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From the ivory tower to the startup garage: Organizational context and commercialization processes

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ABSTRACT

An impressive literature documents how individual-level factors correlate with entrepreneurship and commercialization behaviors. We have far less insight, however, into how different organizational contexts may, in fact, play a dominant role in shaping these individuals and their behaviors. In this paper, I leverage a unique case of commercialization in which a largely overlapping team attempted to commercialize a technology in two different organizational contexts – first, in a university and later in a startup firm. By detailing the contextual features in each organizational environment and by linking these features to the participants' differing approaches and attitudes toward commercialization, I extend the current literature through a demonstration of how organizational context shapes not only the initial decision to become an entrepreneur, but also the specific ways in which individuals interpret and act upon an entrepreneurial mission. More generally, I contribute to the literature on the commercialization of university research by highlighting some of the challenges inherent in adapting a context optimized for exploration to the task of exploitation.

1. Introduction

The commercialization of research – the process of moving scientific or technological developments into saleable products – is a key component of entrepreneurship. Although the literature on entrepreneurship has been dominated by attention to individual-level factors (e.g., Baron and Ensley, 2006; Baumol, 2002; Kuemmerle, 2002; Shane and Venkataraman, 2000; Eesley and Roberts, 2012; Hmieleski and Baron, 2009; Markman and Baron, 2002; Roberts, 1991; Shaver et al., 2001), recent work also emphasizes the role of context (Aldrich, 1999; Dobrev and Barnett, 2005; Lee et al., 2011; Levie and Autio, 2011; Sørensen, 2007a; Stuart and Ding, 2006; Thornton, 1999). This research has offered particular attention to local, regional and national initiatives aimed at promoting entrepreneurship and commercialization, especially in connection with university-invented technologies (e.g., Audretsch et al., 2007; Eesley, 2009; Grimaldi et al., 2011; Lockett et al., 2005; Mustar and Wright, 2010; Wright et al., 2007). The implicit assumption of this literature, therefore, is that individual entrepreneurial efforts are malleable, at least to some degree; although individual-level characteristics are important, contextual features are critical toward understanding entrepreneurial behaviors such as commercialization.

Assessing the role of context, however, is difficult since participants and features of the opportunities themselves (such as the related technologies) typically vary across contexts. For example, if we witness different entrepreneurial behaviors in universities versus commercial firms, it can be difficult to determine if those differences are due to (1) contextual features associated with universities versus firms, (2) the fact that different types of individuals choose to work in universities versus firms (e.g., "entrepreneurially-inclined" individuals may select into firms over universities), or (3) the fact that universities and firms may work on different kinds of technologies, varying in field, "basic-ness," and other important features that shape commercialization processes. Moreover, the literature on context has emphasized "entry" into entrepreneurship – in other words, the initial decision to engage in commercialization or to start a firm – without simultaneous attention to entrepreneurial *processes*, or the activities that take place after this decision. As a result, even as research on context has made important contributions, it has left unaddressed the ways in which "organizational context" shapes entrepreneurship and commercialization activities (Sørensen, 2007a).

In this paper, I employ a novel qualitative case study to unpack the role that organizational context plays in shaping how participants approach technology commercialization. I focus on the commercialization of waveguide physical modeling (PM)

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technology, an advanced sound-generation technique developed at Stanford University. The commercialization of PM is unique in that Stanford hired external developers and graduate students to work in the inventor's laboratory for the express purpose of commercializing the technology; rather than a university spin-out, in which the participants leave the university context, this attempt might be labeled a "bring in," in that commercialization resources were brought into the academic environment with the aim of moving the technology toward a saleable product. Later, these same individuals left Stanford to form an independent startup aimed at commercializing the same technology. Thus, the PM case offers an opportunity to examine a technology development effort that intertwined two different organizational contexts in what might be termed a "hybrid-organization commercialization strategy." On the basis of a grounded qualitative analysis of 17 interviews and extensive archival materials, I detail the specific features associated with each organizational context and I explore the ways in which these contexts both contrasted and interacted over time through the PM development effort.

My analysis illuminates how organizational context shapes entrepreneurial processes beyond "entry." It also contributes to debates about the role of individual versus contextual factors in shaping entrepreneurship by illustrating how these approaches can interact with one another over time. Finally, I address the challenges and opportunities associated with attempts to change organization contexts, focusing on the implications of these findings for the literatures on university commercialization and on entrepreneurial innovation.

2. Contextual approaches to entrepreneurship and commercialization

"Context" is an enduring theme in organization studies. March and Simon (1993, p. 5), for example, emphasized the importance of understanding "the historical, social, and interpretive contexts of organizations" in order to understand behaviors undertaken within these organizations. Schein (1996), too, highlighted how organizational psychology – which traditionally emphasized an individualistic point of view – moved its emphasis away from individual characteristics and toward an exploration of how social context – evident in shared norms, values and assumptions – shapes behaviors. Barley (1986) offered a powerful example of the empirical fruits of such an approach: in his study of the introduction and use of medical imaging technology in two hospitals, he showed that the same technological shift can be associated with dramatically different outcomes depending upon the organizational context. By contrast, had Barley overlooked the contextual elements in his study, he would have missed a critical influence on the technology's dynamic.

In the entrepreneurship literature, attention to context is a more recent phenomenon. Although entrepreneurship scholars have long acknowledged the role of context in explaining entrepreneurial behaviors (for reviews, see Aldrich, 1999; Thornton, 1999 and Shane, 2003), individual-level and dispositional approaches dominated the literature historically. In turn, Sørensen (2007a, p. 387) has described the contrast between contextual and dispositional approaches to entrepreneurship as "one of the central and most long-lasting debates in entrepreneurship research." Aldrich (1999, p. 76) goes so far as to argue that, "personal traits, taken out of context, simply do not explain very much" and he encourages scholars to conduct detailed historic or longitudinal investigations into the role of context in entrepreneurship.

In the past 10 years, especially, a number of scholars have taken up this charge, conducting research that highlights the role of context in shaping entrepreneurial behaviors (e.g., Audretsch et al., 2007; Autio and Acs, 2010; Eesley, 2009; Grimaldi et al., 2011; Levie and Autio, 2011; Klapper et al., 2006). Much of this work focuses on the role of national-level policies and, specifically, on the ways in which these policies may shape entrance into entrepreneurship. Often times, scholars contributing to this stream of research investigate the legal or regulatory environment around a particular industry. For example, Sine and David (2003) show how the Public Utility Regulatory Policy Act of 1978 created a new niche for wholesale electricity markets, thus supporting new entrepreneurial opportunities and the entrance of new organizations. Hiatt et al. (2009) show how social and regulatory changes around the alcohol temperance movement in the United States led to brewery failures but also to new entrepreneurial activity and startups in the field of soft drinks. Webb and colleagues (Webb et al., 2009) offer several examples of legal context shaping entrepreneurial opportunities in a variety of fields, ranging from Internet music distribution to marijuana dispensaries.

Other scholars have focused on the role of more general policies that are not directly tied to a specific industry. For example, Levie and Autio (2011) create a "regulatory burden index" to measure the extent to which a country regulates entry, exit, and labor. This index, therefore, includes items such as the number of procedures required to start a new business, the difficulty of redundancy or layoffs, and the bankruptcy recovery rate. Based on a six-year panel of 54 countries, they find that lighter regulatory burdens are associated with higher rates of strategic entrepreneurial entry. Klapper et al. (2006) also investigate regulatory barriers – defined as bureaucratic costs, income taxes, and the costs of bankruptcy proceedings – in a wide range of European countries. They, too, find that those countries with lower regulatory barriers have higher rates of entry into entrepreneurship. Focusing on bankruptcy specifically, Fan and White (2003) find that U.S. states with higher bankruptcy exemption levels have higher levels of household-owned businesses – one proxy for entrepreneurship – than do states with low exemptions. These studies, therefore, demonstrate how regulatory context is associated with entrepreneurial entry.

