



## Lab, Gig or Enterprise? How scientist-inventors form nascent startup teams<sup>☆,☆☆</sup>

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### ABSTRACT

The entrepreneurial teams that form around university-based technologies influence whether and how those technologies are commercialized. Past research has emphasized the roles of external actors, such as technology transfer officers or investors, in managing the evolution of academic startup teams. But less is known about how individual scientist-inventors form their initial teams. To explore that process, we conducted longitudinal interviews with nine scientist-inventors leading nascent startups at major U.S. universities. Our analyses revealed that these scientists were working with a more extensive set of commercially-relevant knowledge and network connections than past research has accounted for. In fact, the scientists had their own “lay theories” of academic entrepreneurship that encompassed team-specific ideas as well as broader ideas about how their technologies ought to be commercialized. We identified four “design principles” capturing key variations in what the scientists hoped to achieve through their teams: *control*, *scope*, *entitativity*, and *dynamism*. We further found these principles clustered into three distinct commercialization models, which we called *Lab*, *Gig*, and *Enterprise*. Finally, we elaborated the models’ implications for the scientists’ team formation strategies, the sources through which they identified new members, and their approaches to dealing with administrators and investors. Our findings change what we know about nascent academic startups by showing how scientists play a critical internal role alongside, prior to, and sometimes instead of the external drivers of team formation whose roles have been more extensively documented.

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## 1. Executive summary

Innovations that deliver improvements in human health, environmental stewardship, and other widely-valued ends are often grounded in academic research. One way academic research gets commercialized is through university-based startup firms, and a key factor in the success of any startup is the entrepreneurial team (ET). Generally, research on ETs suggests that individual founders' choices play a critical role. But we know less about how individual academic founders form their initial ETs. Instead, studies in this area have tended to focus on how academic ETs are shaped by other actors, such as administrators from the universities' technology transfer offices (TTOs) and investors.

We set out to learn more about how individual scientist-inventors actually navigate the ET formation process. To this end, we identified nine scientist-inventors at major U.S. universities who were considering forming startups, and we conducted several interviews with each of them over a five-year period. We analyzed these interviews along with archival data on their backgrounds.

The scientists we interviewed had substantive and sometimes quite elaborate ideas about ET formation as well as relatively broad social networks that included people with significant commercial backgrounds. In fact, the inventors appeared to be working with their own "lay theories" of academic entrepreneurship. These lay theories encompassed team-specific ideas as well as broader ideas about how their technologies ought to be commercialized, and they focused on ways in which their ETs could advance – or inhibit – their inventions' progress down their preferred pathway of commercialization.

Through inductive analyses, we identified two key elements of the scientists' lay theories: Design principles and design models. Design principles guided the scientists' choices about the characteristics of early-stage ETs. We identified four principles capturing key variations in what the scientists hoped to achieve through their teams: *control*, *scope*, *entitativity*, and *dynamism*. We further found that these principles clustered into three distinct models of the commercialization process, which we called *Lab*, *Gig*, and *Enterprise*. Finally, we determined that each model had different implications for the way scientists formed ETs, such as their formation strategies and the sources through which they identified prospective team members. We also found that the inventors' models influenced their decisions about whether and when TTOs or investors – the external drivers of ET formation in this context – ought to be involved in their ventures. Drawing our insights together, we assembled a framework that highlights the important role scientists play as internal drivers of ET formation in academic startups.

Future scholars can build on our findings to develop a better understanding of founders' intentions and the ways in which those intentions interact with the more widely-understood external drivers of ET formation during the development of an academic startup. In addition, universities can use this knowledge to improve the way they structure and administer programs intended to support academic entrepreneurship. For example, our findings underscore the need for universities and policymakers to pay more attention to non-traditional academic startups, such as those that develop without the support of the TTO, those launched by non-tenure track researchers such as graduate students and postdoctoral fellows, and those that prioritize research translation and social impact over commercial success. In addition, our findings could help technology transfer officers, investors, and others who work with academic startups to understand more fully the beliefs, intentions, and concerns that academic researchers bring to the startup process. Improved understandings of these matters, in turn, can be used to strengthen various initiatives, such as training and coaching programs, incubator programs for academic startups, and communication and incentive systems within universities or university-industry partnerships. Finally, our findings may help faculty themselves to better understand the choices associated with forming an ET within a nascent startup and to reflect on their own goals and intentions as they relate to various commercialization alternatives.

