and eventually we had Turnkey Solutions […] And the longer, the more"* (R&D automation).
(2) *"And with the increasing sale of cell solutions the share of engineering work grew and became more and more demanding. And then I eventually…/ we then spun out the engineering team"* (former CEO)
(3) *"But I believe, the biggest change that I see in R&D and in the die-casting [unit], we shift away from a pure machine developer and supplier towards a solution provider. We take care of automation, integration of peripheral components to make the entire cell more productive" (Leiter R&D)*
(3) "*We actually, after we had done 2014, did 2015, we came to 2016 and we said, 'We've just got too much' […]We eventually made some decisions [to move towards more integration of partners]*" (CEO)
Learning patterns accumulate and decouple from deliberate strategy
(2) *"We would like to be a solution provider. And then we have everything else […] the restrictions, EBIT [targets]. And that means, we want to be a Solution Provider, but we do not want to develop in-house, having in-house components […]. And that continues to be a topic that causes frictions"* (Head of Product Management).
(3) *"But generally, when I look at the external factors: Internet of Things, Digitalization, the overall changes in the industry. Sure, we try […] But the real change has not taken place yet, I think"* (Head of product management).

Table 2: Examples of each sub-process of accumulated learning by cycle of change (numbering indicates position in CASTER case).

The cycles of accumulated learning led to the transformation from a machine differentiation strategy to an ecosystem leader. CASTER **integrated the original product-focused activities with the new cell activities in the**

organizational structure and processes. In the first cycle, CASTER adopted the cell solution provider strategy as a future source of differentiation. This new strategic priority changed the R&D efforts, with process innovations and in-house components, as well as the internal and external communication. It generated, however, relatively little revenue and was executed within the historical organizational structure. In the second cycle, CASTER transitioned from an in-house cell solution to an orchestrator role. As CASTER learned how to address clients who drew a significant benefit from the cell solution, customized orders picked up. The creation of the engineering department supported the cell solution business, but the customized solutions remained complex and non-scalable. The solution business could profit from the success of the machine business to reach clients and extend its scope. In the third cycle, which is still ongoing, CASTER chose a strategy of cell orchestration, but soon transformed into an ecosystem leader with an open, modular standard to integrate partners in the cell solution. CASTER strove for a globally scalable solution, supported by professional, cross-functional and external collaboration. The solution business has reached a status where some managers question the necessity of the machine business for future long-term success. The cycles of change were **accumulative** and built on the original machine business, rather than replaced it. The client need of producing die-casted aluminum parts efficiently was in the center throughout this development process. Product and ecosystem business **interacted** throughout the process, both positively and negatively (see table 3 for an overview).

	Cycle 1: Machine to in-house cell	**Cycle 2: In-house cell solution to orchestration**	**Cycle 3: Orchestration to ecosystem leader**
Accumulating process			
Approx. period	2001-2007	2007-2013	2013-2018
Revenue share of cell solution	<5%	<15%	30-50%
Status of cell solution business	Strategic priority implemented with innovation projects	Frequent customized projects driven by project leaders in a dedicated department	Globally scalable approach integrated into core structure and processes
Status of machine business	Core business extending in product and geographic scope	Core business in cyclical downturn	Integral part of the solution business
Accumulation effect	Cell solutions as continued differentiation potential for premium machines	Machine and cell mutually support each other to develop client relations	Cell ecosystem leadership position enabled and strengthened by machine
Product/cell interactions			
Strength and directionality	Mainly from product to cell	Mainly from product to cell, also from cell to product	From cell to product and vice versa
Examples of positive product to cell interactions	• Client knowledge initiates cell strategy • R&D capabilities apply to product and cell	• Machine business enables access to pioneering cell clients • In-house cell components draw on engineering knowledge	• Machine reputation helps to find platform partners • Central machine position to maintain control over cell

Table continued on next page

Examples of positive cell to product interactions	• Cell solutions as communication tool for entire firm	• Cell solution enables new use for large machines • Cell solution enables better access to new client groups that also purchase machines	• Gain clients for machine because of cell know-how • Adapt machine to new business models developed at the cell level
Examples of conflicts and constraints	• Some clients feel menaced by solution • Cell aspirations exceed technological capabilities	• Cross-functional collaboration between cell and machine focused departments • Product focused strategy conflicts with customization	• Struggles for resource allocation • External partnering hampered by proprietary machine culture • Strategic understanding of double objectives at cell and product level challenging

Table 3: Interactions between ecosystem and machine business in the accumulated learning process.

CASTER's management did not envision its transition from a machine producer to an ecosystem leader from the beginning as a process of accumulated learning with three cycles. Hence, I do not suggest that the process of accumulated learning is linear and teleological, under the control of management. **Each sub-process of accumulated learning could have resulted in alternative futures**, altering the course of strategic change. The sub-process of updating strategic beliefs could have led to many alternative routes for CASTER. For instance, CASTER's management considered to escalate the in-house strategy with acquisitions and other moves, instead of choosing an orchestration strategy. The interventions in the activity system could have proved to be dead ends, abandoned activities that do not lead to learning dynamics. Instead of modifying the value proposition to enable new parts, CASTER could have insisted on its original approach and ultimately abandoned the cell strategy because of lacking client interest. Learning could have remained isolated and myopic, not leading to a pattern that guides future strategic decisions. For instance, CASTER could have continued to muddle through with customized cells instead of recognizing the pattern that led to the orchestration strategy. I do not know if CASTER will continue to successfully change in future cycles of accumulated learning.

5 Discussion

5.1 Implications for research

With my findings, I complement the ecosystem literature by introducing a view of ecosystem emergence as continuous change that incumbents can approach with a process of accumulated learning. In such a change process, ecosystem creation transforms and enhances an existing strategy, and is not the primary strategic goal nor an imperative to adapt to technological change. Because the ecosystem was not in fundamental conflict with product, CASTER could engage in a change process of accumulated learning, a change model that complements existing models of separation or experimentation. Accumulated learning combines deliberate strategic interventions with emerging learning patterns over multiple cycles, resulting in continuous change. Similarities between the product-focused activity system and the ecosystem activities helped to achieve an accumulative change process that created a synthesis between product and ecosystem, rather than conflict.

