Continuity and Change in a Spin-Off Venture:
The Process of Reimprinting[•]

Simone Ferriani
University of Bologna
Management Department
Via Capo di Lucca, 24, Bologna 40126 (ITALY)
Email: simone.ferriani@unibo.it
&
Cass Business School
City University London
106 Bunhill Row, London, EC1Y 8BZ, UK

Elizabeth Garnsey
University of Cambridge
Center of Technology Management
Mill Lane, Cambridge CB2 1RX (UK)
Tel: +441223 338183
Email: ewg@eng.cam.ac.uk

Gianni Lorenzoni
University of Bologna
Management Department
Via Capo di Lucca, 24, 40126 Bologna (ITALY)
Tel: +390512098073
Email: gianni.lorenzoni@unibo.it

forthcoming in
Industrial and Corporate Change

Continuity and Change in a Spin-Off Venture:
The Process of Reimprinting

Abstract
Because new entrants very often spin off from established firms, their learning and capabilities are closely linked to their organizational and technological heritage. While this may provide an initial advantage, parental influence can generate inertia and resistance to change, unless the new company is able to unlearn inappropriate practices and create its unique competitive identity. The tension between inheritance and search for novelty is the subject of the paper. Building on an in-depth case study of Acorn Computers and ARM semiconductors we present a model of intergenerational learning and spin-off performance. Early parental influence is followed by intense learning , improvisation and response to feedback from the market. This we term *reimprinting*, to emphasize the enduring competitive and organizational identity established early on by the spin-off, which in this case provided the basis for disruptive innovation. Focus on the parent-progeny dyad as the unit of analysis can reveal micro-processes that reconstitute past experience to make possible both continuity and innovation in the spin-off venture.

1. INTRODUCTION

Radically innovative products and technologies are often developed and commercialized not by incumbent companies, but by entrepreneurial ventures. Contrary to the popular image of solo entrepreneurs starting from scratch and seizing venturing opportunities, many of these ventures trace their origin back to incumbent firms or academic institutions (Christensen, 1993; Klepper, 2001).

In current literature, spin-offs and spin-outs represent industry entrants that have a clear parental heritage (Klepper and Sleeper, 2005).[1] Because spin-offs are incubated within an organizational setting with established routines, practice, and culture, their learning trajectory and capabilities are closely connected to those with those of their parents. Spin-offs may also inherit from their parent companies blueprints (Klepper, 2001), in the form of routines, technologies and capabilities that are likely to shape not only the founding process of the new venture but its long term behavior and success. Thus, the parent leaves a lasting stamp on its offspring's development (Agarwal et al., 2004; Johnson, 2007) whether its founding takes the form of the departure of employees (spin-off) or the breaking off of a section of the previous organization (spin-out).

In recent years an increasing number of studies have drawn on biological analogies to describe the parent company and its influence on its progeny as a form of "imprinting" (Stinchcombe, 1965). These hold that the fate of the new entity is influenced by conditions at its founding and its initial characteristics. The inspiration for theories on organizational imprinting is the work of Konrad Lorenz (1970), who argued that imprinting in animals is irreversible. But just as organisms are not clones of their parents, so new ventures can differ from their parent organisation. New ventures of this kind need to deviate from their parents' trajectory to establish a unique identity and become self

---

[1] While the terms 'spin-off' and 'spin-out' both refer to a new entity with origins in a previous organization, the term spin-out usually refers to part of an existing organization being demerged to form the kernel of a new venture, while spin-off is used to refer to employees leaving a former organization to start a new venture, with or without endorsement. (De Cleyn and Braet 2009). Since both types involve employees leaving a parent firm, we use "spin-off" as the generic term, although our case study was deliberately formed as a spin-out.

sustaining (Klepper and Thompson, 2006). The tension between inheritance and innovation, between past influence and new identity, is explored in this paper.

While the new firm's organizational heritage may provide an initial advantage, it can also generate inertia and resistance to change, unless the new company is able to experiment and gain knowledge more consistent with its own domain. How does such an internal selection process unfold? How is the past assimilated as a basis for the future? How are inherited resources and capabilities combined to establish a unique advantage? These questions have not yet received adequate attention, as observed by Chatterji (2009).

While there is extensive research linking incumbents' initial conditions to their long-term performance (Cockburn et al., 2000; Helfat and Lieberman 2002; Cattani, 2005) relatively few studies have extended this approach to the parent-progeny dyad (Phillips, 2002; Agarwal et al., 2004; Chatterji, 2009). Most of these studies emphasize continuity between spin-offs and parents, so that little is known about the micro-processes that lead to the offspring deviating from its parent's trajectory and forming of a distinctive identity. We lack a more micro-level understanding of the organizational conditions under which inheritance processes occur. We also lack a clear understanding of the actual practices that are the object of such intergenerational transfer. For instance, in a study among Silicon Valley law firms by Phillips (2002), the transfer of capabilities and resources from parent to progeny is inferred from evidence on the migration of employees across organizations. It is however unclear which blueprints are retained and which are let go in the process. As Chatterji observes (2009: 201): "the existing literature…has hypothesized that spawns inherit technical knowledge from the parent but has rarely demonstrated it empirically". In this paper we adopt a focus on the parent-progeny dyad to shed light on the selection, transfer and absorption of knowledge and practices from the former to the new company. To this end we apply these constructs to an empirical case study, which informed our conceptualization. This is an inductive logic, but at the same time, key constructs derived from the literature guided our investigation, in an iterative inductive-deductive methodology.

We addressed these themes by conducting fieldwork at Acorn Computers (the parent company) and its spin-off Advanced RISC Machines (ARM). The choice of this setting had several advantages. First, both Acorn and ARM are unique in the history of European high tech industry. Though Acorn itself was not a commercial success and was eventually shut down, it gave rise directly or indirectly to more than thirty start-ups. These included ARM, which established itself as the most prominent European company in microprocessors design and a worldwide leader in low power consumption RISC-(Reduced Instruction Set Chip) based processor technologies. Given its long history as a highly innovative and R&D-oriented company and a breeding ground for new ventures, Acorn represented a rich context for evaluating the impact of a firm's existing knowledge base on spin-off performance. Moreover, as a result of the initial success of Acorn during the eighties and the subsequent dramatic take-off of ARM in the nineties, both Acorn and ARM received extensive media coverage over the last two decades. This has generated a large amount of secondary data that we were able to use in the analysis to complement the data we collected during our interviews.

Our process model of intergenerational learning and spin-off performance was inspired by the case evidence, in inductive mode, but informed by prior theory. This reveals how spin-off companies can selectively retain parental influences while developing idiosyncratic features, as a result of organizational learning initiated by new members of the organization and responses to feedback from the changing business environment. We term the transformation that thereby occurs in the new venture '*reimprinting'* because it has lasting impact and reconstitutes past experience to enable both continuity and change. Reimprinting in the new organization is a form of metamorphosis that provides the basis for evolutionary diversity.

The paper is organized as follows. We draw on prior work and our initial observations to construct a preliminary conceptualization. In the methods section we summarize the research design, the setting, and the data. We go on to focus on the case evidence to illustrate how ARM capitalized on its organizational heredity while departing from the practices of its parent, Acorn Computers. We identify key insights from the case evidence and refine our model of parent-progeny

transfer and spin-off performance. We conclude by discussing the implications for theory and practice of the study and its limitations and identify important topics for future research.

2. THEORY

In delineating our perspective on intergenerational learning we combine literature on organizational imprinting and founding conditions with ideas on the role of individual agency and deliberate learning in shaping the evolutionary trajectories of spin-off firms. We conjecture that reflexive agents may critically reconsider their organizational inheritance, as Popper argued in another setting (Popper 1976). It is necessary to filter out unwanted practices and routines and retain only those that are consistent with the demands of the market environment and new objectives; this is a key part of the process of reimprinting.

2.1. The structural imprinting hypothesis

Originally developed by Konrad Lorenz (1970) in the field of ethological sciences, the notion of imprinting is based on the observation that animals' early experience exerts a crucial and permanent influence on their subsequent behavioral patterns[2]. Lorenz's concept is a precursor to Stinchcombe's notion of organizational imprinting. Stinchcombe (1965: 155), described the significance of imprinting in the formation of new organizations as the remarkable stability of "certain structural characteristics . . . over time". Organizations, he argued, imprint and retain characteristics they were born with; they are products of the philosophy of their founders, and the conditions that existed at the time they were conceived.

   Over the last twenty years the notion of "structural imprinting" (Stinchcombe, 1965) has been a major source of inspiration among organizational ecologists (Brittain and Freeman, 1980; Freeman, 1986), and scholars in the sociology of organizations (Aldrich and Zimmer, 1986; Thornton, 1999).

---

[2] One of the better known examples of imprinting is a young goose who became imprinted on Lorenz after hatching. This took place during the period open to imprinting because she did not see the mother goose but Lorenz. Subsequently she accepted Lorenz in his role as mother and followed him as young geese do, all over his institute's premises.

This literature provides evidence of the formative influence of early choices, as well as some explanation of the processes that generate persistence. It holds that over time organizations sustain their commitment to early strategies, reinvesting their resources in employees with consonant skills; building sets of norms, practices and routines that promote the original vision; and refining policies to support the goals arising from their original strategies. Two main factors are suggested as accounting for the imprinting process: the initial conditions (Stinchcombe 1965; Kimberly, 1975) and the founders (Kimberly 1979; Schein 1983; Boeker 1988).

Initial conditions are important because when they are founded, new ventures often choose organizational templates that have proven effective (Ding, *forthcoming*). Later they tend to maintain the initial model to preserve legitimacy, resulting in the survival of organizational elements even after the social structure that triggered these elements has disappeared (Kimberley 1979; Sydow, Schreyögg, and Koch, 2009). Founders' influence occurs through the resources they deploy, and is based on their preferences and past experience. These resources, which include position in social networks, competences, mental models and other characteristics of founders, provide a nascent organization with opportunities and constraints (Boeker 1988; Nelson 2003) which persist even after the founder's departure (Hannan, Burton, and Baron, 1996).

2.2. Parent-progeny imprinting and spin-off performance

At a micro-level of analysis, a majority of new ventures arise from another firm. These new ventures trace their initial founding conditions to incumbent firms where they typically undergo a gestation period before entering the market. Spin-offs are prominent in several industries and account for a substantial portion of entrants. Example of industries where spin-offs are common include automobiles (Boschma and Wenting, 2007), lasers (Klepper and Sleeper, 2005), biotechnology (Stuart & Sorenson, 2003), legal services (Phillips, 2002), and semi-conductors (Braun & MacDonald, 1978). New ventures are imprinted, or otherwise started on development trajectories, based on circumstances surrounding their early years.