## 2. Introduction

University-based startups are important vehicles for innovation and the commercialization of academic research. Accordingly, there is widespread scholarly and practical interest in understanding the factors that influence the formation and growth of these firms (Djokovic and Souitaris, 2008; Fini et al., 2018). Given that a key factor in the success of any startup is the entrepreneurial team (ET) (Klotz et al., 2014), scholars have called for work that deepens our understanding of the formation of ETs that launch university-based startups (Ben-Haïedh, 2017; Nikiforou et al., 2018). Past studies of ETs in university-based startups have tended to focus on the ongoing evolution of teams that have already been formed (Nikiforou et al., 2018; Wright et al., 2008). In particular, past work has emphasized the roles of certain external actors – most notably, university administrators from the technology transfer office (TTO) and investors – and their efforts to shape the composition of academic ETs in preparation for external investment and growth (Lazar et al., 2019; Nikiforou et al., 2018).

This approach, which focuses on the "externally-driven" evolution of existing ETs, has shed light on how academic startups develop. But it provides an incomplete picture of ET formation in academic startups for several reasons. First, the choices academic founders make during the early stages of ET formation remain less well understood even though such choices can exert an "imprinting" effect on the teams and ventures that follow (Baron et al., 1999; Beckman and Burton, 2008; Klotz et al., 2014). Vohora et al. (2004) observed this, noting that the decisions of early-stage team members affected "the entire future success of the [venture], since they directed the path and the alternatives that were available to the firm at a later date" (p. 156). Second, academic startups are heterogeneous. Being founded by a diverse set of scientists within a wide range of institutional environments, academic startups attract – and seek – different degrees of attention from external actors (Goldfarb and Henrekson, 2003; Markman et al., 2008). Despite these variations, however, research on academic ETs has paid less attention to the individual scientists who represent the "internal" drivers of team formation (Nikiforou et al., 2018). As a result, the academic ET formation literature remains somewhat disconnected from the broader literature on private sector ET formation, which has focused in depth on individual founders' formation strategies and networks (Lazar et al., 2019; Ruef, 2010; Wasserman, 2012).

Taken together, these considerations imply a need for more research on how individual scientist-inventors navigate the early stages of the startup process (Jain et al., 2009; Nikiforou et al., 2018). Balven et al. (2018) underscored this point in their recent literature review when they encouraged scholars to “shift more attention to the key ‘supplier’ of [academic entrepreneurship], the faculty member” (p. 38) and, in particular, to the psychological and relational processes that undergird faculty behavior. Accordingly, we ask, “How do academic scientists go about forming ETs to launch startups?”

Because prior theory about academic entrepreneurs’ pre-founding cognition is limited, inductive methods represent a compelling inquiry path (Edmondson and McManus, 2007). Felin and Zenger (2009) observe, for example, that “a grounded approach provides the natural next step” for exploring how “entrepreneurs’ beliefs about the value of resources and resource combinations prompt the decisions and actions that define entrepreneurship” (p. 127). Therefore, we conducted and analyzed multiple interviews with nine academic scientists at major U.S. universities who were considering forming startups.

We found that the scientists we interviewed made thoughtful, conscious choices about ET formation. Like entrepreneurs in private sector settings, for example, they employed a mix of resource-seeking and interpersonal attraction formation strategies, but they did so in distinctive and systematically varying ways. And in identifying prospective team members they drew upon their own relatively broad social networks that included people with significant commercial backgrounds. Moreover, we found the inventors often had strong and specific beliefs about whether and when TTOs or investors – the traditional external drivers of ET formation in this context – ought to be involved in their ventures. We concluded, in fact, that the inventors were working with sets of ideas that extended some distance beyond ETs per se. They had well-formed “lay theories” of academic entrepreneurship (Kruglanski et al., 2009), and they focused on ways in which their ETs could advance – or inhibit – their inventions’ progress down their preferred pathway of commercialization.