5.1.1 Implications for ecosystem strategies

I extend and complement our understanding of ecosystem strategies of incumbents, by contributing the idea of an **ecosystem strategy as continuous change**. Ecosystems can support a range of strategies as an efficient form of governance for economic interaction (Jacobides *et al.*, 2018). Research has tended to see ecosystem emergence mainly as a disruptive change. In the disruptive view, the aspiring ecosystem leader generates an idea, for example a disrupted industry or a new technology innovation, and subsequently uses an ecosystem strategy to drive the implementation of the disruptive idea (as in Ansari *et al.*, 2016; Dattée *et al.*, 2018; Gawer *et al.*, 2013; Snihur *et al.*, 2018). In the case of **ecosystem emergence** as **continuous change, ecosystem creation is historically embedded to support a past**

strategic course. Table 4 presents and overview of the two complementary perspectives. CASTER's ecosystem was historically embedded because several core aspects of the future ecosystem emerged prior to creating the multi-partner platform. The ecosystem inserted itself into a logic of continued strategic change towards a solution provider, as this objective remained unchanged from the initial in-house cell to the ecosystem.

The approach of an ecosystem strategy as continuous change starts with a **new strategic priority addressing a client need, without *a priori* having an ecosystem in mind**. In CASTER's case, this was the solution provider strategy to optimize the cell for the client. CASTER developed competences, relationships, and products to support this strategy. The ecosystem was a further step in this gradual learning process. CASTER did not start with an ecosystem strategy (Adner, 2017), but discovered that its solution provider strategy had to become an ecosystem strategy. Therefore, the in-house cell activities before the creation of the ecosystem were not dead ends that should have been avoided in hindsight. Instead, these activities laid the groundwork that ultimately enabled and supported the ecosystem. These foundations include the development of cell know-how, the establishment of dedicated departments that address the cell level, and a cultural shift towards internal and external cross-functional collaboration. External changes, concerning the relationship with clients and partners, also paved the way for the future ecosystem. CASTER started to address new client groups susceptible to cell solutions, adapted the value proposition to focus on new parts, and established contacts with many component suppliers for customization. These findings indicate that **research must pay more attention to the historical embeddedness of an emerging ecosystem**, also considering the changes that occurred prior to the explicit ecosystem creation. Even if the ecosystem is created around a new technology and a new market, the initial conditions and proprietary research (Dattée *et al.*, 2018) do influence the ability of an incumbent to drive and establish an ecosystem.

	Ecosystems emergence as disruptive change	**Ecosystems emergence as continuous change**
Ecosystem emergence	Radical change that creates a new market or fundamentally alters a sector Technological innovation as a main driver for emergence Ecosystems are the center of a new strategic imperative and cause strategic change	Continuous change that transforms a sector gradually over a longer time period Changing inter-organizational relationships as main driver of emergence Ecosystem are a new way of organizing economic interactions, supporting a strategy
Product-ecosystem interactions	Ecosystem challenges the status quo Ecosystem leaders limit tensions between old and new (with radical shifts or structural separation)	Ecosystem transforms and enhances status quo Ecosystem leaders synthesize tensions and integrate new and old
Observed change processes	Incumbents use punctuated equilibrium, experimentation in a variation-selection-retention model Entrants use strategic adjustments to disrupt inertial incumbents	Incumbents transform through accumulated learning *Not observed hypothesis for future research: limited potential for entrants, entrants co-opted by incumbents*

Table 4: Contrasting two complementary views of ecosystem emergence.

In this inductive process, **the ecosystem emergence was intertwined with the development core business** and drew on the product position to establish leadership in the ecosystem. Flexibility to change competences and activities is key to manage the ecosystem dynamics in nascent or rapidly transforming ecosystems (Hannah et al., 2018). In contrast to such perspectives, CASTER gradually changed its activity system over time and continuously integrated the machine business in the change process towards an ecosystem. The integration with the core product business, as shown in prior research, had constraining consequences for ecosystem creation. Product-driven practices, like intellectual property protection, limited the speed and flexibility of CASTER's ecosystem activities, biased resource allocation favored machine projects, and the scope of the ecosystem strategy tied to the product business. Overall, however, this complements existing work that focuses on these sources of friction by highlighting the potential symbiotic relationships between product and ecosystem. I point out 3 areas where CASTER's machine activities interacted positively with the new cell activities. (1) CASTER used its historical product position to support the creation of the ecosystem. In particular, the sales team leveraged the trust from the machine client relationships to convince clients to invest in cell solutions. The position as a large and differentiated supplier convinced ecosystem partner to engage in collaborations with CASTER to define interfaces. (2) CASTER used the central position of its machine to remain in control of the cell ecosystem, for example by limiting access to certain types of data from the machine. (3) Finally, the presence of machine and cell activities lead to improvement for both, the product and the system. For example, data from cell solution sales helped to improve machine designs, and the new modular machine developments will support new types of cell solutions and business models.

One of the critical factors for the inductive creation of an ecosystem was the **acceptance of the ecosystem value proposition by clients**. The demand side (Priem, Butler, & Li, 2013) of ecosystems is one of the critical conditions for an ecosystem to succeed. This process is not trivial, in particular in B2B ecosystems where clients go through an extensive purchasing process. Engaging in an ecosystem means changes in the clients' purchasing and operations. CASTER struggled more to bring clients on board that to find partners that contribute to the ecosystem. Without the effect of environmental trends, in particular the move of automobile production to China and the consolidation of foundries during the crisis, CASTER's cell value proposition might have never reached sufficient acceptance from historical clients. This aspect raises questions about many ecosystem initiatives that emerge as a response to the discussions about digitalization: do they address a real strategic rationale and compelling value proposition, or is it a purely technology driven project? Failure of an ecosystem to emerge (such as in Ozcan *et al.*, 2015) could not only be caused by a failure of the ecosystem partners to align, but also by the clients to align to the new ecosystem.