It is important to note, too, that studies of regulations and entrepreneurship do not always find a negative relationship. For example, Eesley (2009) studied a 1999 Chinese constitutional amendment that outlawed discriminatory policies preventing the growth of entrepreneurial firms. He found that this legislation increased rates of entrepreneurship, particularly among high human-capital individuals.

Although most studies of "entrepreneurship in context" have focused on formal national regulations, some scholars have investigated the relationship between *organizational*-level context and entrepreneurial entry. For example, Stuart and Ding (2006) find that people whose colleagues are entrepreneurial are more likely to become entrepreneurs themselves. Similarly, Dobrev and Barnett (2005) and Sørensen (2007a) both find that younger and smaller organizations are more likely to spawn entrepreneurs. Finally, Lee and colleagues (2011) find that work environments with an unfavorable innovation climate or a lack of technical-excellence incentives can lead skilled and ambitious employees to engage in entrepreneurship due to their low job satisfaction. More generally, therefore, these studies build upon a long tradition of research that explores the ways in which different dimensions of organizational culture – as reflected in both incentives and structures – can shape employees' behaviors (e.g., Barley, 1986; Cha and Edmondson, 1996; Kunda, 1992).

Research on universities and entrepreneurship has addressed the role of both organizational and extra-organizational context. At the national level, researchers have subjected the Bayh-Dole Act in the United States, in particular, to considerable scrutiny as to its effects on university entrepreneurship (Grimaldi et al., 2011). Several other countries have imitated this specific legislation or have

implemented other policies explicitly aimed at spurring university entrepreneurship (e.g., Kodama, 2008; Mowery and Sampat, 2005; Mustar and Wright, 2010; Wright et al., 2007).

Within the university organization, Kenney and Patton (2011) examine technology spinoffs under two different models: university-ownership of intellectual property and inventor-ownership of intellectual property. They find that startup creation rates are much higher under the inventor-ownership model. Clark (2001), by contrast, focuses attention on a university's organizational culture. He finds that supportive university cultures with a history of entrepreneurship are more likely to lead to entrepreneurial activity by faculty. Finally, Lockett and colleagues (2003) focus on the technology transfer office, specifically. They find that older offices and those offices with greater experience, expectations, and capabilities are associated with greater levels of startup activity.

As these many studies demonstrate, therefore, we are beginning to amass a good deal of evidence on the role of context – including organizational context – in shaping entrepreneurial behaviors. At the same time, however, the existing context literature has focused almost exclusively on "entrepreneurial entry rates" – implicitly assuming that entry is the central feature of contextually-informed entrepreneurial behaviors. Although entry is undoubtedly important, however, we have very little evidence of how organizational context also may shape the *course* or *process* of entrepreneurship. As a result, our understanding of the role of context in shaping commercialization behaviors remains limited and cannot fully speak to the ways in which individual entrepreneurs actually go about being entrepreneurs. In this paper, therefore, I investigate how organizational context shapes entrepreneurs' behaviors and perceptions during the course of the commercialization process.

3. Data and methods

3.1. Setting

My goal is to examine the role of organizational context in shaping the commercialization process for a technology. I take a qualitative case-based approach to this question. Eisenhardt and Graebner (2007) note that case-based research is appropriate when the researcher desires to uncover a rich understanding of a complex phenomenon within its real-life context and when existing theory or data availability are insufficient to engage in quantitative hypothesis testing (see also Yin, 1981).

My case centers on waveguide physical modeling (PM) technology, which is an advanced sound-generation technique developed at Stanford University. (For canonical examples of other case-based research around innovations in sound technology, see Jeppesen and Frederiksen, 2006; Pinch and Trocco, 2002; Sterne, 2012.) The commercialization of PM is unique in that Stanford hired external developers and graduate students to work in the inventor's laboratory for the explicit purpose of commercializing the technology. Later, these same individuals left Stanford to form an independent startup aimed at commercializing the same technology. Thus, the PM case offers an opportunity to explore how the same group of individuals approached the technology commercialization process while interacting across different organizational contexts.

3.2. Data sources

My data consist of both archival materials and interviews. I collected extensive archival materials from two sources. The Stanford Office of Technology Licensing (OTL) providing me with access to their case file for PM. This case file filled two large boxes and included printed copies of email correspondence with licensing associates, licensing agreements, press releases, personnel contracts, financial reporting documents, and other relevant materials. I made copies of approved materials and I made careful notes from other materials. The Stanford University archives contain several boxes of materials from the administration of the interdisciplinary Center that housed the PM researchers. These materials include additional correspondence, minutes of meetings, notes on time allocation, Conflict of Interest agreements, and other materials. The Stanford Department of Special Collections made copies for me of all requested documents.

I approached the interview process through snowball sampling (Atkinson and Flint, 2001; Patton, 2002). Thus, I initially contacted and interviewed three key individuals: the PM inventor, one of the licensing associates, and the director of the interdisciplinary Center. These initial interviews pointed me toward additional individuals to interview, each of whom I asked for further suggestions of people to contact. Occasionally, later interviewees raised new questions that led to follow-on interviews with key individuals. I ceased my interviewing when no new individuals surfaced as important or unique perspectives to capture. Ultimately, I conducted 17 interviews, ranging in length from one to three hours, with 11 individuals. My interview sample includes all of the key players in the PM commercialization process, including the three individuals mentioned above, the three developers hired by the university, two other licensing personnel, graduate students and other faculty. Appendix A details the interviewees and interview dates.

In the early interviews, I began by asking interviewees to convey a narrative of the PM commercialization process from their perspective (Spradley, 1979). Although I asked clarifying questions to ensure that I captured these reflections accurately, I focused on providing open-ended prompts in order to elicit more detailed and unbiased (by me) descriptions (Strauss and Corbin, 1998). I immediately transcribed and reviewed these accounts to shape my later interviews. For example, with certain dates and events in mind, I could prompt later interviewees to reflect on topics or events that they may have missed in an open narrative format. I complemented the narrative of events conveyed by each interviewee with questions about the incentives and constraints that each interviewee perceived along the way.

My triangulation among interviewees' accounts and my use of archival materials also enabled me to address, in part, concerns about retrospective bias in the interviews. Although interviewees reflected on events that took place anywhere from one to 20 years prior, my ability to check their recollections against those of other interviewees and to show them copies of archival documentation tied to specific events and/or indicative of potential incentives and constraints (as with Conflict of Interest policies, for example) served to remind them of the historic landscape. Nonetheless, as with any retrospective interviews, I acknowledge that some degree of bias likely remains.

3.3. Data analysis

As Langley (1999, p. 691) notes, "process data are messy" and their analysis is challenged by the fact that they are eclectic; composed of events; embedded in temporal patterns that vary in precision, duration, and significance; and involve multiple levels and units of analysis (see also, Langley et al., 2013; Pentland, 1999; Van de Ven and Poole, 1995). In light of these features, Langley (1999, p. 695) notes that a narrative strategy can aid in sensemaking and may be particularly appropriate for work that adopts a "contextualist" perspective. A key goal of this strategy is to convey rich detail characterized by high accuracy (Weick, 1979), while moving beyond descriptions to also suggest explanatory mechanisms (Langley, 1999).

Table 1
PM development effort: chronology of events.