Initial conditions for a spin-off - the "available social technology" (Stinchcombe 1965) - can be largely traced to parent-level conditions. This is most obvious for spin-outs that originate as divisions of another organization, but spin-offs by employees also draw on their parent organisation's resources (people, technology, information, capital) in their early years and often undergo an incubation period before entering the market. When employees leave a parent organization to found a new spin-off venture, they walk out with blueprints consisting of unique insights and decision rules that they have developed from their previous experiences (Agarwal et al., 2004; Klepper and Thompson, 2006). Thus, whether the influence lies in initial conditions, or employees transferring blueprints and heuristics, the organizational forms of the spawning firm shape those of its spin-off, leading to persistence of templates, technologies and structures developed in the parent organization. Accordingly, as pointed out by Chatterji (2009: 195): "extant theoretical models have predicted that spawns will look like their parents in terms of the technology they develop."

There is some empirical evidence that supports this stylized characterization. For example, in Klepper and Sleeper's (2005) study of the laser industry, it is shown that nearly all the spin-offs initially produce a type of laser their parent had produced, thus suggesting that spin-offs exploited competencies inherited from their parents. Using evidence from the disk drive sector Agarwal et al. (2004) demonstrate that both technological and marketing know-how can be passed from parent to progeny. In a study of Silicon Valley's law firms, Phillips illustrates how movements align routines and resources across organizations (2002). A follow-on study (Phillips 2005) confirms this genealogical link, showing the parent-progeny persistence of gender hierarchies that founders transfer from their parent firms to their new firms. Gompers et al. (2005) also shows that spin-offs use knowledge and practices developed in the parent firm to exploit entrepreneurial opportunities.

This view emphasizes key features and properties that originate at the parental level and are subsequently inherited by spin-offs with a strong causal relationship between the quality of the parent company and the survival of the progeny. This suggests that "healthy" parents are more likely to spawn healthy progeny (Agarwal et al. 2004: 505). Because spin-offs from successful parents are

more likely to inherit effective routines it is argued that they will perform better than other spin-offs, and other start-ups. As noted by Dahl and Reichenstein (2005: 17): "Spin-offs with better performing parents are based on better routines, which positively increases their chances of survival". In contrast offspring from failing parent organizations should be less likely to succeed due to inheritance of faulty routines and inadequate resources, "progeny that arose in the wake of their parents' failure were more likely to fail […] rather than benefiting from the failure of the parent law firms, progeny assume the same resources and routines that led to the failure of their parents" (Phillips 2002: 502).

This literature has shed light on the continuity that characterizes the parent-progeny relationship, but with few exceptions (i.e. Klepper and Sleeper, 2005) it has left largely unattended the question of spin-offs breaking their parental mold, thereby developing their own sources of distinctiveness. Continuity may well be the norm, since changing course is costly and early practices quickly become taken for granted (Eisenhardt and Schoonhoven 1990). But a richer theorization of spin-off performance should also account for parent progeny discontinuity in order to explain, for instance, spin-offs which are on a very different strategic and/or technological path from their parents and account for successful offspring originating from failing incumbents. In fact, discrepancies not only exist but are important. Some research, for instance, indicate that spin-off entry is often triggered by internal conflicts and disagreement (Klepper and Thompson 2006). For example, Fairchild semiconductors was floundering when it spawned some of the firms ("Fairchildren") that were to establish the semiconductor industry in Silicon Valley. In a recent study on the medical device industry Chatterji (2009) demonstrates that most new ventures do *not* inherit technical knowledge from their parent. The author concludes that other, non-technical and less apparent forms of knowledge shape the parent-progeny relationship. Moreover, replicating parents' products is a competitive challenge and may evoke reprisals that can be avoided by developing complementary technologies through speciation (Garnsey, Lorenzoni and Ferriani, 2008).

These stylized observations suggest the need for a richer theorization of the relationship between spin-offs' development trajectory and their imprinted influences. The challenge is to show

how spin-offs establish their own idiosyncratic capabilities while at the same time building on parental experience. In the present analysis, a critical step was the adoption of a *dyadic* process-perspective in the analysis of the spin-off. Unlike research that predicts progeny performance from traits of parent organizations, or alternatively examines the progeny's performance without identifying parental antecedents, a dyadic perspective reveals the sequence of events as they unfold and shape each other.

Our case history highlights the role of three crucial learning factors in counteracting past influences and contributing to the unique development of the spin-off: (1) the role of critical events in triggering organizational learning and revision of the firm's business model, (2) the role of new entrepreneurial agents who are able to offer new thinking on emerging opportunities, and (3) the role of the user environment and market feedback in shaping the strategic and technological direction of the spin-off.

3. METHODS

3.1. Research approach

The conceptual ideas discussed here evolved as we moved from the study on Acorn to the study of ARM (and its relationship with Acorn). This trajectory was partly intended and partly emergent. It started in the late 80s, when the second author became interested in the rapid growth at Acorn, a young technology-based company founded in Cambridge in 1979. The focus of this research was on processes of organic growth and knowledge creation in innovating firms (Fleck & Garnsey, 1987; Garnsey & Fleck, 1988). Other issues emerging from earlier interviews and data later drew our attention. First, the range and depth of competence developed at Acorn made it possible for former members to start many local spinoffs - early examples include IQ Bio (1984), Qudos Technology (1985), Harlequin (1986), IXI ltd (1988), etc. Second, the entrepreneurial influence that the originating company had on its progeny was very strong, translating into a variety of technology companies drawing on know-how developed at the parental level. These observations resulted in an exploration of the cluster dynamics of entrepreneurial spin-offs (Garnsey & Haffernan, 2005).

Meanwhile in 1997 we had started an in depth study of ARM, the most successful spin-out from Acorn, in order to probe deeper into the parent-progeny relationship. It was at this point that we began to look at literature on spin-off formation (Garvin, 1983; Brittain and Freeman, 1986; Kelepper, 2001) and organizational inheritance (Huber, 1991; Baum and Singh, 1994). We were interested in better understanding the genealogical lineage linking parent to progeny. Stinchcombe's notion of imprinting (1965) was especially pertinent. The idea of reimprinting arose in relation to the metamorphosis of ARM, which preserved distinctive traits inherited from its parent Acorn, yet had its own specific and enduring traits and strategic priorities (Garnsey, Lorenzoni and Ferriani, 2008). Interviews at Acorn, conducted in the context of the first studies, inspired the subsequent inquiry and provided understanding of the conditions under which intergenerational learning occurred. Early interviews were treated as secondary, historical evidence, in contrast with recent interviews at ARM conducted with the comparison in mind. Early evidence remains highly relevant to the comparison and has the methodological advantage of being collected in real time, free of retrospective bias. Table 1 provides a chronological account of these data in relation to the events under study for the parent and progeny company

Table 1 here

3.2. Methodological Rationale and Evidence

We aimed to develop process rather than variance theory: that is, we were interested in "describing and explaining the temporal sequence of events" involved in change (Van de Ven and Huber, 1990: 213) rather than in identifying relationships between dependent and independent variables at points in time. Thus, the case study method, which involves tracing processes in their natural contexts, appeared most appropriate (Pettigrew, 1992). Case studies provide insight into constructs and relationships unobtainable without rich qualitative evidence. Siggelkow notes that "getting closer to constructs and being able to illustrate causal relationships more directly are among the key advantages of case research vis-à-vis large sample empirical work" (2007, p. 22). A single case history

can be justified to inform a conceptual framework and guide further inquiry. It is not claimed that such a case is representative, but rather that it offers evidence of theoretical and empirical significance. Indeed, "… it is often desirable to choose a particular organization precisely because it is very special in the sense of allowing one to gain certain insights that other organizations would not be able to provide" (Siggelkow, 2007, p. 20). Key contributions to management theory have been based on single case studies (e.g. Weick, 1995; Penrose 1960, Schein 1992).

Qualitative research of the kind presented here draws on the inductive tradition (Van Maanen, 1983). Primary evidence from face-to-face interviews are particularly valuable when they are from individuals who can offer understanding from their own experience. To guard against retrospective bias, it is however necessary to check testimonies against secondary evidence obtained from archives, company documents and press reports. Here case evidence was gathered through primary semi-structured interviews. Triangulation was then conducted through secondary and archival data research so the case studies drew on multiple data sources. Documentary sources included internal documents and press reports. We collected archival data from research literature and internal documents on Acorn and ARM, including yearly company reports and a detailed internal newsletter issued quarterly by Acorn between January 1990 and August 1993. Additional data were obtained from industry publications, financial analysts' reports, and press reports about Acorn and ARM. Other sources provided background information on the role of Olivetti in rescuing Acorn from the financial crisis that had befallen the company in the mid '80s (Ciborra, 1994; Piol, 2005), on the career histories of Hermann Houser and Robin Saxby, founder of Acorn and CEO of ARM respectively (Langdon and Manners, 2001) and on the technological transition that marked ARM as providing the leading architecture in the low power consumption embedded processors (Atack and van Someren, 1993). We also built extensively on contemporary evidence and accumulated source material on Acorn and ARM dating back to the late 80s and early 90s. We

used these sources to cross check interview data and control for biases in retrospective accounts of past events.

In contrast with documentary records, interviews allow a greater degree of understanding of why events occurred and participants' feelings about them. Over 30 interviews are drawn upon, each 1-3 hours long, most were taped and transcribed (for details, see Tables 1 and 2). We interviewed at multiple levels of the organizations, often on several occasions. Informants were from different functional areas and had made crucial decisions and critically shaped the genesis and development of the two companies. Some of them only contributed to Acorn or to ARM while others were directly involved throughout the gestation and spin-off. This mix provided us with personal accounts by individuals who experienced the process at different points in time and from different vantage points. Our goal during these encounters was threefold: First, we were interested in understanding the knowledge conditions conducive to the creation of a new company. We therefore asked informants questions about the general context in which research was conducted and knowledge managed inside Acorn. These questions helped us characterize the internal "selection environment" at Acorn. Second, we were interested in tracking the origins of the entrepreneurial opportunity leading to the foundation of ARM. Accordingly, our second set of questions dealt more specifically with "how" the RISC[3] technology was encountered and the choices that were made in order to pursue it. We sought to understand the motives behind the spin-off decision and the links between such motives and the competencies developed at Acorn. Third, we wanted to identify ARM's inheritance from Acorn and its subsequent ramifications. To this end we asked informants to identify the key traits of the ARM business model and technological base, and to reflect on the role of initial conditions and antecedents in shaping the spin-off entry process and performance. The interviews were structured around these general questions but allowed the interviewees choice of

---

[3] A Reduced Instruction Set Computer (RISC) chip is a microprocessor that is designed to perform only the most common types of computer instructions, so that it can operate at a higher speed. By using only the most common instructions, RISC chips can perform the majority of tasks more efficiently.

emphasis. Table 2 summarizes the people interviewed by role within Acorn and/or ARM and specific year of interview.

<div align="center">Table 2 here</div>

This abundance of sources, repeat interviews and the opportunity to track events as they unfolded over time helped reduce the risk of retrospectively imposing meaning on events from knowledge of outcomes (Golden, 1992). The archival data were also used to guard against memory failure. Finally, to ensure construct validity, we shared our findings with 3 key informants (the founder of Acorn and two co-founders of ARM) to gain feedback and corrections from them (Seale 1999:62).