5.1.2 Implications for organizational learning and change in activity systems

The process of accumulated learning highlights an **incumbent's ability to purposefully combine its core business with innovations to enable a process of renewal**. This type of strategic change is a gradual transformation, tightly integrated into the core business of the incumbent. The potential for such a renewal of the core business has been acknowledged in concepts such as "creative accumulation" (Bergek *et al.*, 2013), "managerial coping" and "creative adaptation" (MacKay *et al.*, 2013). The concept of accumulated learning combines this idea of a transformation of the core business, reflected in the term "accumulated", with the underlying mechanism, reflected in the term "learning", which is not captured by previous concepts. On the one hand, it introduces learning as the key mechanism behind the transformations that Bergek *et al.* (2013) and MacKay *et al.* (2013) have observed. On the other hand, it is more specific than concepts such as double-loop learning (Argyris, 1976), as it focuses on learning that concerns an extant activity system of an organization. This study details the process and conditions that underlie accumulated learning as a process of strategic change.

First, the process of **accumulated learning transformed the current activity system from the inside**, complementing change models that focus on experimentation and structural separation of activities. CASTER did not separate the cell activities from the machine activity system, but intended them to enhance the core business. The interventions of CASTER's management in its activity system were commitments to a new strategic course during each cycle. They did not regard their interventions in the activity system as experiments or trials, for example with a separate process for bottom-up experimentation (akin to Burgelman, 1983). Mid and lower level managers thus persisted in their efforts to adopt the new activities, even when there were significant misfits internally and externally. They worked with pioneering clients, customized and adapted solutions, which led to learning dynamics that transformed the initially planned activities over time. Despite this commitment, CASTER refrained from significant investments and avoided reaching a point of no return. For example, it did not go ahead with a major acquisition into in-house components. Nevertheless, the approach of accumulated learning is unlike the adaptation via low cost probes (Brown *et al.*, 1997) or experiments (Cozzolino *et al.*, 2018) that consider the option of failure from the beginning.

Second, **CASTER combined product and ecosystem activities by benefitting from similarities between the two levels.** The core activity of engineering machines was fundamentally similar to the new strategic priority of engineering cells, albeit at another level. CASTER's strategic beliefs as die-casting engineers were applicable both to the machine level and to the cell level. These beliefs could support different activity system configurations, like in-house cells and orchestration, because both enabled to engineer solutions for the client. This self-similarity in the strategic beliefs over time led to reduced levels of conflict during the change process, as the change process was complementary to the core business, rather than a substitution of it. The similarities that helped to **avoid dysfunctional conflicts from the**

interventions into its activity system followed a fractal logic. A fractal logic is defined as self-similarity across dimensions (Mandelbrot, 1982).[3] Some of CASTER's core strategic beliefs, such as the high performance engineering and client focus, were scale-invariant, *i.e.*, applicable to the machine and the cell level. With these findings, I highlight the enabling aspects of strategic beliefs (Bettis *et al.*, 1995; Tripsas *et al.*, 2000) that are at play in the process of accumulated learning. Past research has focused on the inertia caused by strategic beliefs, as a constraining force for organizational change (Danneels, 2011; Tripsas *et al.*, 2000). The strategic beliefs in this case proved to be adaptable over multiple levels and supported various activity systems, because the fundamental beliefs were left intact in a fractal logic. This coherence enabled strategic change with relatively low levels of conflict. Hence, strategic beliefs in times of change are as much a resource as a rigidity, akin to the double nature of core capabilities (Leonard-Barton, 1992). The strategic trajectory in a fractal logic is critically dependent on the strategic beliefs and the activity at the start of the change process. Engineering machines and engineering cells proved to be self-similar, but it is unlikely that a transformation from metalworking to cell engineering would have been possible without fundamentally altering the strategy.

Third, the **cycles of accumulated learning were strategically motivated changes**, not adaptations to an exogenous technological trend. CASTER initiated its strategic changes with the intention of maintaining a differentiated position as a solution provider. This complements perspectives that focus on how incumbents adapt to technological change (Roy & Sarkar, 2016). The impetus for the strategic changes came largely from updated strategic beliefs of managers. It was not technological or product innovation that initiated the cycles of accumulated learning. For example, the investment in cell process technology came after top managers had acknowledged the

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[3] The concept of fractals originated in mathematics and describes forms whose patterns are scale invariant, *i.e.*, the patterns observed at a smaller scale are similar the whole.

differentiation potential at the cell level. The decision to develop a machine-independent software platform followed the orchestrator strategy. However, the roots of the updated strategic beliefs of managers were not superior strategic foresight or decision-making. Managers drew on learning patterns that had emerged in the past, and creatively amplified them to drive strategic change. This contrasts with and complements perspectives of adaptive change, which focus on how incumbents adapt to exogenous technological change (Roy *et al.*, 2016). Exogenous issues, like competitive pressure or a new CEO, had an influence on the timing of the strategizing episodes. Fundamentally, however, the change process was driven by factors endogenous to the incumbent, like managers' willingness to remain competitive using a differentiation strategy and drive sectoral changes.

Fourth, in CASTER's cycles of accumulated learning, **high-level learning regarding strategic choices and lower-level learning in the activity system level complemented each other**. Decisions at both levels are necessary for an organization to achieve sustainable high performance (Siggelkow & Rivkin, 2009). Strategic changes to the activity system triggered learning processes that occurred locally in the activities, where employees were looking to achieve internal and external fit. These strategic interventions helped to avoid a continued reinforcement of the existing activity system, which can lead to inertia (Albert *et al.*, 2015; Siggelkow, 2002). The accumulation of these lower-level learnings, however, were the basis for updated high-level strategic beliefs in a next cycle. Learning dynamics created patterns that decoupled activities from the intended high-level strategic beliefs at the beginning of the cycle. Recognizing these patterns triggered updated strategies and helped to overcome myopia and strategic rigidity. Therefore, in the process of accumulated learning, learning at multiple levels is a complement, where learning at one level enables learning on the other level. Accumulated learning, for an organization, thus has similarities with the concept of first and second order learning, where reconsiderations at both levels are necessary for successful strategic change (Argyris, 1976). It contrasts with views that consider these levels as a constraint on each other, for example when strategic beliefs limit lower level learning or the activity system prevents an modification of strategic beliefs (Levinthal *et al.*, 1993; Siggelkow *et al.*, 2009).