Year	Major events
1986	Julius Smith of Stanford's Center for Computer Research in Music and Acoustics (CCRMA) made a breakthrough in physical modeling synthesis, or PM. Smith's insight dramatically reduced the computational power needed to "play" a physical model in real time.
1988	Yamaha, who also had licensed an earlier CCRMA technology, takes an "option" to the PM license
1989	Yamaha signs as first licensee
1991	The Stanford Office of Technology Licensing (OTL) provides $23,500 in funding for PM in the form of a research grant to CCRMA. The grant is justified, in part, on the basis of an expected financial return through licensing of research results.
1992	The OTL provides another $25,000 in PM funding to CCRMA. This grant also is justified, in part, on the basis of an expected financial return through licensing of research results.
	Stanford signs Sierra Semiconductor and Crystal Semiconductor as licensees
1993	Stanford signs MediaVision and Atari as licensees
	The OTL outlines a technology development and trademark plan. The plan describes three phases: (1) select a trademark and recruit a team to develop sounds; (2) develop sounds and create a logo; and (3) pursue aggressive licensing starting in January 1995. The plan projects $850,000 in expenses to reach Phase 3 and cumulative royalties of $18 million by 1998.
	The OTL and CCRMA jointly commit $1.35 million to PM
	Porcaro and Jaffe hired as developers in October. Their initial charge is to develop a graphical patch program, called SynthBuilder. The plan is to then use SynthBuilder to develop a complete library of 128 "General MIDI" patches (or standardized sounds).
1994	Scandalis hired as a developer in September
	Yamaha releases the VL1 synthesizer, based on PM technology
1995	February meeting notes mention that according to the trademark plan, PM revenues should be approximately $2 million in 1995. (There are no revenues at this point.) They also note that the program has no demonstrable sounds yet.
	The project is $260k into its budget by February
	In an April meeting, the licensing associate, Koepnick, inquires as to whether there is an analysis of the "economics of PM"
	Koepnick leaves the OTL in September. Hammond, another licensing associate, assumes responsibility for the project.
1996	Koepnick returns to the OTL
	The developer team completes the graphical interface and a small set of sounds
	The developers, graduate students, and Koepnick start Staccato Systems in the Fall, funding it with personal and "friends and family" money
1997	Yamaha announces in September that it will invest $1 million in Staccato Systems. Allegis Capital and Chase Capital Partners invest an additional $3.2 million.
1998	Stanford announces in July that "there will be little if any inventor distributions" in light of "very modest earned royalties. . . available credits, investments in the marketing of licenses, and Stanford's requirement to pay maintenance fees on issued patents."
1999	Stanford ceases updates to the PM website, along with efforts to actively market the program
2001	Analog Devices purchases Staccato Systems for $30 million

With the interview transcripts and archival materials in hand, therefore, I began by constructing a detailed sequence of events. Several of my informants reviewed this account to provide clarification and correction of factual matters. Table 1 summarizes key events and the "case synopsis" section below elaborates upon this history.

Next, I re-read each interview transcript and archival document with an eye toward the explanations and interpretations offered. Thus, while the first stage of my data analysis focused upon identifying events, this stage focused upon identifying *why*, in the eyes of the interviewees and the authors of archival documentation, these events unfolded as they did. I began this process by marking potential codes in the margins of documents and transcripts. I then loaded the transcripts and select archival documents into Atlas.ti software in order to perform more systematic open coding (Strauss and Corbin, 1998). As I reviewed each file, therefore, I marked specific segments of text with codes that reflected my interpretation of the reasons offered for specific actions and events. For example, when I asked one interviewee why he developed a particular set of product features that potential customers had not requested, he remarked, "We were just not very focused on the market." I coded this passage as, "(lack of) focus on the market."

My coding process was iterative, such that as new dimensions emerged in later interview analyses, I went back to earlier interviews to assess whether and how they applied. Ultimately, I identified seven primary codes: 1. Research focus; 2. Project goals; 3. Project focus; 4. Conflict of Interest policies and commercialization management; 5. Funding sources and ownership; 6. Funding level; and 7. Board of Directors. These codes were associated with three primary families: 1. Mission and policies; 2. Roles and structures; and 3. Resources. I make no claims, however, that these dimensions are exhaustive; instead, they reflect the goals of my particular study: to understand how organizational context shaped commercialization processes in a case of interest (Lincoln and Guba, 1985).

Alongside this coding of interpretations and explanations, I also noted the associated organizational context. For example, the interviewee quoted above was referencing events within the university context. Thus, my next step was to consider the relationship between the two organizational contexts – university and startup – on one hand and the seven primary codes that reflect interpretations or explanations of events on the other hand. This analysis structures my findings section, which compares and contrasts these dimensions across the organizational contexts.

4. Case synopsis

In 1986, Prof. Julius Smith of Stanford's Center for Computer Research in Music and Acoustics (CCRMA) made a breakthrough in physical modeling synthesis, or PM. PM is based on the idea that physicists can construct a mathematical equation to describe any physical system, including a vibrating string (as with a violin) or an air column (as with a clarinet). In a physical modeling computer algorithm, a "real" instrument's physical parts and playing action are reduced to a series of complex equations. These equations are then inserted into an algorithm that describes their interaction and computes a "solution" that results in a sound. While modeling technology has been around since the early 1970s, the computational requirements are immense and solutions that would permit an instrument to be "played" in real-time were infeasible. Smith's breakthrough, called "digital waveguide synthesis," contributed a massive reduction in computational requirements (Smith, 1986).

Stanford received several patents related to PM. In 1989, it signed Yamaha as the first licensee, after a one-year "option" period during which Yamaha evaluated the technology (Koepnick, 1988; Kamo, 1988; Smith, 1989). In 1992, Sierra Semiconductor and Crystal Semiconductor also signed as licensees, joined in 1993 by MediaVision and Atari (Stanford OTL, 1992, 1993a,b).

Part of Stanford's interest lay in extending and maximizing their PM revenue stream. In other licensing cases, Stanford had found that just as licensing revenue was hitting its peak, the patent protection ran out and revenue abruptly stopped (Nelson, 2005; Stanford OTL, 1993c). To facilitate technology development, the OTL provided small grants to Stanford faculty in 1991 and 1992 (Byer, 1991; Devaney, 1992). In 1993, however, the Stanford Office of Technology Licensing (OTL) outlined a technology development and trademark plan that dramatically increased the active development of both PM technology and associated intellectual property.

The OTL reasoned that if the technology could be commercialized faster, the university would receive greater revenues before the licensing revenue stopped (Stanford OTL, 1993c). One way to speed commercialization, Stanford reasoned, was to engage in development themselves – rather than relying wholly on licensees – by hiring personnel into the inventor's lab for the explicit purpose of commercialization (Stanford OTL, 1993c).

Stanford also planned to develop a trademark around PM in order to extend its revenues. When Stanford applied for the PM patents, the "life" of a U.S. patent was 17 years from date of issue. (This period changed to 20 years from date of application with the TRIPS agreement of 1996.) Trademarks, by contrast, have no expiration as long as they are renewed. Thus, by establishing a trademark around PM, Stanford hoped to maintain a PM royalty stream even after the patents expired (Stanford OTL, 1993c).

In 1993, the OTL and CCRMA jointly committed $1.35 million to PM. They applied the funding to intellectual property protection, equipment and, overwhelmingly, to salaries for engineers whom they hired to do development work on the PM technologies. The first two of these engineers – David A. Jaffe and Nick Porcaro – joined the project in October 1993 (Koepnick, 1993a,b). They received an hourly wage and took up positions alongside regular university researchers – professors and graduate students – at CCRMA. Their mission was to facilitate the commercialization of PM.

The development effort focused on two primary activities. First, Jaffe and Porcaro – who were joined by another engineer, Pat Scandalis, in September 1994 (Koepnick, 1994) – worked to develop a graphical user interface that would make it easier to create physical models of new instruments. Second, they worked to create a sound library to demonstrate PM technology. To assist with the sound library, two CCRMA graduate students also joined the team as paid developers.