Through our analyses, we identified two key elements of the scientists’ lay theories: ET design principles and design models. We identified four design principles capturing the main variations in what the scientists hoped to achieve through their early-stage teams: *control*, *scope*, *entitativity*, and *dynamism*. We further found that these principles clustered into three distinct models of commercialization, which we termed *Lab*, *Gig*, and *Enterprise*. And we elaborated the implications of each model for three critical aspects of ET formation in this context: the formation strategies the inventors adopted, the extent to which they used their networks as sources of prospective members, and how they thought about external actors that could influence their ETs, most notably TTOs and investors.

Taken together, our findings change our understanding of how academic ETs are formed. In contrast to what some past accounts might suggest, the scientists we spoke with were not naïve or marginal participants in ET formation. Rather, by drawing on their own knowledge and connections, the scientists played an active internal role in ET formation alongside, prior to, and sometimes instead of the external drivers of team formation whose roles have been more extensively documented. This, in turn, should prompt scholars to study academic ET formation within a broader range of startup trajectories, to reconsider the criteria of success applied to academic startups and their ETs, and to explore how academic ETs can be shaped by interactions between internal and external actors over time.

### 3. Theoretical background

Researchers divide the ET lifespan into three heuristic stages (e.g., Francis and Sandberg, 2000; Ben-Haïedh, 2017): *formation*, when the team is being assembled; *functioning*, when the team exists and its members are developing a venture; and *outcomes*, when the performance of the team and venture can be assessed.<sup>1</sup> Our focus is on team formation, and – as we explain below – on factors that precede the formation of the ET. What we know about the formation of academic startup teams is based on two main literatures: 1) studies of ET formation in nascent ventures generally, and 2) studies of ET formation in academic startups, in particular. We discuss each of these literatures in turn.

#### 3.1. ET formation in nascent ventures

Scholars reviewing the ET literature have observed that the “formation phase is widely neglected” and that the “level of research is still quite low” (Ben-Haïedh, 2017; p. 29). Nevertheless, some studies have examined ET formation within nascent private sector ventures across a range of industry and geographic contexts (Lazar et al., 2019), and collectively these studies offer several summary insights relevant to our investigation.

First, although ETs may originate with groups (Kamm and Nurick, 1993), individual founders often play an active, deliberate role in the ET formation process (Bolzani et al., 2019; Lazar et al., 2019). For example, Ruef (2010) frames the initial stage of ET formation as one in which “entrepreneurs face a decision as to whether they should recruit others to join their nascent venture and how to involve those participants” (p. 14). Similarly, Shah et al. (2019) concluded, “there is a clear delineation of roles among founders”, wherein ET members are recruited by a lead entrepreneur “through a deliberate search process” (p. 1419). Wasserman (2012) identified ET formation issues among several core “dilemmas” founders face in launching ventures, including choices about whether and how they ought to divide with others the roles and rewards associated with venture creation.

Second, studies of ET formation in nascent ventures have identified two main “formation strategies” by which entrepreneurs identify prospective ET members (Lazar et al., 2019): (1) an “interpersonal attraction” approach wherein entrepreneurs select team members based on interpersonal considerations, such as liking and trust; and (2) a “resource-seeking” approach wherein entrepreneurs

<sup>1</sup> This is a simplified model, not a literal account of how teams evolve.

select team members based on their capacity to bring to the ET needed resources, such as knowledge, skills, or financial assets (Forbes et al., 2006). For example, consistent with the “attraction” approach, entrepreneurs commonly form teams by approaching people whom they already know and trust (e.g., Ruef et al., 2003), including friends (Wasserman, 2012) and in some cases family members (Aldrich and Cliff, 2003; Discua-Cruz et al., 2013). Resource-seeking strategies, meanwhile, are also utilized (e.g., Shah et al., 2019), although Wasserman’s (2012) findings led him to conclude that they were less common than attraction strategies. Finally, studies have shown that the two formation strategies can operate concurrently or alternate with one another (Ben-Haïedh, 2010; Aldrich and Kim, 2007).