Fifth, this case also **sheds light on the development paths of activity systems** (Siggelkow, 2002). We know how activity system can change through processes like patching and thickening, but open questions remain on how the development is initiated and guided (Siggelkow, 2011). Current literature on activity systems mainly considers the how firms search for an activity system configuration (Siggelkow, 2011). I find that, in addition of finding successful activity combinations, the complete process of learning is important to explain the development of an activity system. Learning goes beyond search, to include enacting the insights from search with changes in behavior and cognition (Argote & Miron-Spektor, 2011). When search and subsequent interventions in the activity system are flawed, it could lead to playing an "incomplete game" (Siggelkow, 2001) that prevents successful change. In the case of CASTER, however, the learning processes in the activities corrected the errors in the search process over time. For example, CASTER tried to patch the sale of in-house cells as a core activity, *i.e.*, create a new core element and reinforce it with adjacent activities (Siggelkow, 2002). However, due to the unexpected internal and external misfits (Siggelkow, 2001), the sale of in-house cells never became a core activity. Learning patterns corrected these flawed activity system choices and resulted in a move towards an orchestration strategy.

Overall, the process of accumulated learning is not a teleological change process from start to a deliberately chosen end point (Van de Ven & Poole, 1995), but a **continuous balancing of deliberate strategic goal-setting with learning from the realized activities**. CASTER could neither fully control the environment, nor the its internal activities, during this process leading to an unowned change model (MacKay *et al.*, 2013). The role of the activity system as simultaneously enabling change and providing stability is akin to the strategy process and practice model by Burgelman, Floyd, Laamanen *et al.* (2018), where strategizing episodes and realized strategy flow together and are impacted by arising issues over time. Engaging in a process of accumulated learning is one way of strategic renewal, as CASTER avoided disruption through gradual change of its core business.

5.1.3 Limitations and future research

Thanks to my relationship with the CEO of the focal firm, I had extensive access to current and former members of the organization and could draw on a large trove of archival data. I was also able to speak to clients, partners, and other actors in the sector to complement our understanding of the ecosystem. With my research design, I hope to establish a high level of trustworthiness of the case study and its results. Nevertheless, **my research has several limitations** that need to be considered when interpreting the findings.

The setting of my single case study in the automotive sector obviously limits the transferability to other contexts. In particular, the die-casting industry is asset heavy and has a rather slow clock speed, with equipment replacement cycles of clients reaching up to 10 years and more. The strict oversight of OEMs limits the flexibility of firms in the sector to change products without in-depth testing processes. The capacity of an incumbent to transform its core business towards an ecosystem might be different in a sector with a faster paced rhythm, for example in the service or software sector. Furthermore, the focal firm is part of a diversified conglomerate that is privately owned. Multiple interviews confirmed the hands-off role of the corporate center. Asked about the level of corporate interventions to raise synergies between the business units, one corporate manager stated "*Well my personal opinion is: zero*" (Corporate Business Development). However, more subtle effects of the corporation might affect the applicability of this case to single business firms.

I triangulated my findings with multiple sources of data and multiple perspectives. For my real time study, I compared perspectives from inside the firm and outside actors, archival documents, and observations. I regularly exchanged my impressions with my supervisors and compared field notes, only stopping my data collection and analysis efforts when I reached a point of saturation. Despite these precautions, I cannot exclude an effect of respondent biases on my results. The retrospective part of the case could suffer from omissions, errors of recollection, and hindsight biases. Regarding the real time study, interviewees could have a tendency to embellish their achievements and might downplay conflicts and errors, in particular in the written documents I received.

In addition to the biases in the data collection, the bias of me as researchers could equally have influenced my findings. I took great care not to impose my preconceived categories on the data, changing the scope of my research and the emerging theoretical categories several times to reflect my observations better. Readers of this study need to keep in mind, however, that my perspective as researchers with in-depth theoretical knowledge could still have influenced the interpretations I drew from the case study.

These limitations are a natural by-product of my focus on an in-depth single case study aimed at building a longitudinal process understanding of strategic change. In order to increase the validity and generalizability of the findings, I would encourage further qualitative and quantitative research on the of incumbents' transformation processes. A multiple case study of incumbents' adaptation to ecosystems, distinguishing between successful and unsuccessful firms, could help to discern what aspects of the process of accumulated learning do have a significant impact on performance. Quantitative studies could explore how profit pools shift when ecosystem emerge, and if incumbents that integrate product and ecosystem have a systematic edge over entrant and incumbents that separate core business and ecosystem.

Other than the limitations of the method itself, the **limited scope of my case points to several opportunities for complementary research**. I observed the strategic change process from the first ecosystem-relevant initiatives up to the point where CASTER created a multi-party ecosystem to compete at the cell level. Positioned as an ecosystem leader, CASTER was able to bring partners on board its ecosystem, but we do not yet know if CASTER's ecosystem will succeed in competition with other ecosystems that have been established in the sector. To complement my analysis on how an incumbent's core business influences the ecosystem creation process, I encourage studies on how the historical embeddedness influences the stage of ecosystem competition. What historically embedded characteristics of an incumbent impact its ability to successfully lead the ecosystem in competition with rivals?

My study focuses on an incumbent that had a dominant position in its industry before creating an ecosystem. I would encourage more research on how the initial position of an incumbent influences its ability to create ecosystems. How do the product characteristics, like a central or a peripheral position in the sector, influence the ability to create an ecosystem? What impact does the competitive position of the incumbent have on the ability to be an ecosystem leader? CASTER transformed into an ecosystem leader in a coordinating role, but an ecosystem consists of many actors with different roles. More research should explore ways for incumbents to remain successful in positions other than ecosystem leadership. How can ecosystem complementors remain successful when firms with an orchestration role are present?