Development efforts proceeded outside of Stanford, too. Yamaha, the first licensee, had placed 100 engineers on the project upon signing the license in 1989 (Garman and Kosnik, 1999; Smith, 2013). In 1994, they released their first PM-based product, the VL1 synthesizer.

The OTL continued attempts to sign up additional companies as PM licensees. The project, however, had fallen behind projections: Meeting notes from February 1995 indicated an original expectation of $2 million in revenue that year. Instead, Stanford was $260,000 into the development budget and had yet to develop any sounds (Stanford OTL, 1995a). Moreover, despite ambitious financial projections and detailed licensing terms – the terms specified a $50,000 up-front fee, a $25,000 annual maintenance fee and a percentage of revenues – the market justification remained unclear. In fact, in an April 1995 meeting, the OTL licensing associate, Joe Koepnick, asked if anyone had written down anything akin to the "economics of PM," and argued that they would need such a comparison for marketing purposes (Stanford OTL, 1995b).

Later in 1995, Koepnick left the OTL and OTL licensing associate Ann Hammond assumed responsibility for the project until Koepnick returned in mid-1996. By the end of 1996, the commercialization team had completed the graphical interface and had developed a small set of sounds. To Stanford's dismay, however, these products met with little market interest. As late as 1998, in fact, Stanford warned that "there will be little if any inventor distributions" in light of "very modest earned royalties. . ., available credits, investments in the marketing of licenses, and Stanford's requirement to pay maintenance fees on issued patents" (Stanford OTL, 1998). In other words, the project had yet to make money. In 1999, Stanford altogether ceased updates to a website that they had developed to attract licensees.

In late-1996, the development team and graduate students – having completed their contracts with Stanford – established a startup, Staccato Systems, based on the technology. Koepnick, one of the two OTL associates who had directed efforts at Stanford, joined them, too – as CEO. For its part, Stanford granted a license and took equity in the company. Hammond again assumed responsibility for the OTL. The OTL moved, however, from driving the project to enforcing a standard hands-off licensing arrangement and they ceased active marketing efforts (Salisbury, 1997; Smith, 2013).

In 1997, Staccato Systems raised $3.2 million from venture capital firms Allegis Capital and Chase Capital Partners, and an additional $1 million from Yamaha, who participated as a strategic investor (Garman and Kosnik, 1999; Schrieberg, 1998). This time, the team focused on the computer games market, where they met with considerable success. In 2001, Staccato Systems sold to Analog Devices for $30 million. The original developers and graduate students joined Analog Devices to continue work on the technology, which today provides the sound capabilities for leading-edge videogame consoles and a wide array of other digital media and music devices.

Table 2
Dimensions of organizational context relevant to the commercialization process.

Dimension	University context	Startup context
Organizational research focus	Exploration	Exploitation
Project goals	Share openly while developing novel insights into a product	Maximize financial return
Project focus of participants	Engage in multiple activities besides commercialization	Singularly focus on commercialization
Conflict of Interest policies and commercialization management	COI policy prevents inventor from exercising project oversight. Commercialization managed by OTL personnel	COI policy is not applicable, as individual and organizational interests are presumed to align. Commercialization managed by CEO and CTO
Funding source and ownership	University provides funds. Equity for inventor only; other participants paid hourly	Funding from founders, friends, family, traditional venture capital, and corporate venture capital. Participants have equity stake
Funding level	Limited	Substantial
Board of Directors	Not applicable	Provides feedback, oversight and industry connections

5. Organizational context and the commercialization of PM

The commercialization of PM affords an opportunity to examine how different organizational contexts shape how individuals approach the commercialization process. Table 2 summarizes the dimensions of comparison that emerged from the case analysis. Although each dimension is analytically distinct, the dimensions also reflect broader themes and interact with one another to reinforce the overall context. As I elaborate on each dimension, therefore, I also point to these interconnections.

5.1. Organizational research focus

Participants interpreted Stanford's research focus as emphasizing exploration, not exploitation (March, 1991). For example, when reflecting on technology commercialization in the university context, Smith, the primary inventor, argued, "Universities aren't in the habit of being accountable to markets in the way that companies are. Universities are dedicated to 'sheer excellence' – intrinsic value in new things regardless of market value" (personal interview,

2004). Although a number of scholars have pointed out that many universities – including Stanford – *can* appear market oriented (e.g., Jensen and Thursby, 2001; Kenney and Patton, 2011; Lockett et al., 2005; Stuart and Ding, 2006; Wright et al., 2007), Smith is correct that there was little precedent or structure at Stanford for engaging with the market in such a direct product-oriented manner; instead, market engagement typically took the form of hands-off licensing or consulting relationships.

One implication of this arrangement was that the Stanford-based PM development team had no mechanism to solicit market feedback. As the first licensing associate, Joe Koepnick, argued:

> What we should have been doing at that stage is talking to industry – more. We *were*, but we weren't defining products based on market demand. That's a very simple concept and it sounds stupid now. We didn't know how it was going to evolve, and we already had this tool kind of cooking and it was too good [to change course based on feedback] (personal interview, 2004).

Continuing, Koepnick argued that if commercialization efforts had been guided by a commercial context, "the tool would have been built, developed differently. Marketing 101. We were doing it in a vacuum" (personal interview, 2004). Scott Van Duyne, one of the graduate students who worked on the commercialization, concurred, "We could have explored the market a lot more. . . . We had kind of this vision of SynthCore and SynthBuilder [the products on which the university-based commercialization team focused] and all that. That was a little bit of a vision in an academic vacuum, a technology vacuum. . . . We lost a lot of time remaining in the blue-sky world" (personal interview, 2004).

By contrast, as members of Staccato, the team engaged in regular market engagement. Scott Van Duyne, the PhD student, reflected on the differences:

> There was a lot more optimization of stuff [at Staccato versus Stanford]. Consideration of "if this is going to run on a PC or if this is going to run on a DSP that doesn't cost $2,000 then I'd better hack out some of this stuff that doesn't matter that much." So there was much more sensitivity to practical value of things in terms of, "Why are we doing 'this' instead of 'this?'" In [the university environment, by contrast], if it was really expensive but sounded good, that's good. We should do some other examples. The measuring stick was different (personal interview, 2004).

In other words, participants associated the "exploration" focus of the university with an emphasis on quality and novelty, and they associated "exploitation" in the firm with an emphasis, in Van Duyne's words, on "practical value." The degree of engagement with the market, however, reflected other aspects of each organizational context, too, as described below.

5.2. Project goals

The specific PM project goals in the university environment reflected a lack of focused attention on the market, too. In the university context, the commercialization goal was accompanied by a desire to generate new ideas and to share these ideas broadly. Thus, each of the developers – the individuals who were hired explicitly for the purpose of commercialization – noted that they adopted the perceived norms of the academic lab and subscribed to academic incentives. For example, as developer Pat Scandalis remembered, "it was just a big pool of ideas, everybody tossing their ideas in. It was a free-for-all . . . it was all about open sharing of ideas. It was an academic environment" (personal interview, 2004). Although the engineers were presumably focused on commercialization, they shaped their activities to match their perceptions of what engineers do in an academic environment. Thus, their work focused not only on refining the core PM product in order to ship it, but also on generating new ideas and sharing them. Publication data reflect these activities: the three developers published eight academic papers between 1993 and 1996, as they were employed at Stanford; between 1997 and 2001, when they were part of Staccato, they published only one paper (in 1997).