3.3. Data Analysis

We structured our methodology using a *temporal bracketing* strategy (Langley, 1999). This strategy involves decomposing the chronological data for the parent and progeny cases into successive discrete time periods, or phases. Phases are defined so that there is continuity in the activities within each period but discontinuities at their frontiers (Langley and Truax, 1994). The boundaries of the three chosen periods were defined either by changes in governance structure or major changes in the institutional context associated with the spin-off event. As pointed out by Langley (1999 p.703): "Beyond its descriptive utility this type of temporal decomposition also offers interesting opportunities for structuring process analysis and sensemaking" Specifically, these phases allow the constitution of comparative units of analysis for the exploration of theoretical ideas (Denis, Langley and Cazale, 1996). Within these phases data were used to describe the processes as evolving patterns and show how actions in one period affect action in the next (Langley, 1999). In this case, the three most important categories that emerged were (1) the founding context in the parent company, (2) the events and actions that led to the spin-off decision, and (3) the metamorphosis of the spin-off as it established its own identity. During analysis of the evidence, revision of the theoretical ideas, and iterative return to the data, these categories were refined. All the authors engaged in the analysis.

4. FINDINGS: ARM'S GENESIS AND DEVELOPMENT

The transition from Acorn to ARM and the underlying key events and decisions could be understood in terms of three sequential, partly overlapping phases. The first phase (1978 – 1985), coincides with the initial years at Acorn, when the company accumulated technical know-how and established an organizational culture strongly dedicated to technical excellence. In this period Acorn first came across Reduced Instruction Set (RISC) technology and started to learn about its potential. This phase highlights the parental conditions for spin-off. During the second period (1986 - 1990), events occurred at Acorn that led to the decision to spin out the new technology and to set up a new venture. ARM acquired from its parent the RISC technology together with distinctive cultural traits and complementary resources. The crisis looming at Acorn and the arrival of new external investors also triggered the abandonment of inappropriate practices from the parent company and new efforts to learn what was consistent with the emerging strategic agenda of the founding team. During the third period (post 1990), ARM's technological know-how in RISC processors was combined with the competencies of a new CEO coming from a different environment and with strong marketing experience. He had to adapt to conditions different from those envisaged for this joint ventures. Continuity together with new impetus shaped the emergence of a radically new intellectual property and partnership-based business model. This fueled new investments and innovations, and set the spin-off on a highly idiosyncratic competitive track. In the following section evidence is presented demonstrating these unfolding processes. We then reflect on this evidence to develop inductively (albeit informed by the literature outlined above) a process model of parent-progeny influence and spin-off performance.

4.1. Founding conditions: Acorn Computers

In 1978 Herman Hauser, a PhD in Physics at Cambridge University, founded CPU Ltd together with Chris Curry to pursue the opportunity for a low cost micro-computer that would be very powerful by the standards of the time. Hermann knew how to find the people who could design a

high performance machine rendered affordable by low overheads. Chris Curry during his years at Sinclair had learned the benefits to a start-up company of the mail order business model which required minimal capital. The novice entrepreneurs invested only £100 in their new company and in 1979 and used the income from their design-and-build consultancy CPU to finance the development of a 6502-based microcomputer system. This system was launched in January 1979 as the first product of Acorn Computer Ltd, a trading name used by CPU to keep the risks of the two different lines of business separate. Acorn was at the forefront of micro-computer ideas because it was able to utilize expertise from the Computer Lab of the University of Cambridge.

In 1981 Acorn was placed on the list of companies invited to tender for a BBC contract which would allow the selected computer to carry the BBC emblem in return for royalties. There was a visit from the BBC at the start of a week to look at their designs which were viewed as promising. Hauser succeeded in persuading a group that included Sophie Wilson and Steve Furber, to build a working prototype in four days, in time for the next meeting about the BBC contract. He says he did this by telling each of the team members that the others thought this was possible. Together they achieved what they individually thought to be impossible. As recalled by Steve Furber:

> *"I built the first prototype by hand and Sophie looked at it and said 'I could do better than that!' and went away and did so. I thought the System 1 was entirely designed over an Easter vacation…. I do recall that Sophie produced the monitor program by hand (hand assembly of 6502 code), we blew it into a PROM and it worked straight off. There may have been a minor bug or two but basically it run first run, previously untested" (Electronics Weekly, 29 April 1998).*

The favorable report of the BBC's technical advisors and energy of the young team with its strong university connections led the BBC group to select Acorn's prototype as the demonstration model for their computer literacy series. Acorn's reputation grew with their innovative R&D and high quality standards. New product design and development were a priority. Creativity was viewed as a strategic need, the view being that a leading company had to be ahead of its rivals on as many fronts as possible. In the early 1980's the company was developing products which were very new at the time but to become familiar ideas ten years later, including modems, other telecommunications products for satellite and cable broadcasting, interactive video and an operating system to rival

UNIX (*The Guardian,* March 8, 2001). Despite Acorn's eagerness for technical excellence, it soon became apparent that too many senior managers were more interested in technology than in the day-to-day mechanics of running a business. Few projects developed into marketable products, and few of those produced sold well. Yet, this propensity toward experimentation and inventiveness remained over the years as a distinctive trait of Acorn, turning it into a power house of potential innovations.

In 1983 Acorn was growing fast and the founders sold 10% of the company on the stock market. In order to prevent any further delays in the launch of the Archimedes, the next generation computer, a group responsible for chip design was set up in late 1983 with the task of identifying new microprocessor designs to replace the existing 8 bit 6502. Yet none of the existing architecture seemed to fit with Acorn's vision:

> *"We looked at National's 16032 and Motorola 680000 but they did not suit our design style. They had very complicated instruction sets giving poor interrupt response. Basically they were too slow."* (Herman Hauser, interview)

Hauser decided to give the R&D group free rein, despite having no resources to offer them, to create their own 16-bit chip for the Archimedes computer. At that time, starting from scratch to design a 16-bit microprocessor *"would simply appear insane to most of the people in the microprocessors business"* (Herman Hauser, interview)

Yet, the design team was enterprising enough to get themselves to the Western Design Centre in Phoenix and discover that other small teams were designing their own chips using early RISC techniques pioneered at AT&T.

> *"We knew that it had taken National 200 years of development time for the 16032 and Acorn could not afford that – we only had 300 people at the time", recalls Furber, "then we came across the Berkeley RISC. A group of graduate students had built a microprocessor with only a tiny percentage of the resources used by National. It was simple, it addressed the interrupt problem and it seemed something worth looking at"* (Electronics Weekly, 29 April 1998)

Once again Acorn proved it could meet extraordinary technical challenges and create new competencies from scratch. Whereas IBM were simulating RISC instruction sets on powerful mainframe computers, at Acorn, Steve Furber, Sophie Wilson and their small team of engineers

managed to designed a RISC chip using their native wit. Having limited resources and a limited group of people they succeeded in coming up with a highly efficient architecture which capitalized ingeniously on their previous core technology. As explained to us by Andy Hopper, chief technologist in Acorn:

> *"One of the reasons it is very low power is that we had no idea how to do it … We wanted it to go into a plastic package because that's much cheaper than a ceramic package and there were power limits so we did everything we could to minimize power. Not because we had this far sighted view that we're going to be the portable products of the future. It was small because we kept it simple. It was essentially reusable because we were a very small design team with no resources and we had to reuse our own core design".*
> (Herman Hauser, interview)

Having learned how to build an entire computer system, Acorn had generated know-how in all computer specialties, including silicon chip design, operating system design, computer architecture and local area networking. The first sample of Acorn's RISC Machine,, subsequently Advanced RISC Machine,(ARM) was delivered in 1985 and was manufactured by VLSI which also gained the right to sell chips using Acorn's new chip design.

The ARM microprocessor emerged in a period when Acorn was experiencing financial difficulties. The main problem for Acorn since its inception had been increasing output to meet demand. The Electron model had been launched in 1983 but problems with the supply of its ULAs meant that Acorn was not able to capitalize on the 1983 Christmas selling period. A successful advertising campaign, including TV advertisements, had led to 300,000 orders but produced was outsourced and the suppliers were only able to supply 30,000 machines. During 1984 production reached its anticipated volumes, but, unexpectedly, a consumer downturn set in (Fleck and Garnsey 1988). By January 1985 one third of the Christmas stock had remained unsold; sales were about 35% below the April forecast and the pressures on Acorn made it necessary to cut staff numbers from 450 to 250 by early in 1985. Suppliers' demands for payment became pressing and by early February 1985 a winding up petition was issued. Acorn had to cease trading.

4.2. Learning shift: Acorn crisis and spin-off decision

When Acorn was unable to find any British company willing and welcome to help them to sustain operations, Elserino Piol from Olivetti made an unexpected approach. On February 20th, 1985, after a short period of negotiation, Curry and Hauser signed an agreement with Olivetti giving the Italian computer company a 49.3% stake in Acorn for £12 million. The money went some way to covering Acorn's £11 million losses in the previous six months. Sales targets were agreed, which depended on Olivetti distributors selling Acorn stock. This did not occur. Distributors were attributing the fall in sales of Acorn computers to their proprietary operating system which was not compatible with the emerging industry standard, DOS. When Bill Gates had offered a license on favorable terms, Hauser had rejected the idea of moving to an inferior operating system and a different microprocessor because he saw the RISC chip as the critical competence at Acorn. His foresight was to apply to ARM, not Acorn, where sales targets were missed over the summer of 1985, and a second round of refinancing was eventually implemented. In September 1985, Olivetti took ownership of 79% of Acorn. They paid under £15m for the company, which had been valued at £100m in the previous year.

In accordance with Olivetti's innovation policies, Acorn had originally been acquired to gain market share in the UK and a strong foothold in the education market. After the acquisition, both of these objectives lost their importance because of the very troubled financial situation of the company.   However, it came as a surprise to Olivetti that Acorn's labs contained a wealth of people, skills and on-going projects that turned out to be of strategic relevance, putting the company on a new track, at least as far as corporate R&D was concerned; more precisely, they envisioned for Olivetti the option to be a world leader in workstation technology instead of just being a follower of IBM (Ciborra 1994)

The key issue in Acorn was to realize a transition from independent company to subsidiary and benefit from Olivetti's international distribution network and resources. Yet, Olivetti's own financial performance in 1987 was disappointing and pressures on Acorn to keep out of the red increased. In 1988 Olivetti started pursuing several avenues to sell Acorn's core technology:

"The first option was to sell it internally but Olivetti was already using Intel; then we tried to sell it to ST Microelectronics, but they were already linked to another chip manufacturer, then we approached Siemens, but they became skeptical because we were using Intel rather than ARM, at some stage we also approached Larry Ellison but he declined too" (Elserino Piol, personal interview).

By late 1980s it became clear that the great potential of the ARM micro-processor was being stifled within Acorn and that integration with Olivetti's product planning branches was not forthcoming. At the same time most computer companies were unwilling to buy a microprocessor that was owned by a competitor.