Further research should explore and deepen our knowledge about accumulated learning of incumbents. Is the process of accumulated learning specific to the changes caused by ecosystems or can be used to overcome other forms of disruptive innovation? To what extent can the process be consciously steered? What are the conditions to engage in such a process? In this respect, the role of an organizations' strategic belief is particularly interesting. This case points to the potential for change that is inherent in strategic beliefs, for example in a fractal logic. I encourage further research that explores how strategic beliefs influence change process, focusing on how they can be a source of leverage rather than myopia and inertia.

5.2 Implications for managers

5.2.1 Ecosystem solutions as a new level of competition

The creation of solution-focused ecosystems that fundamentally change how clients purchase and consume products can be a disruptive challenge for product-focused incumbents. Ecosystem-based solutions for clients rest upon innovative re-combinations of products from multiple partners in different industries, rather than on the production of a physical product. Mobility solutions, for example, combine the products of different industries like cars, public transport, maps, payments, etc. into a new offering for clients. Technological advances make such complex value propositions that span different industries, and draw on a range of partners, much more prevalent. The creation of ecosystem solutions in a sector ruptures traditional industry boundaries and disrupts established relationships of incumbents. Product-focused firms can lose access to clients and their profit pools, when clients choose based on an ecosystem solution rather than on the criteria of the traditional product-market industries. The ecosystem solution thus creates a new level of competition that transcends different industries and changes the dynamics in a sector. Examples for such disruptions abound in many contexts. Hotels and restaurants increasingly deal with platforms that help clients select, book, deliver and pay, rather than directly with their guests. Car producers face mobility solutions that combine different modes of transport and erode the need for clients to own a car. In B2B markets too, equipment producers are increasingly aware that digitalized production systems can offer higher value to clients than isolated components. Facing such pressure, ABB's new strategy is to focus on automation and digitalization rather than the production of equipment.

Developing appropriate strategies to counter this risk of disruption by ecosystem solutions is challenging for incumbents. Ecosystem solutions introduce a new playing field, with different rules than in the established product-centric industry. The traditional products often continue to play a role in the ecosystem, but their status can diminish because value resides more in the ecosystem solution rather than the product itself. A major challenge for incumbents is to perceive what changes to the competitive landscape the ecosystem will entail. What will be the scope of the solution, who will be the critical players, how will client behavior and spending shift with new revenue models, etc.? What are the strategic positions that will make the incumbent a leader or key player in this future ecosystem? Incumbents are not blind to these challenges. Consultants, researchers, and the press communicate in detail about the disruptive nature of ecosystems and the need for incumbents to radically change, focusing on platforms instead of products (Van Alstyne, Parker, & Choudary, 2016; Zhu & Iansiti, 2019).

An equally significant challenge for incumbents, however, is how to reflect these changes towards ecosystems in the organization, *i.e.*, how to develop the strategies, competencies, and relationships that are required to reach a leading position in the ecosystem playing field. The standard organizational response is to foster experiments in structurally separated units, to overcome the inertia and rigidity of the core business. Many incumbents have started to experiment with ecosystem solutions in new-venture departments, investing in start-up firms and entering alliances. This separation of ecosystem initiatives from the product business stems from a fear that the current products and the solutions of the future are fundamentally incompatible. Integrating them in one organization can lead to resistance, conflicts, resource misallocation, reduced innovative capacity, and myopia to new developments. While these are all valid concerns that can stymie ecosystem initiatives of incumbents, there are mounting signs that the ecosystem solutions and the original product can interact positively. Illustrating that point, in an ironic twist, are ecosystem firms that start to enter the industries of the product-focused incumbents they have attacked. Some recent examples include Amazon entering physical retail, Netflix producing movies, and software companies engaging in the production of autonomous vehicles.

I argue that incumbents should not neglect the power of their product business to create successful ecosystem solutions. Incumbents can complement and enhance their products with ecosystem solutions and thus transform their core business to remain successful and in control of their sector. Based on my multiyear work with a machine manufacturer, as well as many case studies and consulting projects, I propose a change model that can help incumbents' leverage their product business during the creation of an ecosystem solution (see table 4 for an executive summary). The focus of this section is *how* an incumbent can create an ecosystem to cope with potential shifts in the profit pool that could affect the original, product-focused business. To complement this perspective, I invite readers to combine this process view with complementary research on what strategies for a platform ecosystem provide competitive advantage (Van Alstyne *et al.*, 2016; Zhu & Furr, 2016), and how ecosystem competition differs from product competition (Zhu *et al.*, 2019).

The problem	The findings		
How can product-focused incumbents create ecosystem solutions and leverage their historical strengths in the new competitive playing field?	Incumbents should leverage the potential of their product business to create ecosystem solutions that enhance – rather than disrupt – the core business	Strategic change of the core business towards an ecosystem is guided by a scale-invariant logic, requires multiple cycles, and the recognition of learning patterns	Product business can help to define an ecosystem solution drawing on client access, to position the firm in ecosystem using market power, and to sustain a competitive edge with positive feedback loops

Table 5: Overview of managerial takeaways.

5.2.2 Accumulated learning to enhance the core business

My research indicates that to establish an ecosystem solution that enhances – rather than disrupts – the product business, incumbents need to engage in a process of accumulated learning to transform their core activities. Key elements of this process are a scale-invariant logic, strategizing cycles, and the recognition of learning patterns. For the change process to succeed, an incumbent must find a balance between deliberate and emergent strategizing, between shaping and adapting to external changes, as well as between building on historical strengths and transforming the organization. I label this process accumulated learning because it focuses on building on the core business and integrating new elements (accumulating), as well as on continuous change and creative adaptation to unforeseeable events (learning). I will elaborate on the three key elements in the next paragraphs.