Part of this focus appeared to be tied to the developers' work alongside university researchers who had certain established norms. As David A. Jaffe, another developer, noted, "I knew Julius [Smith, the faculty inventor]. We'd worked together before [at the university and at NeXT] and it was great to work together again – to publish and to push projects forward" (personal interview, 2009). In other words, the developers appeared to view themselves as *joining* an existing culture rather than *forming* a new culture. In turn, they adopted the perceived norms of the existing academic lab.

In the Staccato environment, exploration gave way to exploitation (March, 1991), as guided by progress toward a saleable product. Van Duyne, for example, shared how, "[At Staccato] no one cared if you brainstormed new ideas for the sake of new ideas. We had rewards for contributing to the bottom line or at least moving in that direction." In other words, the project goal in the startup environment was solely focused on producing a product that would make money. In turn, that project goal shaped the participants' focus.

5.3. Project focus of participants

Just as the market focus of the university-based effort was diffuse, so was the focus of some of the university participants. The sole responsibility of the three developers was to work on PM, though their engagement in practice included the generation of new ideas and broader participation in academic sharing, as noted. Yet for the other participants – including the OTL personnel, faculty, and graduate students – the PM effort was one of many responsibilities. Koepnick, for example, recalled how he was pulled between multiple cases and could not devote the necessary attention to PM: "I was also carrying a whole bundle of other cases. And it [PM] required more than a full time effort" (personal interview, 2004). For their part, involved faculty still had teaching responsibilities, administrative duties, and other ongoing research projects. Graduate students faced a tension between shared commercialization efforts and conducting the independent and novel work required for a dissertation. As Koepnick recalled:

> I know we had a couple of conflict [of interest] things that we had to be careful about. . .we always have that at the university. You want to make sure that the student is not distracted from his research and that he's not doing research that's not benefiting him, that's [just] benefiting the university or the company. In this case, if you weren't careful, somebody could argue that we were distracting Tim [one of the graduate students] from finishing his dissertation. Tim is there three years and his advisor's going, "You should be out of here." And Tim says, "Well, I'm spending all this time on Sondius [the name of the Stanford effort]" (personal interview, 2004).

Minutes from a February 1995 meeting of the developer group reinforce these multiple priorities for graduate students. One excerpt reads, "Scott Van Duyne is now writing his dissertation and must take tests, but otherwise is willing to work, inasmuch as he can work it out with his funding" (Stanford OTL, 1995a). Thus, the student-developers in the university context, like the licensing associates and faculty, were torn between multiple projects and priorities.

In the startup environment, by contrast, these multiple roles and responsibilities did not exist. As Van Duyne, one of the graduate students, shared, "[At Staccato], we were all singularly focused on

getting the product out" (personal interview, 2004). Continuing, he emphasized how his focus in each organizational context shaped the urgency he associated with commercialization:

> Of course, working here [at Stanford] it was an hourly thing. I put this many hours into it. If I can't finish that today, I'll do it in two weeks when I get back, or whatever. That wasn't how it worked at Staccato. It was more, "We have to do this now, and it doesn't really matter if you're going on vacation or not really, because we're trying to do this." It was more sensitive. So that was good (personal interview, 2004).

Of course, the university explicitly designed the commercialization participation by faculty and graduate students so as not to interfere with other duties. For university personnel, these multiple duties and the primacy of traditional academic roles were inscribed in the Conflict of Interest policy.

5.4. Conflict of Interest policies and commercialization management

Stanford's Conflict of Interest (COI) policy played an important role in shaping project participation and focus, not only for the graduate students but also – and especially – for faculty. Stanford's policy reads, in part:

> A mission of the University is to promote public good by fostering the transfer of knowledge gained through University research and scholarship to the private sector. . .It is wrong, however, for an individual's actions or decisions made in the course of his or her University activities to be determined by considerations of personal financial gain.
>
> . . .Faculty must foster an atmosphere of academic freedom by promoting the open and timely exchange of results of scholarly activities, ensuring that their advising of students (defined for this policy to include postdoctoral scholars and other trainees) and their supervision of staff are independent of personal financial interests. . . . Faculty may not use University resources or personnel, including facilities, staff, students or other trainees, equipment, or confidential information, except in a purely incidental way, as part of their outside consulting or business activities or for any other purposes that are unrelated to the education, research, scholarship, and public service missions of the University (Stanford University, 2013a)

A primary implication of the COI policy was that the principal inventor, Smith, was excluded from an official role in managing the university-based commercialization effort. Since Smith would receive royalties on the success of any product, in accord with the OTL policy on revenue sharing, he could not direct commercialization efforts that might increase these royalties. Thus, as Van Duyne noted, "The guy with the knowledge, the best resume, for overseeing our work wasn't allowed to oversee our work" (personal interview, 2004). Smith, who was excluded from a management role, concurred:

> I was the principal inventor and [academic] advisor to the later inventors, and I had five years of experience at NeXT Computer managing a professional software engineering team, including one of the OTL developers who I brought into the project. Despite my qualifications to contribute technical oversight, I was actively excluded from participating, even while development continued in my own research lab. The project was managed by administrators with little or no technical background of any kind (personal interview, 2004).

In short, the person in the strongest position to manage commercialization was prevented from acting in this role due to potential conflicts of interest. In fact, Smith later reflected that the incentives seemed to encourage him to compete *against* Stanford; since he could not actively direct development of his PM technology, he contemplated working with an outside firm to develop a competing technology (Smith, 2013).

That situation left the OTL licensing associate in charge of managing the team. Although Stanford licensing associates have technical backgrounds, they do not have deep expertise in each technology that they manage so as to enable them to direct commercialization. Thus, as Ann Hammond, the licensing associate, recalled, "From a direction, you know, grossly speaking, this office was involved in signing their [the developers'] paychecks and meeting with them, but we weren't managing them technically at all. I can't really say who was technically managing them" (personal interview, 2004). The developers concurred. Nick Porcaro, for example, recalled, "We were pretty much self-directed. . .They told us, 'Do something cool. Make it sound good.' Besides that, we had no direction. None" (personal interview, 2004).

The relative lack of technical oversight complicated efforts to direct the overall development effort. As Hammond acknowledged:

> The technology was much more difficult from a technical standpoint than we originally thought and than the *inventors* originally thought. It was much more difficult for people to assimilate into their programs. And that was one of the things – the biggest thing – that prevented this I believe from becoming a success. We didn't just overlook [it]; we didn't know. I mean the licensing people aren't the ones who could even make that assessment [about technical issues]. But we [nonetheless] made that assessment (personal interview, 2004).

Similarly, in reflecting on his meetings with the engineers, Koepnick, the other licensing associate, recalled, "Now the problem was for me, I just didn't have the experience to know when to say, 'No' [to the developers' desire to pursue certain technical paths]" (personal interview, 2004). Together, these reflections highlight two related challenges: By virtue of the Conflict of Interest Agreement, Stanford precluded the person with the greatest technical knowledge from overseeing technical development efforts. In turn, this arrangement forced the licensing associates into a technical oversight role for which they were ill equipped.

By contrast, authority and expertise were combined in the same position at Staccato: a Chief Technology Officer who directed commercialization efforts. Without a conflict of interest policy, this CTO could direct technical efforts as he deemed appropriate. Moreover, the CTO worked closely with the CEO – who focused primarily on the market feasibility of the evolving product, on integrating technical development with market research, and on fundraising – to integrate the team's technical knowledge with its market knowledge (Siegel and Renko, 2012). As a result, team members shared that they faced few questions about technical or market management while at Staccato.