Third, notwithstanding the active role that founders have been shown to play in the team formation process, studies have also made clear that the decisions and behaviors of any individual founder are significantly shaped by various aspects of their social contexts, including their networks (Ruef, 2010; Kim and Aldrich, 2017). In the simplest sense, for example, a founder’s social network defines both the number and type of people at hand who could be considered prospective ET members. Thus, network effects represent an alternative and sometimes complementary explanation for patterns of ET formation that may be more commonly attributed to the two main formation strategies reviewed above. For example, when early-stage team members are found to belong to the same family or ethnic group as the founder (Ruef, 2010; Hart, 2014), this observed homogeneity may be a function of “choice homophily,” which arises when people exhibit a propensity to associate with similar others, as well as “induced homophily,” which arises when people exhibit an in-group bias based on the opportunity structures to which they are exposed (Ruef, 2010: p. 74). Relatedly, founders may be more likely to exhibit one or the other of the two main formation strategies depending on the structure of their own networks (Aldrich and Kim, 2007). More broadly, context can affect ET formation through the setting in which it occurs (Lazar et al., 2019). For example, ETs formed in accelerators (Cohen and Hochberg, 2014) or in connection with family businesses (Discua-Cruz et al., 2013) are likely to exhibit formation processes that reflect those settings.

In summary, research on ET formation suggests that entrepreneurs form teams by working with a mixture of their own ideas, such as their intentions and decision criteria, and various aspects of their contexts, including their social and professional networks. Accordingly, scholars have sought to shed light on both the cognitive and social determinants of ET formation and on the ways in which these determinants interact (e.g., Parker, 2009; Ruef, 2010; Wasserman, 2012). At the same time, research on ET formation across a range of industry and geographic contexts has made clear that the formation process can vary considerably across contexts (Ben-Haïedh, 2017; Lazar et al., 2019), which is why it is important to look closely at the subset of ET formation studies that have focused on academic startups.

### 3.2. ET formation in academic startups

Compared to the broader literature on ET formation, the literature on academic startup team formation has paid considerably less attention to the choices and networks of individual scientist-inventors in assembling the initial ET. Instead, this literature has tended to focus on how ETs evolve after they are founded and on how external actors, such as TTOs or investors, influence the teams’ ongoing development. To the extent these studies attend to early-stage ETs, they call attention to the homogeneity of the ETs academics form. They also tend to characterize this homogeneity as a defect and infer that it stems from the narrowness of scientists’ own knowledge and networks.

For example, Colombo and Piva (2012) compared the ETs of academic and non-academic technology-based startup firms in Italy. They found that the academic startup ETs had higher levels of scientific or technical work experience and less commercially-relevant work experience. These teams, they concluded, “tend to be composed of academics who work on similar research topics” (p. 80). Although they did not specifically study ET formation, they speculated that “the formation of firms’ founding teams is mainly driven by the similarity of personal characteristics and by prior network ties among individuals” (p. 80). Similarly, Ensley and Hmieleski (2005) compared the top management teams of academic and non-academic startups in the U.S. and found that academic startup teams were more homogeneous. They did not directly study ET formation either, but they speculated that this homogeneity arose because scientists “have knowledge of normal behavior only as it relates to their given field, and only easily recognize and integrate information from within their restricted environment” (p. 1095).

More direct evidence regarding these claims is provided by Mosey and Wright’s (2007) study of the networking behaviors of academic entrepreneurs. They looked at changes in the human capital and social capital of 24 academic entrepreneurs in the U.K. exhibiting different levels of prior commercial experience. Their observations led them to conclude that “the social network of academics is typically constrained to a narrow scientific research network” and that “many academics may have only loose or weak ties with actors located outside their department” (p. 911). But they further observed that those academics who did possess business knowledge were better able to develop their social capital, as they tended to have “broader social networks and [were] more effective in developing network ties” (p. 932).