(1) Successful incumbents **combine the ecosystem solution and product-focused activities with a scale-invariant logic.** A scale-invariant

logic means that the change trajectory follows a core idea that is valid on the historical product level *and* the new ecosystem level. To initiate such changes, managers need to identify characteristics of the product-focused core business that are applicable not only to the scale of the product, but also at the ecosystem level. The critical question becomes: What is the core strength than can be transposed from the core business to the ecosystem solution? The scale-invariant logic helps to align the product and the ecosystem strategy, because the core idea is similar – though not identical – at both levels. This similarity helps to avoid destructive conflict and resistance both within the organization and from clients. For CASTER, the identity as 'die-casting engineers' provided this coherence between the machine and the ecosystem solution. CASTER's employees and clients felt that the die-casting engineering competence from the machine business was compatible with the cell ecosystem. For instance, both required engineering and thermodynamic know-how and close collaboration with the client. They did not feel a threat or opposition between those levels, which led to reduced conflict and productive feedback loops. To engage in a strategy using scale-invariant logic, the understanding of an incumbent's current activities is extremely important. CASTER could have identified itself as a die-casting expert, automotive supplier, machine manufacturer, lightweight specialist… Each of these core ideas would lead to different trajectories with different solutions. Another example of a firm that combined product and ecosystem solution in a scale-invariant logic is Apple. Its core strength of ease of use design was coherent from products like iMac or iPod to ecosystem solutions like iTunes or the iOS.

(2) Even when managers envision a development path for the ecosystem strategy based on a scale-invariant logic, they must **enable and apprehend learning patterns that emerge** in the change process. Managers cannot rationalize the full impact of the ecosystem strategy ahead of its implementation, as unexpected positive and negative interdependencies will necessarily arise. Apart from the scale-invariant logic, many past assumptions

that are not valid at the new level and managers will often continue to rely on these historical beliefs. For CASTER, one of these assumptions was the revenue model focused on equipment sales, which worked well for machines but was difficult to implement at the ecosystem level. When encountering such problems, mangers should not easily abandon the strategic change, but enable learning. CASTER, for instance, persisted in its cell solution strategy even after initial negative client feedback. The additional time spent enabled CASTER to learn from its pioneering clients and adapt the value proposition. As many ecosystem solution initiatives are ahead of time (Cozzolino *et al.*, 2018), providing the necessary financial slack can allow the time for learning, both internally and in the ecosystem. To justify the necessary patience and hedge against failures, CASTER started to commercialize intermediary results of ecosystem projects. Employees and middle managers need to be flexible and empowered to interpret the firm's strategic priorities in their interactions with clients, for example through customization. The task of managers is to apprehend patterns that emerge in these learning processes. It is important that managers identify and integrate these learnings into new strategic priorities on a go forward basis – but only when local learning accumulates and patterns emerge, not based on idiosyncratic examples.

(3) Managers should approach the creation of an ecosystem solution as a **strategizing process with multiple cycles**. These cycles combine the deliberate strategy with the learning patterns that emerge over time. It is unlikely that all required information about the future ecosystem is available from the beginning, and that top managers can conceptualize and execute the accumulated learning process linearly. Instead, managers should seek to discover the final ecosystem strategy over multiple cycles. Each cycle introduces new strategic priorities, which proactively change the organization. After introducing the new priority, managers have to enable and recognize the learning patterns, as well as use them as a basis for a new strategic cycle when significant and compelling. Recognizing that there will be multiple cycles of

strategy making does not imply the organization is experimenting – every cycle is a commitment to a new strategic course. However, the commitment is subject to modification when learning patterns emerge. CASTER, in a first cycle, introduced the strategic priority of cell solutions. It implemented this strategy in-house and persisted even facing negative client feedback. Over time, CASTER's sales team and engineers learned how cell orchestration can be a more successful approach than in-house production, and managers changed the strategic priority to becoming an orchestrator – but also persisted with the cell solution objective. Introducing different strategic priorities in a next cycle does not mean the organization has reached a dead end with its past strategy, rather it should be viewed as the integration of necessary learning. Firms need to know more than their in-house activities to be a central actor in an ecosystem (Brusoni, Prencipe, & Pavitt, 2001), so even an abandoned strategic initiative can leave behind fertile knowledge that supports the development of new priorities. In a process of accumulated learning, each cycle builds on previous strategies to enhance the organization.

How can managers envision the approach of accumulated learning? Figure 7 schematically presents the mode of thinking underlying this change process. The wooden trunk represents the product-focus, based on which managers can develop a full treetop that represents the ecosystem solution. This development process follows a scale-invariant core idea that links the product 'trunk' with the many facets of the ecosystem solution (represented by a similar pattern at the level of the trunk and the level of the treetop). The initially chosen strategic 'branch', in cycle 1, will most likely not lead to the final solution. However, learning patterns in this cycle will help to initiate further development cycles to uncover more branches of the treetop, ultimately leading to an ecosystem solution around the product. CASTER created an in-house cell solution in cycle 1, using die-casting know-how as the scale-invariant logic. Learning that clients hardly adopted this in-house 'branch', CASTER shifted to an ecosystem leader role in a next cycle. CASTER now provides the solutions with a multipartner network, but continues to build on the die-casting know-how from the machine activities and the learnings from the in-house cell cycle.