5.5. Funding sources and ownership

As noted in the case synopsis, the OTL and CCRMA each contributed funds to support commercialization in the university context. The participants themselves worked for an hourly wage. With the exception of the inventor, no team member would share in product royalties since OTL rules specify a royalty split only with inventors (Stanford OTL, 2013). Koepnick referred to the hired developers within the university, therefore, as "the den of no equity" (personal interview, 2004). He recalled, "What we did was hire these consultants, and then they would have to sign everything to the OTL. So they didn't own it" (personal interview, 2004). This lack of equity motivation extended to the licensing associates, too, who would not share in the financial success of the project

that they were managing. From Smith's perspective, therefore, "the only people in the driver's seat [while it was at the university] were those who had no financial incentive for it to succeed" (personal interview, 2004). In fairness, a long line of work highlights how non-financial incentives can motivate university-based participants (e.g., Dasgupta and David, 1994; Stern, 2004). Koepnick and Smith are correct, however, that the financial incentives were not aligned with the management structure or the developers' efforts at Stanford.

In the startup environment, the founders themselves provided most of the seed funding for the first year of Staccato. This self-funding moved the financial aspects of commercialization into a prime consideration. As Koepnick argued, "That's [self-funding] quite motivating in itself" (personal interview, 2004). Van Duyne, one of the PhD students, elaborated:

> It [commercialization success] mattered now [at Staccato]. We weren't getting paid now. That was the difference. We were losing money. So, there was more urgency. More focus and having to take ownership for the decision of what we're doing, rather than saying, "that would sound neat. Why don't we spend a few more weeks on that?" It was more focused. . . . Instead of sexiness, it was opportunity [that directed commercialization efforts] (personal interview, 2004).

In other words, interviewees argued that funding sources influenced commercialization focus and urgency.

Seed funding from friends and family of the founders further tied some of the founders to the success of the company. Koepnick recalled one founder who brought in several investments from blood relatives: "Talk about some handcuffs! You know, when you got people saying, as people get fed up, saying, 'Well, I quit!' Well, he couldn't because his family would be going, 'What?!?'. . .It worked out great. I knew he wasn't going to walk out" (personal interview, 2004). By providing all participants with significant financial incentives tied to the project's success, the startup context elicited different behaviors and attitudes toward commercialization.

5.6. Funding level

Later, Staccato raised venture capital from a combination of strategic and financial investors. These investments provided both financial resources and other benefits (see Wright et al., 2007, for evidence on the different emphases, resources, and networks of VC-backed versus non-VC-backed spinouts). At Stanford, the total funding commitment had been $1.35 million. Notes from the archives and interviewees' statements indicate that both the OTL and CCRMA considered this sum to be very significant and both groups worried about providing further funding in case the project was not successful (personal interview with Julius Smith, 2007; personal interview with Joe Koepnick, 2004; personal interview with Chris Chafe, 2002; Stanford OTL, 1993b, 1995a).

Of course, venture capital funds also worry about commercialization success. They manage these risks, however, through a portfolio approach: although most investments fail, by investing in a broad range of ventures they increase the chances of a runaway success within the portfolio. Thus, downside potential, which is always present, is not the sole or even primary detriment of investment size. By contrast, PM was the only investment of this type for both the OTL and CCRMA and both groups were weary to assume too much downside risk.

Moreover, venture capital funding levels tend to be driven higher, in part, by the larger pool of money that they have to invest and by the venture capitalists' desire to hold a meaningful ownership percentage. Staccato Systems, therefore, raised $4.2 million from Allegis Capital, Chase Capital Partners, and Yamaha. (There is no evidence, incidentally, that this higher funding level was tied to reduced technical risk; by contrast, the difficulties encountered by the team while based at Stanford may have *highlighted* the technical risk of PM.)

In turn, Koepnick argued that the funding level was tied directly to the commercialization approach and performance. Reflecting on how commercialization proceeded in the Stanford context, Koepnick argued:

> We just didn't have the resources. When I say resources, obviously the first thing you need for resources is money. I think it might have been a different story if we had more money. . . . The way it would have been done at a commercial firm would have been a lot more money. The [funding level] limited our runway [the amount of time they could operate until cash ran out] and it limited our personnel. So, we used a lot of money to build the tool and didn't have anything for the strategic marketing – to find out what people really wanted and then wrap it into our development. . . . We just didn't have the resources (personal interview, 2004).

As Koepnick's commentary indicates, financial resources shape and enable technology development strategies. With limited financial resources, the within-university effort shortchanged marketing. By contrast, venture-capital funding of Staccato enabled the team to build out its marketing efforts and to hire additional engineers as they pursued the video games industry.

5.7. Board of Directors

Funding sources also influenced the broader network of people involved in each commercialization effort. Specifically, university funding was not accompanied by external connections, nor did it result in the formation of a Board of Directors since the effort was a "project" but not an independent organization. In investment parlance, university money was not "smart money" (Sørensen, 2007b).

By contrast, Staccato's formation and fundraising efforts resulted in the creation of a Board of Directors. With the initial seed funding, the board consisted of an angel investor, CEO Koepnick, and one other Staccato co-founder. In turn, the board expanded to five people with the Series A investment, including representatives from the venture capital firms and from Yamaha (and retaining Koepnick as the only Staccato employee on the board). In other words, the board composition evolved with the financing and reflected a growing team of allies (Vanaelst et al., 2006).

Fundamentally, the board oversaw the Staccato management team and, to an extent, the commercialization efforts. As then-CEO Koepnick recalled, board oversight led to greater accountability and urgency:

> [At Staccato] we had to report to the board what was going on and why. And then we had a timeframe. At the university, it's a little easier to go "Alright. That's cool. Let's just push back a little bit." At the corporation, that's just almost unacceptable. They'll give us a number. Don't exceed it. Don't be late. Don't be early. Just hit the number, whatever you do (personal interview, 2004).

Zahra and colleagues (2009) have argued that also boards serve an important role by infusing resources and knowledge into an entrepreneurial effort (see also Garg, 2013). To this point, the board's network of connections proved particularly important to Staccato. As Koepnick argued, "If you go outside for funding, you bring in the people, the Whims of the world [James Whims was one of the venture capitalists on Staccato's board] and the people that can introduce you to the right people" (personal interview, 2004). Koepnick went on to relay his account of a difficult negotiation with a large consumer electronics firm. When Whims appeared

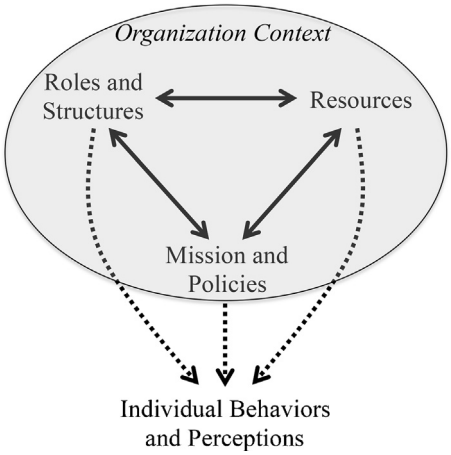

Fig. 1. Model of the relationship between contextual elements and individual behaviors and attitudes.

in Koepnick's office one day and Koepnick shared news of the difficulties, Whims picked up the phone and called the president of the US headquarters. The next day, they reached an agreement. Indeed, several team members recalled how Whims and other board members guided Staccato's strategy and helped them to overcome roadblocks – again shaping the commercialization process and playing a role in Staccato's ultimate success (personal interview with Tim Koepnick, 2004; personal interview with Scott Van Duyne, 2004; personal interview with Will Snow, 2010).

5.8. Interactions between organizational context and individuals

The foregoing analysis highlights several features of the organizational contexts at Stanford and Staccato that influenced the PM commercialization process. Some of these features concern roles and structures, as with the project focus of participants, the technical oversight and management, and the role of a Board of Directors. Other features concern organizational missions and policies, as with the emphasis on exploration or exploitation (March, 1991), the role of open sharing and other academic norms, and the university-context Conflict of Interest policy. Still other features concern resources, which are apparent in the source and size of funding and the role of external advisors and other connections. An important aspect of this analysis, however, is that these features interact to shape the overall organizational context. For example, the Stanford COI policy both influenced and reflected commercialization management roles; funding arrangements were tied to the degree of focus on commercialization and to the creation of a Board of Directors; the Board of Directors encouraged exploitation over exploration; and so on.