In that period Apple was defining a new architecture for handheld devices, known as "Newton", and prototyping the first products to feature this new hardware and software architecture. Apple believed there would be a market for the "personal digital assistant" (PDA) amongst the traveling business community. Having concluded that the ARM chip design was powerful enough to be portable, the Apple Vice President of Advanced Projects Group, Larry Tesler, then played a key role in initiating the launch of an independent company to develop the full potential of the ARM technology. John Stockton at VLSI Technology was also instrumental in initiating ARM's foundation. VLSI had licensed the first RISC designs from Acorn and could see the potential to extend their applications. After intensive interaction by Acorn managers and Board members, backing for the decision to spin off ARM in 1990 was obtained from Olivetti. A joint venture was undertaken with VSLI and Apple Computers. The new company was now free to fully leverage the extensive expertise it had inherited from Acorn, where the market potential of the RISC microprocessor was inhibited by the many organizational and competitive pressures. As the current managing director Sam Wauchope explained in the wake of the spin off decision:

"It is a bit of a wrench to separate what has been an integral part of Acorn, but we have decided that ARM and Acorn are best served by the creation of a separate company. The deal opens up many possibilities in terms of product development which we probably would not have been able to afford." (personal interview).

The bulk of the Advanced R&D section of Acorn that had been developing the ARM CPU for seven years and was composed of 12 engineers formed the basis of ARM Ltd when that company was founded in November 1990. Thus, at start up ARM had already benefited from

several years of incubation and experiments aimed at turning a generic technology (RISC) into viable applications through suppliers' feedbacks and interactions between Acorn, Apple and VLSI. The new venture started up with the technical expertise required to design the processor. ARM's initial business model involved partnership with Acorn and Apple as clients, and VLSI providing the manufacturing capability. The initial business idea was to replicate externally what the group had previously been doing in and for Acorn. However, they were now free to approach other computer manufacturers, who could implement the ARM core without the fear of using a component controlled by a competitor (Acorn Computers) who could block them out. While this seemed the logical and easiest avenue to pursue, ARM had also learned important lessons from the mistakes that led to the downfall of Acorn. Acorn's major problems had always been production volume and lack of market focus. The proliferation of promising research projects with no market follow through had demonstrated the crucial importance of establishing tight links with customers and listening to their needs before venturing into costly innovation. As ARM's co-founder and formerly leading engineer at Acorn Tudor Brown pointed out:

> *"Acorn was not a well run company. It didn't pay attention to the market […] to me the most obvious mistakes was that creating technology by itself, even very good technology is completely useless. […] It's how you capitalize on that which makes the difference. This to me was the most important lesson"* (personal interview).

Moreover, Acorn had been insisting on maintaining proprietary systems when it was becoming apparent that in order to compete successfully in the computer industry, firms had to aim for compatibility and open standards. Attempts at exporting Acorn's products had achieved limited success, and had failed in the US (Fleck and Garnsey 1988). As ARM's CEO noted:

> *"The lesson had been learnt from failures at Acorn that, in order to succeed, a product had to succeed on the world stage and to do that, it had to become a global standard, which meant it had to be used by many companies."* (Langdon and Manners, 2001: 121).

These factors suggested the need for a critical revision of strategic direction. ARM's learning process benefited from these lessons, which was soon mapped onto a radically new business model.

4.3. Incubation and metamorphosis: The development of ARM

With ARM established as a new company, the team set about recruiting a CEO with the right skills. From his 12 years career with Motorola in the US and South East Asia, Robin Saxby brought new kinds of experience to ARM. In addition to a mix of technical and marketing expertise, Saxby's infectious optimism gave the joint venture with Apple high hopes. With significant experience in the industry, Saxby immediately sought to gain leverage fro the company's very limited resources. From his first involvement with ARM, Robin Saxby recognized the importance of managing relationships. Before accepting the job as managing director he arranged to meet the twelve engineers from Acorn to establish a rapport with them. Within the company Saxby quickly developed an open culture. He played an active part leading weekly management meetings and, right from the start, he involved everyone in ARM in identifying its strengths and weaknesses.

Compared with the capital investment of $2-3 billion that a silicon wafer factory requires, ARM's resources were laughably modest. But although fabrication was clearly not an option, there were other ways of entering the microprocessor market. Jamie Urquhart, one of the 12 founders, explained how he, Saxby and other two members of the early team conducted a SWOT analysis that made the case for ARM to become an IP company:

> *"We got everyone into one room and reviewed the options. We had already successfully licensed technology to VLSI. So we built on strengths we had. We also avoided weaknesses – no expertise in the company in the backend product/shipping logistics required in a chip business."* (personal interview).

Other companies had already taken the IP route by becoming "fabless" chip companies contracting out the manufacture of their chips. ARM took this one step further and decided that they would be a "chipless, chip company". As a pure intellectual property firm, ARM would license its chip designs to semiconductor companies. But while ARM original business plan had been to capitalize on its members' consultancy expertise, licensing this technology to Acorn, Apple and

VLSI, Robin Saxby ramped up this model with the strategic goal of making ARM's RISC chip design a global standard.[4]

Partners would take the ARM enabling technology, add their own application specific technology to it, and use their silicon plants to manufacture the chip. To pursue this strategy ARM had to develop new relational capabilities that were not in the repertoire of its founders. Given the scarcity of resources, rather than recruiting specialized marketing personnel, Saxby chose to promote three of the twelve Acorn engineers to positions of sales and marketing. He believed that it was quicker and easier to teach engineers to sell than teach salesmen to understand ARM's complex technology. He hired a part time external consultant to train his team in sales and customer management. As one of the founders told us:

> *This guy taught us the SPIN approach [Situation, Problem, Implication, Need-payoff] Essentially the first thing you do with a customer is you work out the Situation. How big is the company? How many chips do you design? How many chips do you manufacture? Then the P is problems. What sort of problems exists? Because getting a customer to take your product, if there are no problems - it is very difficult [...]. And they had problems because they had to design a different chip for every different application (it) goes into. A number of people went through that training and we were speaking a common language internally [...] The culture was to learn and to understand, to assimilate and to see what works.* (personal interview).

The combination of deep technical know-how and a learning attitude allowed ARM to set out on a new developmental course in a very short span of time. In November 1991, ARM launched its first products, the ARM6 family of chips including the ARM600 power efficient microprocessor, at the Microprocessor forum in San Francisco. VLSI Technology offered to manufacture the new processors customized to users' requirements. During this first year of operation, ARM focused on its immediate source of revenue from licensing agreements. In January 1992, ARM announced that GEC Plessey Semiconductors (GPS) had become their first independent licensee to manufacture ARM chips and incorporate ARM features into application-specific microcontrollers. ARM now had their first independent partner with whom to work on the basis of the licensing model. The

---

[4] As explained to us by Saxby: "To be the world standard, we had to get partners everywhere in parallel. And to get partners everywhere in parallel, we had to license the technology many times. That's the order of thinking".

relationship with Plessey turned out to be a source of learning opportunities. As a former Design Manager at Plessey (now Principal Staff Engineer at ARM) explained to us:

> *"At Plessey we were looking around for a micro processing core and then […] we picked ARM […]. The thing that was different about ARM was that they were not just providing a core technology […]. They were also excellent listeners […] they were willing to learn because they knew we were on the same boat. So they said to us, 'We've got this core. It must be useful to people for something. We don't really know how you might want to use it but we're prepared to work with you to understand it." And I think it was so refreshing from our point of view because, at the same time, we knew we needed a core, and we didn't know how to do it. We knew there were more questions that we knew answers to but didn't know what the questions were[…] It was a teacher-student thing."* (personal interview).

Saxby and his colleagues concentrated on the 'brain' side of the chip business", and at the same they made sure their company also benefited from a deep understanding of manufacturing 'muscle' by establishing a very strong, customer-oriented approach towards its licensees.

> *"We need to have an intimate understanding of the manufacturing process and work with our partners in areas like test, de-bug, yield and performance enhancement […] We really treat our customers as partners involving them in agreeing specifications and taking joint risk and benefit on projects."* (personal interview).

Saxby also introduced a new business discipline to the group that had previously worked in the unstructured environment of Acorn. As one of the founders stressed:

> *"He (Saxby) can be very structured…So every year, we would have business plan. We would have strategy review, an operational plan and a tactical plan. And these were not huge documents, but they were important documents. They were important in that they built on what we had been learning. They aligned everybody in the right direction. They gave us focus and made us challenge what we were doing."* (personal interview).

A strategy of frugal design and a frugal business model, focused on gaining maximum value from available resources to deliver the technology and nurture key relationships, proved to be very effective. ARM became self-sustaining by only its second year of operation, without the need for further financing. In 1993 Sharp became the third licensee to manufacture and market ARM processors. As experience increased, ARM offered further services to its clients such us consultancy, feasibility studies, training and prototypes supply. The extent of learning and experience that ARM was able to gain through these partnerships was dramatic.

In May 1993 when Texas Instruments took out a license ARM's business strategy as an independent chip designer was endorsed by another major player. After Plessey and Sharp, this was the first licensee not signed up through Apple's established contacts. TI pushed the boundaries of ARM's contractual discipline further and provided additional learning opportunities:

> *"TI imposed us new level of discipline. Contracts would contain all of the deliverables; they'd have all of the timing specified. They were very professional and it was hard. They were demanding but they taught us a great deal in terms of helping to regularize the set of deliverables that we would then license on to our licensing partners."* (James Urquhart, personal interview).

At the time, TI was trying to win mobile phone business as supplier to Nokia. TI had deep expertise in one of the key technologies required, Digital Signal Processing (DSP), but they needed a CPU design that would work reliably in the background, use minimum power, and be well supported with design tools, models and applications. Based on this platform, they could focus on making a chip that was uniquely attractive to Nokia. Nokia came back with a list of problems: the ARM processor needed too much memory because the software code was too large, making it too expensive. But Nokia also recognized that there was no other product on the market that provided the required performance and that the solutions to these problems were not obvious. ARM was breaking new ground.

In response to Nokia's feedback ARM worked with TI to set and then meet ambitious targets for power consumption and code size. The outcome was a significant innovation that became known as the "Thumb" architectural extension. By creating a subset of the most commonly used 32-bit instructions, ARM's engineers found they could compress these into smaller 16-bit code without any reduction in performance. The endorsing effect of TI and the growing success of Nokia benefited ARM, attracted increasing numbers of licensees and fueled growth and innovation. After a decade of expansion, ARM had, by the end of 2001, 65 partners located in Europe, the US and Asia and about 800 employees. Four years later it had market capitalization of £1.6 billion and with

ARM chips in an estimated 77% of the embedded RISC processor market, ARM's chip design had become the de facto global standard.

ARM's new business model distinguishes it from Acorn, but at the same time the technical standard developed at ARM has a lineage tracing back to its parent. This interplay between imprinted know-how and the new organizational impetus shaped ARM's further development. ARM inherited from Acorn Computers a preference for what may be called frugal design, on an analogy with frugal engineering, which is "…an overarching philosophy that enables a true "clean sheet" approach to product development. Cost discipline is an intrinsic part of the process, but rather than simply cutting existing costs, frugal engineering seeks to avoid needless costs in the first place." (Sehgal et al. 2010.2).[5] This was the hallmark of RISC chip engineering at Acorn, inherited by ARM, and complemented by the development at ARM of a frugal business model built around the licensing of IP through partnerships in order to generate maximum value from limited resources and to retain customers by providing design and support services. This novel business model, ,the outcome of choice and necessity, became the hallmark reimprinted, as it were, on ARM.