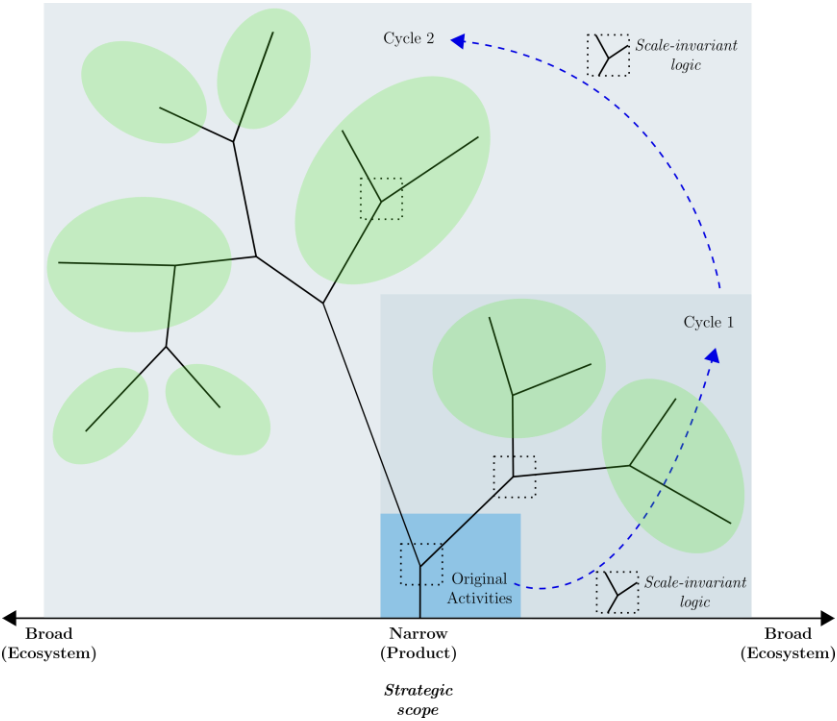

Figure 7: Schematic representation of the approach of accumulated learning.

5.2.3 *Leveraging complementarities between product and ecosystem solution*

With a successful process of accumulated learning, positive interdependencies between product and ecosystem can help incumbents during the multiple stages of creating an ecosystem solution. These stages are (1) identifying a relevant value proposition for the ecosystem solution, (2) positioning the firm in the ecosystem playing field, and (3) creating positive feedback loops between the ecosystem solution and the product. During all these stages, the traditional, product-focused core business can have a positive impact and help incumbents gain a competitive edge over rivals.

(1) Shaping and co-creating an ecosystem solution starts with **identifying the complex value proposition**, *i.e.*, a concrete vision of benefits (Dattée *et al.*, 2018), that will become the core of the new playing field. For the ecosystem solution to succeed, the value proposition has to be attractive to clients, but also to other players in the ecosystem. Managers have to understand and narrow down the countless potential ecosystem solutions that could emerge in their sector, as only a concrete vision will mobilize the organization around an ecosystem strategy. In this phase, incumbents can leverage access to their historical client base, to better understand the circumstances that clients face with the product on a day-to-day basis. Just offering a more comprehensive solution that expands the product, along the product lifecycle or purchasing process, is most often not enough to justify an ecosystem solution. Clients have to perceive a real need for the solution, hence it is unlikely that the first draft of the ecosystem value proposition developed without client input will succeed without modifications. We worked with a health care provider where managers were overwhelmed by the many potential solutions surrounding their wellness products, and failed to agree on an ecosystem strategy. The difficulty to envision the ecosystem in detail, however, should not discourage incumbents from starting ecosystem initiatives. CASTER initially focused its strategy on increasing productivity by comprehensively optimizing the value chain, but soon realized that clients did not sufficiently value such a generic improvement. By working with pioneering clients on solution prototypes, CASTER realized clients needed help to produce new types of parts and to close their employees' competence gaps. These issues were significant 'pain points' and provided a concrete value-add. One approach for incumbents to identify these pain points is to look for patterns among the service requests as these typically point to client needs

beyond the technical product features. Furthermore, many incumbents already have technological knowledge that can serve as a basis for the ecosystem solution and help to narrow down the range of potential solutions. For CASTER, it was the thermodynamic engineering know-how that helped to identify technically feasible cell solutions. Finding the ecosystem solution, for incumbents, thus consists of expanding client and technological knowledge in an iterative process to narrow down the options for value propositions.

(2) Once an ecosystem solution gains traction among clients and other actors, the product-focused core business can help to **reach a leadership position in the new playing field**. Becoming a key player in the ecosystem rests on the coordination and orchestration of partners, or the positioning in bottlenecks, *i.e.*, activities that are critical for the ecosystem to function. Ecosystem leadership does not always require creating a digital platform right away, and other options, like orchestration via inter-firm relationships, or bottleneck positions, might be (at least temporarily) viable alternatives an incumbent should not neglect. An incumbent can use its network and reputation to find partners and engage with them in the ecosystem creation process. The prominent position of the health care provider in its regional market enabled it to bring several players from other industries on board, who were interested in profiting from the potential ecosystem solution. An incumbent can also use its market power to force certain partners to align with its ecosystem vision. For example, CASTER could refuse access to the data of its machine to a rival ecosystem or a partner that is not compliant with critical aspects of its ecosystem.

(3) After the creation of the ecosystem solution, the **product business and the solution business can mutually reinforce** each other. Knowledge from the solution business, about clients and technologies, is useful to improve the product design. Products that are specifically adapted to the functionalities of the system, in turn, improve the quality of the ecosystem solution. CASTER used the knowledge about the entire die-casting process to improve the features

of its machines. Better machine performance, for example higher pressure, allows new types of ecosystem solutions for larger parts. Similar dynamics are in play at Netflix. The company uses data from its platform to learn about customer preferences and produce adapted entertainment, and the quality of the entertainment lures users who generate more system data. I argue that sustainable ecosystem leadership requires that the ecosystem leader's products live up to the quality of the system and mutually reinforce each other.

These positive examples of complementarities between product and ecosystem should not hide the many conflicts that can occur. An incumbent, whose focus of attention is the manufacturing of a product, can be myopic to new trends in the ecosystem, inertial when fast actions are required, confuse priorities for resource allocation, stick with past assumptions, experience resistance from the sales team, etc. When these potential conflicts are not properly addressed, incumbents can fail to build an ecosystem solution and fall behind new entrants or competitors in their sector. CASTER mitigated some of these issues by introducing an open strategy process, more cross-functional collaboration, and communicating the combination with strategy of "marrying" product and solution. It is possible for managers of product-focused firms to mitigate the sources of conflict, with the benefit of playing to one's historical strengths during the change process.