Critically, these organizational context features also shaped individual-level attitudes, perceptions and activities. For example, the broader university mission, which celebrates novel ideas, shaped the way in which the developers approached their commercialization work by encouraging them to pursue these ideas; the lack of technical oversight and the disconnect between market and technical leadership reinforced non-market-oriented pursuits; and the lack of individual equity suggested to participants that commercialization in the university environment might be approached like any other hourly job and without the sense of urgency that accompanied commercialization in the startup context.

Fig. 1 illustrates these relationships graphically. A primarily implication of this model is that individuals' approaches to commercialization activities cannot be understood independent of their organizational context. In turn, this perspective shifts attention from identifying the "right people" to facilitating the "right environment." Indeed, the specific people involved at both the university and the firm constituted what might be termed a "dream team." Following Jensen and Thursby (2001), the team included the faculty inventor. It also included the world's other foremost experts in PM. As licensing associate Hammond reflected, "The people who had the most technical expertise were the people that we were working with. . . . If anybody was going to make it fly, it would be them." Hammond continued, however, by sharing her realization that "[We needed] someone to start a company. . . . to fully realize the technology" (personal interview, 2004). In other words, PM commercialization was not a matter of getting the right people; instead, it was a matter of getting the right people in the right organization context to commercialize the technology. Ultimately, as Koepnick reflected, "It needed to be run more like a business than we did [at Stanford]. . .Trying to do it wholly within the university with a licensing associate running it is probably not a very practical thing to do" (personal interview, 2004).

6. Discussion

6.1. Organizational context and entrepreneurial behaviors

This analysis adds to a growing body of research that illustrates the role of organizational context in shaping entrepreneurial behaviors (Dobrev and Barnett, 2005; Lee et al., 2011; Sørensen, 2007a; Stuart and Ding, 2006). Specifically, I show how organizational context not only shapes the decision to engage in entrepreneurship – as prior studies have demonstrated – but also the approach taken to commercialization processes. I also detail how university and firm contexts, in particular, influence these behaviors and perceptions. In the PM case, the participants embodied the phrase, "When in Rome, do as the Romans" – or rather, "When in a university (or a startup), do as the archetypal university researcher (or the archetypal entrepreneur)." In turn, these results suggest that understanding entrepreneurial behaviors may demand attention not only to individual-level characteristics but also to contextually-informed approaches to action. Indeed, a striking finding from the case concerns the extent to which the same individuals adopted very different behaviors and perspectives in the different organizational contexts.

Incidentally, the evidence that organizational context plays such an important role in shaping entrepreneurship and commercialization is good news for policy makers and educators alike: if entrepreneurship is a genetic or a personality characteristic, then policy and education initiatives are limited to shaping the "rules of the game" (North, 1991) to motivate those individuals who already are inclined to act entrepreneurially. A more substantial role for context, however, opens space for policy and educational initiatives to have greater potential impact by shaping the behaviors of *all* individuals and not only the small subset already inclined toward entrepreneurship.

At the same time, however, organizational context might not be as malleable as some would hope or believe. Instead, the multiple aspects of organizational context (Table 2) and the self-reinforcing interactions between these elements (Fig. 1) can make it difficult to change a context to be more conducive of commercialization activities. For example, although Stanford could alter its Conflict of Interest (COI) policy to allow faculty to oversee projects in which they have a direct financial stake, the influence of other factors – including the broader exploration-focused university mission, the multiple ongoing responsibilities of participants, and the restrictions around equity compensation for some team members – would still limit the success of commercialization efforts. Similarly, in the PM case, it is doubtful that individual initiatives such as faculty workshops on entrepreneurship, access to technical equipment,

or a seed grant in the tens of thousands of dollars – all common approaches taken by universities in their attempts to spur entrepreneurship – would have changed the fundamental commercialization process and influences at Stanford. (In fact, Stanford offered all of these resources.) Instead, the multifaceted and integrated means by which contextual features reinforce one another make for a system that can be difficult to change.

In turn, struggles within the Stanford environment to commercialize PM may be attributed, at least in part, to the tension or misalignment between different contextual features – evident, for example, in Stanford's desire to increase licensing revenue by bringing in developers, while also maintaining a COI policy that limited the oversight of these developers. Thus, even as features of a university research group can be similar to features of a startup firm (Etzkowitz, 2003), it is the *combination* of features that matters.

For a similar reason, attempts to shift an organizational context to facilitate a subset of activities (such as commercialization, in the Stanford case) also can have negative consequences for other activities. For example, the university context is wonderfully effective in supporting basic research and other activities that more market-oriented organizations have little incentive to conduct (Arrow, 1962; Nelson, 1959). In turn, to the extent that a university attempts to become more "firm-like" to facilitate market-oriented technology development, it could have a detrimental effect on those aspects of its context that undergird its success at supporting non-market-oriented research and other activities. (Here, it is important to note that even from a financial perspective, the perceived magnitude of commercialization activities through the technology licensing office is almost certainly overrated compared to the teaching and research activities at the core of the university. For example, in fiscal year 2013–2014, Stanford was a $4.8 billion enterprise; its Office of Technology Licensing revenue was approximately $77 million, or less than 2-percent of that total (Stanford University, 2013b).)

As this point signals, the contrasting organizational contexts in the PM case appear to be tied to a broader tension between exploration and exploitation (March, 1991). In fact, one reading of the case evidence builds upon Zahra's (2008) argument that some contexts are more conducive to discovery while other contexts are more conducive to opportunity creation. In the PM case, the university and firm contexts, in particular, appear to be optimized toward different goals.

Of course, there is room here for healthy skepticism about the extent to which exploration (exploitation) is endemic to the university (firm). As Shapin (2009, 2010) points out, industrial settings can actually be *more* congenial to curiosity-driven research than university settings. In fact, extensive evidence of open sharing by firm-based researchers (e.g., Cockburn and Henderson, 1998; Hicks, 1995) and of market-oriented activities at universities (e.g., Kleinman, 2003; Owen-Smith, 2003; Vallas and Kleinman, 2008) suggests that simplistic university-firm dichotomies may be of limited utility. In turn, my results are not intended to establish that universities will necessary function like Stanford in this case or that firms will necessarily function like Staccato. Instead, they provide evidence that these specific examples of organizational context shaped in meaningful ways the actions of individuals within them, and that different elements of organizational context can be mutually reinforcing.

Consideration of how context shapes universities' commercial and non-commercial pursuits also raises questions about the extent to which organizations may adopt "hybrid" positions. Owen-Smith and Powell (Owen-Smith, 2003; Owen-Smith and Powell, 2001) have described the ways in which universities can emphasize commercial and non-commercial aims simultaneously, leveraging success in one arena into success in another and, therefore, acting as "hybrid" organizations. Although the present case does not directly contradict that argument – indeed, Stanford is well-known for its successful "hybridity" – it does suggest that universities may not be optimized for more "pure" commercial activity and that this limitation stems from their organization, resources (and business model), and governance and mission (Fig. 1). In turn, even as some universities move toward hybrid models, these moves may face contextual limits or they may introduce increasing conflicts as contextual elements bend and break under new pressures.