Technology and business models which economise on resources to provide new solutions for customers (who are often in new market segments) based on close understanding of their needs, may disrupt the existing terms of competition and shift demand onto a new basis (Christensen 1997). A form of disruptive innovation which was achieved by ARM's technology and business model as the outcome of imprinting at Acorn and reimprinting early on at ARM.

---

[5] Though frugal engineering is a term applied recently to technologies for bottom of pyramid markets, it is an approach that can be found wherever resource intensive solutions are rejected in favour of economy of design and materials.

5. A STYLIZED MODEL OF INTERGENERATIONAL LEARNING AND SPIN-OFF PERFORMANCE

Our process model, illustrated in figure 1, begins with parent's imprinted influences and ends with variations in the spin-off's likelihood of developing its own idiosyncratic trajectory. The new model enriches previous conceptualizations of spin-out by highlighting how reimprinting takes place through the impact of a new set of influences on the venture that have enduring effects and modify (but do not erase) the influence of the initial imprinting process in the parent organisation.

Figure 1 here

The processes of imprinting and reimprinting roughly map onto the stages in which we have divided the case evidence. In stage one, the parent company develops its own distinctive blueprints. The culture, resources and routines that crystallize during this phase set the initial conditions under which the progeny is to emerge. Stage two is the gestation period that culminates with the emergence of the new firm. This is the stage of congenital learning and critical revision. The spin-off draws on parental blueprints to make sense of the external environment and rapidly set out on a developmental course. Yet, this can also be a phase of critical revisions as the offspring tries to develop its own identity and override its parental influences while selectively retaining inherited traits. Deviation from the parental pattern increases to the extent that the parent experiences severe failures or crises. Negative events serve as stimuli for the progeny to reconsider the value of its heritage and point to the plasticity of this process in contrast with the rigidity implied by the classic imprinting notion. This stage is followed by intense learning efforts whereby the spin-off establishes its idiosyncratic trajectory based on a blending of retained routines, input from newcomers and experimentation, as well as feedback from the market. The term reimprinting emphasizes the enduring metamorphosis experienced by the spin-off as it departs from the parent's path and sets on a new and idiosyncratic track.

The three time-windows displayed in table 3 identify the salient elements distilled from these transition stages. We use these points to illustrate essential features of the metamorphosis from parent to progeny, with imprinting and reimprinting at either end of the process which unfolds through the intermediary stage of critical revision.

Table 3 here

The table suggests that while some blueprints are invariant across the two ends of the continuum, others disappear and new ones emerge, either as a result of the mutation of inherited blueprints or the creation of new ones. We saw for instance that at Acorn there was a noticeable lack of plans for setting a global standard. Acorn had a proprietary technology developed in-house and did not attempt to create an internationally accepted technology standard, in contrast to ARM where this strategy was prioritized from early on by Saxby and his colleagues. The parent company sold micro-computers to end consumers while ARM was very soon established as an Intellectual Property company, not producing or selling microprocessors but licensing them. Acorn's form of innovation was in effect closed, despite collaboration with software houses. ARM embraced open innovation, gathering insights and knowledge through multiple partnerships and licensing agreement worldwide. Similarly, Acorn did not file a single patent during its existence, relying on non-imitable competence for competitive advantage, while ARM started very early to patent as a condition for the sustainability of its emerging business model. ARM's ensuing know-how was not just technology-based but encompassed a whole spectrum of customer service and support capabilities.

The seeds of this approach can be seen in Acorn's early relationship with VLSI and Apple, but were not formalized into a systematic and replicable template. Moreover, while Acorn and ARM were both characterized by the engagement of visionary champions who committed themselves to a business idea, these individuals were very dissimilar in terms of expertise and prior experience.

Hauser's expertise lay in technology, while Saxby was a marketing manager whose entry brought into ARM a completely new marketing approach.

5.1. Imprinting, critical revision and reimprinting

The reimprinting process in a spin-off occurs through a process of selective retention of knowledge (Campbell, 1965). Some practices are retained while others are relinquished in the light of experience and new possibilities - the sounding out of new options is partly deliberate and partly serendipitous. At Acorn this process was triggered by the crisis which culminated in the company's acquisition. But despite the pre and post acquisition turmoil, subsequent layoffs and knowledge leakages, the sheltering of the RISC unit remained a priority throughout this period. As one of ARM co-founders Tudor Brown recalled:

> *"Acorn management had told Olivetti right from the start that this group had to survive while anything else could go…so it survived with enough of its shell through those very difficult times. It was protected".* (personal interview).

In adverse circumstances, Acorn managed to identify and shield valuable expertise. This deliberate salvaging of selected technological know-how in an effective development group prevented the dissipation of crucial resources and created the conditions that made it possible to benefit from earlier mistakes. Critical reappraisal proved possible in no small part because of acknowledged weaknesses at Acorn. These conditions clarified the nature of threats and demonstrated how resources and emerging market opportunities could be better matched. The need to set a global standard, for instance, was recognized because Acorn's technology had been displaced by an inferior dominant design – the PC with Microsoft's operating system. This was an object lesson for the management team on the nature of markets for interactive products and their network effects (Rogers, 1995).

Also important in shaping the offspring's development is the influence exerted by powerful new stakeholders who can shift the power structure and undo previous influences, proposing and authorizing novel practices. ARM was formed by joint venture which made it necessary for Acorn to share influence with other major players, namely Olivetti, Apple and VLSI, lessening the extent to which developments were shaped by the parent organisation. The redirection of ARM's technology effort from the production of a PC component to the design of low power, low consumption SoC (Systems-on-Chip) was steered by Apple's needs for its forthcoming Newton handheld device. The founders of Acorn were not sole champions of the new venture, and participants sought new leadership for the joint venture.

Consistent with the prior literature on organizational imprinting and parental influence, our findings suggest that ARM inherited important blueprints that had originated in the parent company. But these elements were reconfigured. The inherited practices were subject to critical reappraisal and subsequent selection in the spin-off organization. The need for selective retention of useful blueprints, a basis for adaptation (Burgelman 1983; Miner, 1990, 1991), is more likely to be recognised where the parent company has experienced crises, that also highlight for the new team what to retain and what to discard from their legacy. Critical events represent powerful learning stimuli, not only for gaining confidence and knowledge, but in terms of encouraging reflection on the past and action to prevent adverse developments from reoccurring (Cope, 2001).

As Smilor (1997) points out, entrepreneurs "learn from what works and, more importantly, from what doesn't work" (p. 344). Not all failures, however, are equally adept at enabling constructive learning. Sitkin (1992) refers to failures that foster learning as "intelligent failures": failures that provide a basis for altering future behavior through new information. These failures are sufficient to require attention yet not such as to have terminal outcomes (firm exit, etc.). Intelligent failures can promote willingness to take risks and foster experimentation that encourage resilience

(Lounamaa and March, 1987). Progeny whose parents have experienced failures or near-failures have therefore an opportunity for critical reflection, to relinquish faulty practices and address uncertainties that could be disregarded by progeny of successful parents. This may be less so in the case of successful parents, since previous successes are more likely to reinforce existing practices (Levinthal and March, 1993; McGrath, 1999). However, disagreements or crises are no less likely than success to initiate spin-off processes (Klepper and Thompson, 2006).

The combination of retained and new knowledge in response to market feedback, entry of new top managers, and successful experimentation set the spin-off out on a new trajectory. These developments provided the basis for its reimprinting, which resulted in a significant change in the original repertoire of capabilities. In addition to the entry of Saxby as the CEO, with his distinctive background and strategic orientation, another early influence was the internalization of expertise from external consultants who trained the team in new marketing and customer relation practices. More crucially, interactive learning with lead clients, and with clients' customers, provided ongoing feedback on how to customize and improve the technology. As one of our informants explained:

> *"ARM, when it's operating properly, should be able to assimilate information about what's happening in the market much more quickly than most companies because bizarrely, it will work with hundreds of competitors […] not competitors to ARM, but competitors to each other and with their customers so that in the end it benefits from an incredible intelligence machine".* (personal interview).

Thus ARM's emerging capabilities were nurtured by what amounted to an intelligence system that spanned many value chains and tapped into extensive information and competencies through numerous partnerships with clients in different sectors. These clients were explicitly referred to as "teacher customers" by one of our informants. Clients imposed a rigorous work discipline in terms of timing and relationship management and at the same time provided useful feedback on how to craft highly customized services.

ARM rapidly encoded learning from these experiments with customers (Von Hippel, 1988, 2005) into embedded routines and collective practices. This learning effort was critical to ARM's

metamorphosis. Through the ongoing feedback stemming from the emerging market for low consumption embedded devices and the resulting experiments, ARM's choices converged into a new strategic trajectory.[6] As these experiments and improvised efforts (Baker and Nelson, 2005) developed into consistent patterns, they became codified into routines that provided the basis for the venture's new organizational make-up (Gong, Baker and Miner, 2005).

We suggest that this process of metamorphosis is reminiscent of the process of technological speciation (Levinthal 1998). The spin-off shares a prior lineage with its parent, but certain traits become prominent as a result of exposure to the selection criteria that characterize a new niche. To the extent that the resources available in the new niche domain are sufficiently abundant to support the spin-off's distinctive development, this process may result in a metamorphosis with dramatic consequences. By building on selected expertise from Acorn, while at the same time diverging from its parent's strategic path, ARM developed a highly idiosyncratic combination of resources congruent with the selection criteria of the new market for microprocessors with low power consumption. Traits that were favored by the new niche environments were then incrementally reinforced and the market offering refined.

Overall, this process was partly intended and partly opportunistic. On the one hand there were deliberate efforts on the part of managers to refine and replicate selected traits by means of directed actions that set ARM's new strategic orientation very early. However, it was only through emergent feedback from the new market for low consumption embedded devices that this orientation consolidated into a strategic trajectory. This occurred through exposure to external selection processes and the emergence of internal selection priorities that shaped ARM's

---

[6] As a similar illustration of such a phenomenon also consider Burgelman's account of Intel's shift from memory business (Burgelman, 1994). The firm was gradually pulled by market feedback and middle managers decisions about the allocation of resources away from the memory business, engendering a whole new set of routines and practices. Initially minor efforts were reinforced and ultimately fundamentally altered the organization's business.

organizational and technological path in ways that could not have been anticipated (Garud and Karnoe, 2001).

6. DISCUSSION AND CONCLUSIONS

We started with the idea that firms reproduce themselves in spin-offs which are imprinted with the traits and knowledge of the parent. Organizational imprinting literature and genealogical perspectives on spin-off performance suggest that parental influences exert powerful and enduring effects on the developmental course of their progeny. In fact, spin-offs often share features of culture, organizational routines and market focus of the parent organisation. Yet unless spin-offs can differentiate themselves, there would be no significant variation between the organizational form of the parent and that of the progeny. Literature on spin-off entry, organizational imprinting, and learning provided important clues to sources of variation. Below we discuss them separately and summarize the key contributions of the study for theory and practice.