5.2.4 Implementing ecosystem solutions through accumulated learning

Incumbents need to respond to the challenges of ecosystem solutions, lest they risk losing control of the profit pool to new entrants or competitors. Drawing on the historical product business to facilitate a change process of accumulated learning should be one of the considerations of managers. However, not all firms can successfully embark on such a transformation of the core business. Conditions for a process of accumulated learning are, amongst others, a core idea in the product business that can serve as a scale-invariant logic, sufficient financial slack, and moderate or slow sectoral clockspeed. It also helps if the historical product is central in the clients' perception. When these criteria are met, incumbents can enhance their product business with ecosystem solutions and create mutually reinforcing relationships. Using a process of accumulated learning can help to transform the core business over time, integrating new priorities into the core business in multiple strategizing cycles. CASTER has successfully integrated its die-casting machine into an ecosystem solution. Other product firms are also working to enhance their historical business with system solutions, for example John Deere with agriculture solutions and ABB with industrial solutions. The successful combination of product and solution will determine whether these longstanding incumbents can remain successful key players in their sector.

6 Conclusion

The objective of this dissertation was to understand how incumbent firms can transform their product-focused activity systems to become ecosystem leaders. I contribute to the literature on ecosystems by introducing a complementary view of ecosystem creation as a process of continuous change, highlighting the historical embeddedness of ecosystem emergence. With my findings, I also contribute to the literature on organizational learning and change by identifying and detailing the process of accumulated learning. Managers of product-focused firm can draw on these insights to initiate active and gradual changes in the core business early on, to avoid disruption or radical transformation. Knowing when and how to utilize their core business should give incumbents a competitive edge to succeed in the ecosystem playing field.

My results are subject to a number of important limitations, in particular the generalizability of a single case study. My general argument for a process of accumulated learning closely follows March (1994: 45), who stated: “The idea is not that any imaginable organization can be designed and built but that natural developmental processes of organizational histories can be affected significantly by relatively small, timely interventions”. I encourage managers and research to think more about how such interventions, in a process of accumulated learning, can continually transform businesses and help to avoid radical change in crisis mode or disruption. Given the increasing importance of ecosystems in many sectors of the economy, the relevance of an empirically grounded understanding of ecosystem creation and its impact on firms has never been greater. I hope that this dissertation, despite its limitations, will contribute to the advancement of research in this area and inform managerial practice.

7 Appendix

Company	Detail	Interviews
CASTER	CEO	5
	Marketing and Product Development	12
	Research and Development	4
	Sales	2
	Application Technology	2
	Engineering	1
	Other	3
	Former employees	3
Clients	Medium-sized clients	2
	Large clients	3
Complementors	Product Manager	2
	Total	**39**

Table 6: Details about the number of interviews per domain of activity.

	STRATEGIC CHANGE…	…GROUNDED IN ACTIVITIES
Updating strategic beliefs	***Driving new strategic priorities…***	***…blended with historical assumptions***
(2) Re-focusing the strategy on the cell level	Shifting from machine focus to cell solution focus	Conceptualizing cell solution as an in-house engineering issue
(3) Abandoning prior in-house configuration	Deciding official end to in-house strategic initiatives	Little operational impact, maintaining some components requested by clients
(3) Continuing the solution provider strategy as an orchestrator	Implementing cell strategy through "Marrying machine and cell automation"	Reconfirming cell solution provider strategy, machine remaining core element
Intervening in activity system	***Developing activity system…***	***…and discovering interdependencies***
(2) Initiating in-house activities to provide the cell solution	Introducing cell engineering projects, selling complete cells, developing in-house components	Machine R& D overshadowing component development, solution targets clashing with technical problems and incompatibilities
(2) Struggling with client acceptance	Communicating the new strategy, educating clients through symposia	Discovering misfits with client activities as cell solution menaces competitive advantage
(3) Organizing to support the orchestration activity	Establishing cross-functional processes, strengthening product management and application technology department	Silo mentality and focus on machines slowing down orchestration
(3) Driving cell orchestration with modified client interactions	Interacting with clients on a strategic level, adapting value proposition from productivity to enhance value	Attracting clients for machines because of cell solution

Table continued on next page

Local learning	***Learning dynamics…***	***…within the context of the organization***
(1) Learning from increasing client service activities	Aiding clients that require assistance with issues that are not machine specific, but concern the cell	Responding with interventions and consulting from service, sales and R&D teams, "not leaving the client alone"
(2) Learning from pioneering clients	Discovering that new die-casting parts are more attractive to clients than efficiency increases	Drawing on interactions with new client group for large machines, building on engineering competence
(2) Solution provider strategy starts to align with emerging client issues	Realizing significant potential for cell solutions outside the historical core clients	Combining new geographies and client groups for machines with cell development, maintaining differentiation strategy
(2) Learning to build customized solutions	Customizing cells with partner components fulfills client needs better than in-house solution	Drawing on newly established engineering department, dealing with complex collaboration
(2) Learning to work with third parties	Integrating components with a professional partnering approach instead unstructured collaboration	Using machine position and reputation during partner search, preference for full control and financial targets hampering collaboration
(3) Learning from machine-independent innovation projects	Developing cell level innovation with machine-independent technology and revenue models, instead of "marrying" machine to cell	Equipment-focused thinking reducing creativity of business models, open strategizing diffusing into core business, *e.g.*, modular machine
(3) Learning to integrate partners with a digital cell standard	Standardizing open interfaces necessary to solve connectivity issues of cell solutions, instead of proprietary interfaces	Machine position aiding with finding partners and negotiations, fear of open intellectual capital hampering collaboration

Table continued on next page

Accumulating learning patterns	***Realizing accumulated learning…***	***…decoupled from intended strategy***
(1) Pressure in the machine business	Accumulating client experience with cell issues outside machine	Deviating from a strategy focused on machine differentiation
(2) Customizing decouples activities from strategy	Accumulating customization activities to develop client-specific cells	Decoupling from intended strategy to rely on in-house components
(3) Starting to compete as an ecosystem leader	Accumulating knowledge about cell level platforms and business models for ecosystem value creation	Shifting from “Marrying machine and cell” to a separation of cell and machine

Table 7: Examples of each sub-process of accumulated learning by cycle of change, numbering indicates position in CASTER case.

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