Many academic ET formation studies are longitudinal, adopting a wide temporal lens. One reason is that academic venture development is a long process – sometimes considerably longer than in private sector ventures. For example, the startups studied by Rasmussen et al. (2011) developed over periods ranging from eight to fifteen years. During this time, academic ventures may pass through several distinct stages, and the ET may evolve considerably (Vohora et al., 2004; Wright et al., 2008). For example, Vohora et al. (2004) studied the development of nine academic startups from UK universities and found that academic startups go through different “phases” of development, each of which is associated with distinct challenges. Although they did not focus in depth on how ETs form, they did determine that the ventures passed through a “pre-organization” phase, which entailed identifying the resources and knowledge needed by the venture and the means through which those would be acquired. They further observed that, in general, “academic entrepreneurs involved in creating USOs lack the necessary entrepreneurial human capital and social capital synonymous

with commercial awareness and prior business experience" (p. 170). But they also acknowledged that their study focused explicitly on startups pursuing commercialization "backed by business angel or venture capital investors" and that future research should explore "the process relating to the decision to select this route to commercialization" versus others (p. 173).

Other longitudinal studies show that academic ETs frequently evolve through a series of entries and exits as they attempt to adapt to their changing resource needs, and they have sought to document the evolution of ETs. For example, [Clarysse and Moray \(2004\)](#) studied the development of a high-tech startup at a Belgian university. They observed that a single scientist inventor served as the "champion" who "steered the idea and motivated others to join" (p. 67). But they also observed that very soon after its founding the venture took on an investor and a university-affiliated company coach who assumed CEO responsibilities. They went on to document ways the ET co-evolved with the development of the venture. Similarly, [Vanaelst et al. \(2006\)](#) studied ET development within 10 academic startups in Belgium. They found that team formation was critically shaped by the involvement of actors drawn from beyond scientist-inventors, including coaches, consultants, and TTO staff members, and that these actors in turn facilitate the involvement of still other external actors, such as professional managers and venture capital investors. [Rasmussen et al. \(2011\)](#) studied four university-based startups in the UK and Norway over a twelve- to eighteen-month period. During that time they chronicled the development of "entrepreneurial competencies" within the ventures. They found that these competencies were created through the interaction of academic scientists and external actors based at or near their respective universities, including investors, TTO staff, and other academic administrators.

In summary, studies of academic startup teams paint a rich picture of how such teams develop, especially when external actors are involved early in the venture's development. These studies also provide some evidence that early-stage academic ETs tend to be homogeneous. But this literature provides little direct evidence as to how individual scientists actually form or influence their early-stage ETs. Instead, academic ET formation studies tend to share a common assumption that the scientists' own contributions to ET formation are limited, because scientists generally lack commercially-relevant foresight and connections and must therefore rely on the guidance of external actors.

### 3.3. Limitations of current knowledge about academic startup team formation

When we compare the findings of studies of academic startup team formation with those of the broader literature on ET formation in nascent ventures, it becomes evident that we lack a clear understanding of how individual scientists navigate the earliest team formation stages. For example, whereas [Wasserman \(2012\)](#), [Ruef \(2010\)](#), and others examined specific, early-stage ET formation decisions made by individual founders in the private sector, the academic ET formation literature does not provide analogous insights as to how individual academic scientists make such decisions. Are scientists purposeful and reflective in forming their teams and ventures? What considerations do they have in mind, and on what basis do they seek out specific team members? Ultimately, these are questions about *individual-level cognitions* of scientist-inventors, and there are reasons to believe these questions matter.