6.1. Implications for theory

These findings hold several implications for theory. First, the study contributes to the emerging literature on spin-off performance and pre-entry experience (Agarwal et al., 2004; Klepper and Sleeper, 2005; Phillips, 2005). Scholars in this stream have suggested that spin-offs can overcome liabilities of newness by building on skills, networks and capabilities learned from their parent companies (Philips, 2002; Klepper and Thompson, 2006; Chatterji, 2009). While this idea has been supported by numerous studies, very little was known about the precise nature of this learning process. What is it that spin-offs learn from their parents? How do they replicate patterns brought into the new company from the parental organization? Our evidence indicates that the parent-progeny relationship is complex. ARM did inherit deep technical expertise, a proven technology and

the basic constituents of its early business model. Through the joint venture, Acorn provided ARM with its first semiconductor partner (VLSI) and customer (Apple). But development of the core capability that fueled ARM's competitive leadership was brought about through subsequent interaction with customers and the leadership of a new CEO coming from a different industry and committed towards establishing a global standard as well as receptiveness towards rapidly emerging market opportunities for low power embedded applications. As pointed out by Baum and Rao (2004), "…we still know too little about processes leading to the emergence of new organizational forms, or the structure of organizational inheritance that foster their persistence and transformation over time" (p. 213). These processes were illuminated by taking the parent-offspring dyad as the unit of analysis.

Understanding of the intergenerational processes shaping the formation and performance of the new spin-off, contributes to Stinchcombe's (1965) treatment of "imprinting". Organizational scholars who have embraced the imprinting hypothesis have maintained a rather deterministic stance towards the influence of the founding context on the development of new organizations (Kimberley, 1975; Boeker, 1989; Marquis, 2003), suggesting that "what an organization knows at its birth will determine what it searches for, what it experiences and how it interprets what it encounters" (Huber, 1991: 91). In contrast, we have shown the existence of internal selection processes in the new venture that are sufficiently autonomous to assimilate certain inherited elements but not others. Unlike genetic determination, replication in organizations can be modified by proactive individuals when entry into a new market setting and correspondingly new business models are required. These actors negotiate with internal and external constituencies in order to selectively defend their legacy and cope with the demands of a changing environment where previous practices are no longer appropriate. By doing so they can counteract inherited practices and devise novel organizational forms conducive to new business strategies and consistent with their

own personal values (Burton, 2001). We have also suggested that crisis in the parent organization may set off these processes and give rise to more plastic mechanisms than implied by most proponents of the imprinting effect (Johnson, 2007). In this respect our findings resonate with Chatterji's (2009) recent study on the medical device industry where, using large sample statistical evidence, the author suggests that spin-offs only acquire certain forms of knowledge from their parent. But detailed evidence from rich case material is needed to reveal selective micro-processes that underlie the intergenerational influence leading to "… a reconstitution and transformation of the past in such a way that continuity and change are both preserved in the act of path creation" (Garud and Karnoe (2001.26).

Finally, the research design has implications for empirical work on spin-offs and technological entrepreneurship. It is well known that spin-offs have given birth to major innovations (Christensen, 1997), yet much less is known in terms of the antecedents and processes underlying the emergence of such technologies. The prevailing tendency to look at the parent company and the spin-off as two separate entities obscures the complex interplay of intended and coincidental occurrences that may characterize the migration path from one company to the other. In addressing this shortcoming, the paper illustrates the benefits of focusing on the parent-progeny *dyad* as the appropriate unit of analysis to identify micro-processes that would otherwise go unnoticed. For instance, the adoption of a dyadic perspective was crucial for appreciating the long span of incubation of ARM technology in Acorn. Indeed, the project of building a new microprocessor started at Acorn in the early 1980s and the team dedicated to the RISC technology had ten years to experiment, work with prototypes, and improve their designs for Acorn's computer products before spinning off. By tracing the spin-off's heritage back to its parent company we were able to illuminates the role of antecedents in incubating a new technology and shaping its trajectory, tracing reciprocal influences at work. In sum,

the dyad as unit of analysis can contribute to our understanding of reproductive processes and critical change in organizational histories (Larson, 1992; Granovetter, 1995).

Could a dyadic account have been derived from a simpler, more stylized product life cycle approach as found, for instance, in work by Klepper and associates (Klepper, 1997; Klepper and Graddy, 1990, Klepper and Simons, 1997)? Such an approach is certainly relevant to understanding the difficulties faced by Acorn and the progress achieved by ARM. Acorn had developed a pioneering and proprietory operating system, but as the PC industry matured, the market tipped in favour of IBM's operating system (MS-DOS), eliminating firms that failed to confirm to the new industry standard. Acorn was just one of many early micro-computer companies to struggle in consequence of network effects (Fleck and Garnsey 1988). In contrast, ARM used the RISC chip expertise developed at Acorn to expand with the fast growing mobile phone industry where there was growing demand for chips of this kind. Hence, a more stylized model could show Acorn's decline to be consequent on the maturation of the PC industry and ARM's expansion to reflect the growth phase of the mobile phone and embedded device market. But a conceptual framework viewing the experience of both companies as determined by product life cycle influences would be reductionist, in contrast with the scope for transformative human agency identifiable from rich qualitative evidence (Pettigrew, 1992). A rationale for an explanatory approach that assigns agency to specific individuals instead of attributing change to determinist forces is provided by complexity thinking (Garnsey and McGlade 2006). This shows that underlying statistical representations of the world: " ... is the richer, more difficult, microsocopic reality of diversity and individual subjectivity, which in fact provides the basis for the adaptive responses of the system and its creativity ... moments of instability and structural change in a system are precisely when the macroscopic average description breaks down.." Thus theory must encompass "... the individuals and local events within

the system who, cumulatively and at critical points are .... the source of diversity and change". (Allen 1997 p 2.)

In this case, micro processes operated whereby, for example, the difficulties faced by the new parent company opened new opportunities for the spin-off company. We show that it required proactive choices and strategies by knowledgeable agents to search for and exploit the growth markets into which ARM expanded. To explore these efforts is a research task which requires acknowledgement of complexity of causal influences at many levels, including PLC factors and learning processes.

6.2. Implications for practice

The study provides insight to practitioners interested in new business models and business model design. A business model elucidates how an organization is linked to external stakeholders, and how it engages in economic exchanges with them to create value for all exchange partners (Chesbrough and Rosenbloom, 2002; Amit and Zott, 2007). ARM's business model is an exemplar of open innovation characterized by high transaction intensity with customer-partners and focus on a set of core activities. ARM entered as a stand-alone I.P. provider in a market already inhabited by other providers of RISC technology (Khazam and Mowery, 1994). Unlike extant players, however, ARM engaged in pure architectural design of the microprocessor's instruction set. A 'fabless, chipless' chip company requires a novel approach to the management of intellectual property and licensing-out as the means of value capture. ARM's distinctive use of patenting, licensing and cross licensing allowed it to navigate the rough sea of knowledge appropriation and litigation. ARM used inflow and outflow of knowledge to accelerate internal innovation and expand the market for external use of its innovation (Chesbrough, 2003). Yet, patenting is not the only means by which value is captured. Protection is enhanced by non formal mechanisms based on technology road mapping and

accelerating the pace of new product development. ARM's licensing model is complemented with customer-oriented services that facilitate the manufacturers' absorption of both design and engineering know-how. As a result, licensing royalties fuel a value system that is shared with customer-partners and protected by them. The intertwining of these factors generates causal ambiguity (Lippman and Rumelt, 1982) making it difficult for imitators to catch up. Moreover powerful customers with a stake in ARM's chip design had an interest in opposing infringement of ARM's IP.

What is also remarkable in ARM's case is the short span of time from founding to the implementation of its unique business model. The new way of doing business, free from parental influences, and the early internationalization of the company as provider of the global standard resulted from the ability to learn very quickly from lead clients and partners and internalize key competences (Lane and Lubatkin 1998). In the case of ARM this process occurred through a rapid sequence from improvisation through routinization to new capability (Gong, Baker and Miner, 2005). Capability development represents a crucial organization-level learning process for new resource-constrained organizations (Baker and Nelson, 2005). Our evidence suggests that maintaining an open attitude towards learning and experimenting is a crucial condition for successfully undertaking the path from improvisation to routine-based capabilities

Related to these themes is the issue of how to preserve and safeguard capabilities and knowledge with high technological and wealth creation potential but whose value cannot be fully anticipated ex-ante (Garud and Nayyar, 1994; Hoetker and Agrawal, 2007)). By the time the ARM spin-off took place, Acorn had already taken a downward turn which would eventually lead it to its dissolution. Had it not been for the successful spin off of ARM, an invaluable legacy of know-how that generated wealth and technological progress would have been lost. Thus not only was ARM instrumental in the redeployment of this valuable know-how into a new technological domain, but

the prevention of its extinction. The role of progenies in rescuing innovative knowledge from the downfall of their parents is an important area for future inquiry and one that has important policy implications

6.3. Boundary conditions and future directions

Although our empirical investigation is informed by a unique case, we believe our findings are relevant to tracking genealogical processes underlying the formation of new ventures. However there were undoubtedly particular contextual features in the business environment of the Cambridge cluster that affect the generality of our results. The Acorn-ARM story unfolded within the socially and historically unique background context of the Cambridgeshire region (Garnsey and Heffernan 2005). The proximity to world-class University laboratories, the ongoing exposure to nearby technological expertise and know-how, the international visibility of Cambridge and its attractiveness in the eyes of potential investors and executives, all shaped the Acorn-ARM dyad in a very distinctive manner. It is therefore the generic processes of parent- progeny interaction that should be examined, with the understanding that specific manifestations will differ from case to case. Some of the specificities of this case were as follows.

First, Acorn was exceptional in its culture of fostering enterprise and innovation, as testified by the number of technological ideas generated and companies that were spun-off to pursue those ideas. Thus Acorn differed from organizations in which less flexible cultures prevail. For example, Sorensen (2002) shows that in 'strong cultures' the lack of heterogeneity in worldviews and assumptions within the organization leaves limited room for novel thinking. This suggests that employees of parent organisations with a dominant culture are less likely to generate innovative entrepreneurial ideas. Further research should examine the cultural factors in the parent company that affect the processes through which reimprinting occurs.

Second, the search for new opportunities was imposed on Acorn by resource constraints. As noted by Sorensen and Fassiotto, corporate pressures may hinder the willingness to invest in exploring alternatives; in particular "Routinization makes it more difficult for organizations to react to possible entrepreneurial opportunities" (*forthcoming*, p. 7). Accordingly, future empirical work could explore how procedures and systems in the parent company channel and constrain, or facilitate, decision-making and learning in the spin-off.

Third, the reimprinting of the spin-off was in no small part the result of the arrival - as CEO and co-founder - of an individual who had accumulated experience in a different market and technology domain than the parent company. Phillips (2002, pg. 502) suggested that "if organizational blueprints and resources travel from parent firms to progeny across generations, populations should become less diverse as the rate of progeny foundings increases." This assumes that parent and progeny founders are drawn from the same population and knowledge pool. If so, the spin-off will inherit conservative beliefs and organizational arrangements (Simons and Roberts, 2008) rather than incentives conducive to reimprinting and change. Thus further research should pay particular attention to sources of variety in the form of newcomers and new ideas in inter-generational learning and look into the creative blending of different perspectives and organizational blueprints .