6.2. University technology development efforts: a (mostly) cautionary tale

This case also illustrates how university technology development efforts can present other (largely unforeseen) challenges. First, commercialization attempts may place universities in conflict with industry players, including those with whom positive relationships currently exist. In the PM case, for example, Korg, another company in the music/audio industry, hinted at suing Stanford over potential patent infringement when the Stanford team directed its commercialization efforts toward a product similar to one of Korg's own (Stanford OTL, 1994). Interestingly, Korg was, at the same time, a member of CCRMA's industrial affiliates group, meaning that it paid an annual fee to CCRMA in order to gain access to research results and recruiting events (Nelson, 2012). Similarly, Stanford's actions may have represented a competitive threat to Yamaha. As Koepnick recalled, "They [Yamaha] never in their wildest dreams would think that Stanford itself would try to set up something that might be competitive with them. I don't think that was in their thought process" (personal interview, 2004). Thus, university commercialization pursuits can run the danger of upsetting important research sponsors, partners, licensees, and future employers.

Second, such efforts could threaten universities' legal status. In the Madey versus Duke University case, the Federal District Court found that Duke was not liable for patent infringement because Duke is "dedicated to teaching, research, and the expansion of knowledge. . .[and] does not undertake research or development work principally for the purpose of developing patents and commercial applications" (Madey v. Duke University, 2002) and thus enjoys a research exemption. The Federal Appellate Court overruled this finding, however, on the basis that Duke *did* seem to be engaging in activities with commercial aims (Madey v. Duke University, 2002), a finding that dramatically curtailed the research exemption. In the PM case, Stanford's efforts to develop technology were explicitly driven by the desire to increase their commercial value and, therefore, to realize increased revenues for the university. If a university begins to look like a firm by engaging in profit-driven commercialization – albeit with less success, perhaps, for the reasons outlined above – it may run the danger of losing the special legal status that enables much of the teaching and research at the core of its mission.

Third, commercialization efforts can raise questions about which activities constitute legitimate pursuits for a university. Meyer and Scott (1983, p. 201) define organizational legitimacy as "the degree of cultural support for an organization – the extent to which the array of established cultural accounts provide explanations for its existence, functioning, and jurisdiction, and lack or deny alternatives." Thus, organizations enact cultural roles that align with particular activities, such as exploration or exploitation (Deephouse and Suchman, 2008; Suchman, 1995). In turn, attempting to change these roles and/or activities can present challenges to an organization's legitimacy (Suddaby and Greenwood, 2005) – and can threaten the success of the new roles and activities themselves.

Finally, university efforts to spur commercialization through internal development may, ironically, *limit* the ultimate commercialization of technologies. For example, the PM commercialization

effort led Stanford to charge relatively high licensing fees because, they reasoned, the technology was now more developed. To Smith, the inventor, "They priced it out of reach of small companies. It's extremely expensive. . .There have been lots of people over the years who want to do something, but are locked out" (personal interview, 2004). In this way, Stanford's commercialization efforts may have prevented others from engaging in commercialization and, ironically, may have limited the diffusion of the technology, especially among small firms.

The lessons learned, however, are not all cautionary. Undoubtedly, the Stanford effort fell short of published expectations and several participants reflected on it as a "failure." Yet, another reading of the case evidence is that Stanford created a unique hybrid-organization commercialization strategy through the PM effort: They accomplished enough through the Stanford development effort to facilitate the subsequent success of Staccato. Indeed, Staccato's $30 million acquisition – and Stanford's 20% share of the proceeds – was certainly fueled to some degree by what the participants learned during the Stanford effort. Moreover, the Stanford effort may have enabled the Staccato team to better "time" the market (e.g., introducing a product once there was demand) and to sustain the development effort over a longer period of time by spanning and integrating organization types.

At the same time, it is critical to acknowledge Stanford as a special case: Stanford was an early entrant into commercialization activities (Colyvas, 2007; Mowery et al., 1999); it has a history of embeddedness with corporate interests and commercial firms (Kenney et al., 2004; Mody and Nelson, 2013); its students, faculty and alumni engage in considerable entrepreneurial activity (Eesley and Miller, 2012); and it benefits from a central location in Silicon Valley and from the significant resources of an elite private university (Kenney, 2000). In other words, Stanford enjoys many advantages tied directly to technology commercialization – and yet the effort within Stanford still fell short of expectations. Universities that do not have Stanford's features, therefore, might be especially cautious about engaging in such market-oriented commercialization activities.

6.3. Implications for entrepreneurial innovation

These various challenges and opportunities also give pause for reflection on the relationship between university-directed commercialization efforts and entrepreneurial innovation. Baumol (2002) makes the case that entrepreneurial innovation is the true source of national competitive advantage, contrasting entrepreneurial innovation against efforts by large multinational firms. As Baumol would be the first to recognize, however, some innovations (such as particle accelerators, semiconductor manufacturing equipment, large-scale weapons systems, and passenger jets) may be beyond the capacity of lone startups, due to their significant resource requirements. In turn, Jon Sandelin, a senior licensing associate at Stanford, shared that the majority of Stanford's licenses are to existing larger companies, not startups, in part because these companies have the necessary resources to devote to technology development (personal interview, 2005). Indeed, recall that Yamaha put 100 engineers on their PM development effort. This point suggests that technology context may be critical to assessing the role of entrepreneurial innovation in relation to universities. Ironically, if university technologies are "early stage" and require more development, as some scholars suggest (e.g., Jensen and Thursby, 2001), then universities may be tied more closely to what Baumol (2002) terms "structural innovation" than entrepreneurial innovation.

At the same time, however, the illustration of PM's successful commercialization through a startup, Staccato Systems, reinforces the critical role of startups in commercializing university research (Grimaldi et al., 2011). In turn, these potentially conflicting observations point to the need for a contextual approach to innovation itself. Rather than suggesting that "firms are better at innovation than universities," "small firms are better at innovation than large firms," or "entrepreneurial innovation plays a more important role structural innovation in universities," the present case points to the need to seek alignment between technological, organizational, institutional (and likely national) contexts – for it is in leveraging context and in recognizing where each context excels that we may hope to further both innovation and excellence in other university activities.

6.4. Conclusion

Ultimately, this case analysis supports scholars who highlight the critical role that context plays in shaping entrepreneurship and commercialization behaviors, extending the role of context to the organization and examining the ways in which it shapes behavior beyond the initial decision to become an entrepreneur. It also underscores the potential mismatch between organizational context and the resource, structural, and mission-oriented demands of commercialization processes – in turn, raising questions about the appropriate level of university involvement in technology commercialization. What is challenging for technology development, however, may be good for technological progress; indeed, the Stanford context gave rise to PM in the first place. In our race to exploit university research, therefore, we might be well-advised to not only acknowledge but also embrace those aspects of the university context that mark it as distinct from the firm – for it may be these very features that plant and nurture the research undergirding future marketable technologies.

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Appendix A. Interviewees

Interviewee name	Position	Interview date(s)
Chris Chafe	Stanford professor (CCRMA)	March 2002
John Chowning	Stanford professor (CCRMA)	July 2005, March 2008, April 2008, May 2008
Ann Hammond[a]	Stanford licensing associate	July 2004
David A. Jaffe	Hired developer, Staccato co-founder	April 2009
Joe Koepnick	Stanford licensing associate, Staccato co-founder and CEO	August 2004
Nick Porcaro	Hired developer, Staccato co-founder	August 2004
Jon Sandelin	Stanford senior licensing associate	February 2005
Pat Scandalis	Hired developer, Staccato co-founder	August 2004
Julius Smith	Stanford professor (CCRMA), PM inventor, Staccato co-founder	July 2004, March 2007, April 2008, May 2008
Will Snow	Staccato engineer	October 2010
Scott Van Duyne	Stanford PhD student (CCRMA), Staccato co-founder	September 2004

[a] This name is a pseudonym.

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