Finally, we have explored the parent progeny process occurring through inter-generational learning in two firms, but as yet such issues present challenges to quantitative, variable based research. A dyadic case study such as the one we present here does not claim to yield results that are representative of all such cases, but it does provide rich historical material "through which to develop and articulate theoretical approaches contributing to improved social scientific explanation" (Johnson 2007, p. 122). We saw that seminal contributions to management theory have been based on single case studies which provided insight into conceptual constructs and their relationships in a

generic explanatory model (Penrose 1960, Schein 1997). Insight obtained through single cases can subsequently be explored through multiple case studies and larger-scale quantitative analysis (Van de Ven and Huber, 1990). Quantitative, variable based research that lacks rich background evidence faces problems referred to by Ragin: "In most variable-oriented research, it is difficult to examine multiple conjunctural causation because researchers lack in-depth knowledge of cases and because their most common analytic tools cannot cope with complex causal patterns." (Ragin 1997 p. 42). Instead they often have recourse to simplistic conjectures that are amenable to standard statistical manipulation though lacking in realism. Variable research that builds on detailed evidence from rich case histories is more likely to address these shortcomings and draw on relevant constructs appropriately operationalised as variables. Cross case comparison provides an intermediate methodology leading towards this type of approach as a promising direction for future research.

References

Agarwal R, Echambadi R, Franco A., Sarkar, MB. (20049, Knowledge transfer through inheritance, spin-out generation, development and survival. *Academy of Management Journal* **47**(4): 501-522.

Aldrich H, Zimmer C. (1986), Entrepreneurship through social networks. In *The Art and Science of Entrepreneurship*, Sexton DL. and Smilor RW. (eds.). Ballinger: Cambridge, MA: 3-23.

Allen, P., 1997, *Cities and Regions a Self-Organizing Systems; models of complexity*, Gordon and Breach Science Publishers, Reading UK

ARM, Annual Report, 1999.

_____ Annual Report, 2004.

_____ Annual Report, 2005.

_____ Annual Report, 2006.

_____ Annual Report, 2007.

Atack A, van Someren A. (1993), *The ARM RISC Chip - A Programmer's Guide.* Addison-Wesley, Wokingham, UK.

Baker T, Nelson RE. (2005), Creating something from nothing: resource construction through entrepreneurial bricolage. *Administrative Science Quarterly* **50**: 329–366

Baum JAC, Rao H. (2004), Dynamics of organizational populations and communities. In *Handbook of organizational change and innovation*, Poole MS., Van de Ven AH. (eds.). New York: Oxford University Press: 212-258.

Boeker W. (1988), Organizational origins: Entrepreneurial and environmental imprinting at the time of founding. In *Ecological Models of Organizations*, Carroll G. (ed.). Cambridge, MA: Ballinger Publishing: pp. 33-51.

Boeker W. (1989), Strategic change: the effects of founding and history. *Academy of Management Journal* **22**(3): 489-515. Links

Boschma, R.A. and Wenting, R. (2007), The spatial evolution of the British automobile industry. Does location matter? *Industrial and Corporate Change*, 16(2): 213–238

Braun E, Macdonald S. (1978), *Revolution in Miniature. The History and Impact of Semiconductor Electronics.* Cambridge University Press: Cambridge.

Brittain JW, Freeman JH. (1980), Organizational proliferation and density dependent selection. In *The Organizational Life Cycle,* Kimberly JR., Miles RH. (eds.). Jossey-Bass, San Fransisco, CA: 291-338

Brittain J, Freeman J. (1986), Entrepreneurship in the semiconductor industry. Paper presented at the Annual Meeting of the Academy of Management, Chicago, Illinois, August 1986

Burgelman RA. (1983), A process model of internal corporate venturing in the diversified major firm. *Administrative Science Quarterly* **28**: 223-244.

Burgelman RA. (1994), Fading memories: A process theory of strategic business exit in dynamic environments. *Administrative Science Quarterly* **39**(1): 24-56.

Burton MD. (2001), The company they keep: Founders' models for organizing new firms. In *The Entrepreneurship Dynamic*, Schoonhoven CB, Romanelli E (eds.), Stanford University Press, Stanford, CA

Campbell DT. (1965), Variation and selective retention in socio-cultural evolution. In *Social change in developing areas, a reinterpretation of evolutionary theory*, Barringer HR, Blanksten GI, Mack RW (eds.), Schenkman publishing company, Cambridge Massachusetts.

Chatterji, A.K. 2009. Spawned with a silver spoon? entrepreneurial performance and innovation in the medical device industry. *Strategic Management Journal* 30: 185-206.

Chesbrough H. (2003), *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Harvard Business School Press: Boston, MA.

Chesbrough H, Rosenbloom RS. (2002), The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology. *Industrial and Corporate Change* **11**(3): 529-555.

Christensen CM. (1993), The Rigid Disk Drive Industry: A History of Commercial and Technological Turbulence. *Business History Review* **67**: 531-588.

Christensen C. (1997), *The Innovator's Dilemma*. Harvard Business School Press, Boston, MA.

Ciborra C. (1994), A Platform for Surprises: the Organization of Global Technology Strategy at Olivetti, in *Transforming Organizations with Information Technology,*: Baskerville R, Ngwenyama O, Smithson S, DeGross J (eds.), North-Holland, Amsterdam: 97-111.

Clarke P. (2000), ARM RISC leads the 32-bit Embedded Market, *Electronic Engineering Times*, February 14.

De Cleyn, JB Braet J, (2009), Research valorisation through spin-off ventures: integration of existing concepts and typologies. *World Review of Entrepreneurship, Management and Sustainable Development* 5 (4): 325 - 352

Cockburn I, Henderson R, Stern S. (2000), Untangling the Origins of Competitive Advantage. *Strategic Management Journal*, **21**: 1123-1145

Dahl M., Reichstein T. (2005), Organizational Routines and the Survival of New Firms, Paper presented at The DRUID Tenth Anniversary Summer Conference, Copenhagen, Denmark, June 27-29, 2005

_____. 2007. Are You Experienced? Prior Experience and the Survival of New Organizations. *Industry and Innovation.* **14**(5): 497-511.

Denis JL, Langley A, Cazale L. (1996). Leadership and strategic change under ambiguity. *Organization Studies* 17(4): 672–99

Ding W. (*forthcoming)*, The Impact of Founders' Professional Education Background on the Adoption of Open Science by For-Profit Biotechnology Firms. *Management Science*, forthcoming

Eggers, J. P. & S. Kaplan (2008), Bringing a New Technology to Market: Comparing CEO & Organizational Effects on Timing of Entry. *Organization Science*, 20(2), 461-477

Eisenhardt KM, Schoonhoven CB. (1990), Organizational growth: linking founding team, strategy, environment, and growth among U.S. semiconductor ventures, 1978-1988. *Administrative Science Quarterly* **35**, 504-529.

Fleck V, Garnsey E. (1988), Managing growth at Acorn Computers. *Journal of General Management* **13**(3): 4-23.

Freeman J. (1986), Entrepreneurs as organizational products: semiconductor firms and venture capital firms. In *Advances in the Study of Entrepreneurship, Innovation and Economic Growth*, Libecap G (ed.), Greenwich, Conn: JAI; 33- 58.

Garnsey E., McGlade J., eds., (2006), Co-evolution and Complexity in Socio-Economic Systems, Edward Elgar, Cheltenham

Garnsey E. (1999), ARM. Case Study of the University of Cambridge Entrepreneurship Centre

Garnsey E, Fleck V. (1988), Acorn Computers and technology policy. *International Journal of Technology Management* **2**(3/4): 554-566.

Garnsey E, Heffernan P. (2005), High Tech Clustering through Spin Out and Attraction; the Cambridge Case. *Regional Studies* **39**(8): 1127–1144.

Garud R, Nayyar PR. (1994), Transformative Capability: Continual Structuring by Intertemporal Technology Transfer, *Strategic Management Journal* **1**(15): 365-385

Garud R, Karnoe P. (2001), Path Creation as a Process of Mindful Deviation. In *Path Dependence and Creation*, Garud R, Karnoe P. (eds.), Mahwah, London: Lawrence Erlbaum; 1-40

Garvin, D.A. 1983. Spin-Offs and the New Firm Formation Process. *California Management Review* 25(2): 3-20.

Granovetter, M. (1995), Coase Revisited: Business Groups in the Modern Economy. *Industrial and Corporate Change* 4(1): 93-130.

Golden B. (1992), The past is the past - Or is it? The use of retrospective accounts as indicators of past strategy. *Academy of Management Journal* **35**: 848-860.

Gompers P, Lerner J, Scharfstein D. (2005), Entrepreneurial spawning: Public corporations and the genesis of new ventures, 1986-1999. *The Journal of Finance* **60**: 577-614.

Gong Y, Baker T, Miner AS. (2005), Organizational routines and capabilities in new ventures. *Frontiers of Entrepreneurship Research*. Wellesley, MA: Babson College; 375-388..

Hannan MT, Burton MD, Baron JN. (1996), Inertia and change in the early years: employment relations in young, high technology firms. *Industrial and Corporate Change* **5**: 503-536.

Helfat CE, Lieberman M. (2002), The Birth of Capabilities: Market Entry and the Importance of Pre-History. *Industrial and Corporate Change* **11**: 725-760.

Hoetker G, Agarwal R. (2007), Death hurts, but it isn't fatal: the post-exit diffusion of knowledge created by innovative companies. *Academy of Management Journal* **50**(2): 446-467.

Huber GP. (1991), Organizational learning: the contributing processes and the literatures. *Organization Science* **2**(1): 88-115.

Johnson V. (2007), What is Organizational Imprinting? Cultural Entrepreneurship in the Founding of the Paris Opera. *American Journal of Sociology* **113**(1): 97-127.

Khazam J, Mowery D. (1994), The commercialization of RISC: strategies for the creation of dominant designs. *Research Policy* **23**: 89-102.

Kimberly JR. (1975), Environmental constraints and administrative structure: a comparative analysis of rehabilitation organizations. *Administrative Science Quarterly* **20**(1): 1-9.

Kimberly JR. (1979), Issues in the creation of organizations: initiation, innovation and institutionalization. *Academy of Management Journal* **22**(4): 37-457.

Klepper S. 1997. Industry Life Cycles. *Industrial and Corporate Change* 6(2): 145-181.

Klepper S. (2001), Employee startups in high-tech industries. *Industrial and Corporate Change* **10**(3): 639-674.

Klepper S, Graddy E. 1990. The Evolution of New Industries and the Determinants of Market Structure, *Rand Journal of Economics* 21: 27-44.

Klepper S, Simons K. 1997. Technological Extinctions of Industrial Firms: An Inquiry into their Nature and Causes. *Industrial and Corporate Change* 6(2): 379-460.

Klepper S, Sleeper S. (2005), Entry by spinoffs. *Management Science* **51**(8): 1291-1306

Klepper S, Thompson P. (2006), Intra-industry Spinoffs. Florida International University, Department of Economics, Working Paper 0605.

Lane PJ, Lubatkin M. (1998), Relative absorptive capacity and interorganizational learning. *Strategic Management Journal* **19**(5): 461-477.

Langdon C, Manners D. (2001), *Digerati Glitterati: Hi-Tech Heroes*. New York, Wiley&Sons.

Langley A. 1999. Strategies for theorizing from process data. *Academy of Management Review*, 24(4): 691-710

Langley A, Truax J. 1994. A process study of new technology adoption in smaller manufacturing firms. *Journal of Management Studies*, 31: 619–652

Larson, A. (1992), Network Dyads in Entrepreneurial Settings: A Study of Governance of Exchange Relationships. *Administrative Sci. Quarterly*, 37: 76-104

Levinthal DA. (1998), The slow pace of rapid technological change: gradualism and punctuation in technological change. *Industrial and Corporate Change* **7**(2):217–247.

Levinthal DA, March JG. (1993), The myopia of learning. *Strategic Management Journal* **14**: 95–112.

Lippman S., Rumelt R. (1982), Uncertain imitability: An analysis of interfirm differences in efficiency under competition. *Bell Journal of Economics* **13:** 418-453.

Lorenz K. (1970), *Studies in Animal and Human Behavior*. Cambridge, MA: Harvard University Press.

Lounamaa P, March JG. (1987), Adaptive Coordination of a Learning Team. *Management Science* **33**(1): 107-123.

Marquis C. (2003), The Pressure of the Past: Network Imprinting in Intercorporate Communities. *Administrative Science Quarterly* **48**: 655-689.

McGrath R. (1999), Falling forward: Real options reasoning and entrepreneurial failure. *Academy of Management Review* **24**: 13–30.

Miner AS. (1990), Structural evolution through idiosyncratic jobs: The potential for unplanned learning. *Organization Science* **1**: 195-210.

Miner AS. (1991), Organizational evolution and the social ecology of jobs. *American Sociological Review* **56**: 772-785.

Nelson T. (2003), The persistence of founder influence: management, ownership, and performance effects at initial public offering. *Strategic Management Journal* **24**(8): 707-724.

Pettigrew, A.M. 1992, The character and significance of strategy process research. *Strategic Management Journal*, 13: 5–16

Phillips DJ. (2002), A Genealogical Approach to Organizational Life Chances: The Parent-Progeny Transfer among Silicon Valley Law Firms, 1946–1996. *Administrative Science Quarterly* **47**(3): 474-506.

Phillips DJ. (2005), Organizational Genealogies and the Persistence of Gender Inequality: The Case of Silicon Valley Law Firms. *Administrative Science Quarterly* **50(3)**: 440-472.

Penrose, E., (1960), The Growth of the Firm – a Case Study: The Hercules Powder Company. *Business History Review,* 34 (1), 1-23.

Piol E. (2005), *Il sogno di un'impresa. Dall'Olivetti al venture capital: una vita nell'Information technology.* Il Sole 24 Ore.

Popper KR. (1976), *Unended Quest.* London: Fontana.

Prencipe, A. and F. Tell (2001), Inter-project learning: processes and outcomes of knowledge codification in project-based firms, *Research Policy* 30(9): 1373-1394

Ragin C.C., 1997,Turning the tables: how case-oriented research challenges variable-oriented research*, Comparative Social Research*, Vol(16):   27-42.

Rogers E. (1995), *Diffusion of Innovations.* New York, The Free Press

Schein, E. H., (1992), *Organizational Culture and Leadership*, Jossey-Bass Publishers, San Francisco

Schein EH. (1983), The role of the founder in creating organizational culture. *Organizational Dynamics* **12**(1): 13-28.

Seale, C. 1999. *The Quality of Qualitative Research.* London: Sage.

Sehgal V., Dehoff V. & Ganesh P, 2010, "Frugal Engineering: A powerful approach to develop products and services", Economic Times May 7th 2010

Siggelkow, N., 2007. Persuasion with Case Studies. *The Academy of Management Journal*, 30(1): 20-24.

Simons, T., & Roberts, P.W. (2008). Local and non-local pre-founding experience and new organizational firm penetration: The case of the Israeli wine industry. *Administrative Science Quarterly*, 53(2): 235-265

Sitkin S. (1992), Learning through failure: the strategy of small losses. *Research in Organizational Behavior* **14**: 231-266.

Smilor RW. (1997), Entrepreneurship: Reflections on a subversive activity. *Journal of Business Venturing* **12**(5): 341-346.

Sorensen, J., Fassiotto, M. A. (*forthcoming*), Organizations as Fonts of Entrepreneurship, *Organization Science*, forthcoming: 1-10.

Stinchcombe AL. (1965) Social Structure and Organizations. In March JG (ed.). *The Handbook of Organizations*, Rand McNally: Chicago IL: 142-193.

Sydow, J., Schreyögg, G. and J. Koch (2009), Organizational Path Dependence: Opening the Black Box, *The Academy of Management Review*, 34(4): 689-709

Swaminathan A. (1996), Environmental conditions at founding and organizational mortality: a trial-by-fire model. *Academy of Management Journal* **39**: 1350-1377.

Thornton PH. (1999), The sociology of entrepreneurship. *Annual Review of Sociology* **25**: 19-46.

Van de Ven A.H., Huber G.P. (1990) Longitudinal Field Research Methods for Studying Processes of Organizational Change. *Organizational Science*, 1(3): 213-219

Van Maanen, J., (1983), *Qualitative Methodology*. Beverly Hills, CA: Sage.

von Hippel E. (1988), *The Sources of Innovation* New York: Oxford University Press.

_____ 2005. *Democratizing Innovation*, Cambridge, MA: MIT Press.

Weick, K.E., (1993), The collapse of sensemaking in organizations: The Mann Gulch disaster. *Administrative Science Quarterly*, 38(4), 628-652.

Yin, R.K., 1994. *Case study research: Design and methods* (2nd edition). Newbury Park, CA: Sage.

Zott C, Amit R. (2007), Exploring the fit between business strategy and business model: Implications for firm performance. *Strategic Management Journal* **29**(1): 1-26

Table 1 Data sources and chronology

Year	Parent		Progeny	
	Documents	Interviews	Documents	Interviews
1986	X	3*		
1987	X	1*		
1988		7*		
1990	X	1*		
1991			X	
1992			X	
1993			X	
1995			X	1*
1997				2**
1999			X	2**
2001		1**		
2004		3**	X	3**
2005		2**	X	2**
2006			X	4**
2007			X	3**
Total interviews		18		17

* Secondary historical evidence
** Primary evidence

Table 2 People interviewed by role, number of interviews and year

Interviewee	Role	Interviews	Interview year
Hermann Hauser	Co-founder, Acorn	5	1986, 1987 1988, 2004, 2005
Andy Hopper	Co-founder, Acorn	2	1988, 2005
Chris Curry	Co-founder, Acorn	1	1986
Peter Wynn	Acorn, Financial Director	1	1986
Jeff Tansley	Technology Manager, Acorn	2	1988
Jim Merriman	Chief Operating Officer, Acorn	1	1988
Brian Long	Managing Director, Acorn	3	1988
Sam Wauchope	Managing Director, Acorn	1	1990
Clare Livingstone	HRM Manager, ARM	2	1997
David Lee	Managing Director, Acorn	2	1999
Sam Boland	CEO, Acorn	1	2001
Malcolm Bird	Technology Director, Acorn	3	2004
Alex von Someren	Acorn engineer, wrote 1993 ARM RISC Chip Programmer's Guide	1	2004
James Urquhart	VLSI Design Manager, Acorn; Co-founder and Chief Strategy Officer, ARM	2	2006, 2007
Robin Saxby	Co-founder and CEO, ARM	3	1995, 2005, 2006
Ian Phillips	Principal Staff Engineer, ARM	2	2006, 2007
Elserino Piol	Deputy Chairman, Olivetti	2	2005, 2006
Tudor Brown	Principal Engineer, Acorn; Co-founder and Chief Technology Officer, ARM	1	2007

Figure 1 A stylized illustration of intergenerational learning and spin-off reimprinting
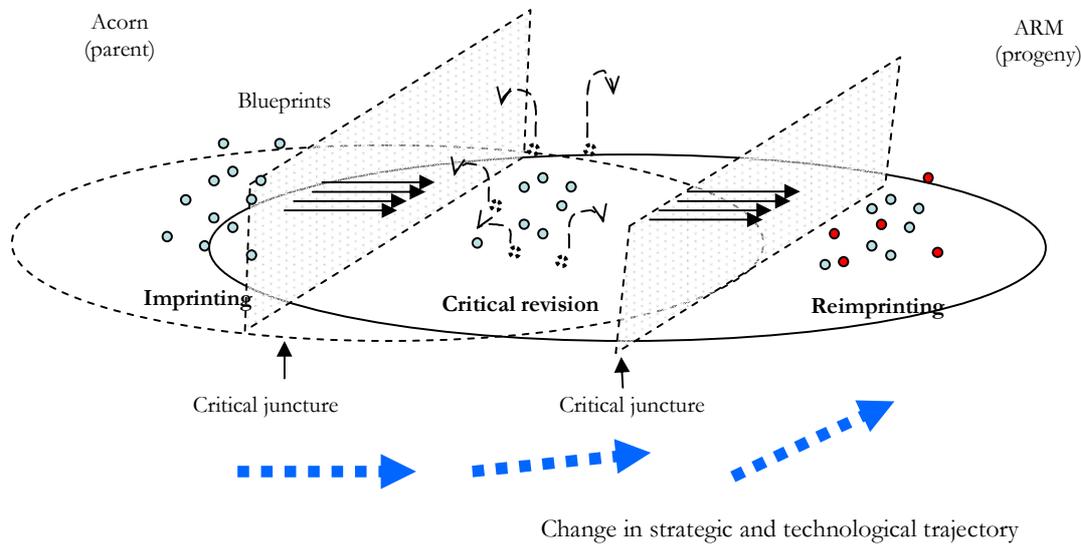
Table 3 Acorn-ARM transitions stages: Imprinting-Revision-Reimprinting

Imprinting (1979-1985)	Critical revision (1985-1991)	Reimprinting (1991-)
♦ Focus on technical excellence ♦ Core team ♦ Core technology ♦ Improvisational capabilities ♦ Resource constrain – *less is more* ♦ Fabless ♣ **Technology champion (HH)** ♣ **Inward looking approach (solo effort)** ♣ **Focus on domestic market** ♣ **R&D freedom** ♣ **No focus on standards**	● Parental crisis & buyer search ● Multiple options ensue ● Divergent pressures from external constituencies (Olivetti-Apple-VLSI) ● Selection-retention tension	Inheritance ♦ Focus technical excellence ♦ Core team ♦ Core technology ♦ Improvisational capabilities ♦ Resource constrain – *less is more* ♦ Fabless Change ♥ **Marketing champion (RS)** ♥ **Learning from lead clients** ♥ **Early international partnerships** ♥ **R&D focus** ♥ **Patents** ♥ **IP standard**