First, as we noted, academic startups often emerge very slowly – sometimes over a period of five or ten years or more ([Agarwal et al., 2017](#); [Rasmussen et al., 2011](#)). Thus, even in cases where TTOs and investors ultimately become involved, their involvement may be preceded by a long period of incubation during which a nascent venture is led by scientists involved in the invention or an initial founding team chosen by the inventor. The early-stage teams assembled during this incubation period may determine whether the nascent venture survives and advances to such a point that it attracts the interest of external actors ([Nikiforou et al., 2018](#)). Moreover, early-stage teams shape the set of team- and venture-level capabilities that will later be available for external actors to work with ([Vohora et al., 2004](#)). Thus, it is important to understand how academic founders form early-stage teams even – and perhaps especially – when these activities predate the interest or involvement of the TTO.

Second, TTOs are not necessarily involved in all academic startups ([Miozzo and DiVito, 2016](#)). In some cases the TTO chooses not to pursue commercialization of an inventor's technology, either because it seems insufficiently promising or because the TTO is overwhelmed with alternative projects, in which case the prospects for commercialization depend on the inventor's own interest in moving the process forward ([Aldridge and Audretsch, 2010](#); [Chukumba and Jensen, 2005](#)). In some cases, too, the inventor may effectively "bypass" the TTO, either because she does not value or is not aware of the TTO's services ([Goel and Göktepe-Hultén, 2018](#); [Huyghe et al., 2016](#)). In still other cases, "the intellectual property that leads to spinoff formation takes the form of knowhow or trade secrets", as opposed to patents, which may mean the technology is harder for the TTO to assess and monitor ([Shane, 2004](#): p. 4). The exact number of startups pursuing such "back door" routes to commercialization is difficult to document, because many such activities are not formally tracked by universities ([Shane, 2004](#)). However, [Markman et al. \(2008\)](#) found that 42% of the inventors they surveyed had bypassed their TTOs at least once, and [Aldridge and Audretsch \(2010\)](#) found that 30% of academics had chosen a back door route to commercialization. Despite the apparent prevalence of these phenomena, however, we know much less about how ETs and ventures are formed in cases where the TTO is not involved.

Third, even where TTOs are at least nominally involved, the degree and nature of their involvement can vary considerably. For example, there are large institutional variations within and across countries in how university-based ventures are launched and managed ([Goldfarb and Henrekson, 2003](#); [Roberts, 2020](#)). Yet the majority of academic ET formation studies were conducted in European universities. Although these studies have provided valuable insights, their findings may be less applicable in other institutional settings, such as the U.S., where the boundaries between academic and industry circles may be more porous than is the case in Europe ([Colyvas et al., 2002](#); [Mowery et al., 2004](#)).

Finally, in recent years universities have changed in ways that call into question the blanket assumption that academics lack entrepreneurial knowledge and connections. For example, many contemporary scientists have completed their graduate studies and begun their careers within universities that support entrepreneurial activity in a variety of ways ([Boh et al., 2012](#); [Miller et al., 2018](#)).

Such changes prompted [Siegel and Wright \(2015\)](#) to encourage scholars to “rethink” the study of academic entrepreneurship, and in particular to “embrace greater variety in the extent and nature of academic entrepreneurship” (p. 583). A recent Kauffman Foundation report observed that, apart from TTOs, “the university’s larger ecosystem also plays a critical role in providing resources and enhancing the competencies of faculty and students interested in commercializing university technology” ([Boh et al., 2012](#), p. 6). Due to these changes, there exist today many “entrepreneurial academics” who do in fact have access to commercially-relevant knowledge and connections, either through their own past experiences or because they have observed and learned from the experiences of others around them ([George and Bock, 2009](#); [Miller et al., 2018](#)). But we have yet to understand whether and how faculty might be applying this knowledge to the formation of academic startup ETs.

For all of these reasons, understanding how academic startup teams form requires closer attention to phenomena that precede the ET’s emergence and operation ([Lazar et al., 2019](#)). At that stage, the task of identifying team members often falls within the discretion of individual scientist-inventors ([Clarysse and Moray, 2004](#); [George and Bock, 2009](#)). Collaborations in a laboratory may sometimes result in groups jointly deciding to pursue a startup, but a single scientist often “champions” the startup process ([Nikiforou et al., 2018](#)). These scientists generally maintain their academic positions and careers, and they draw upon these resources in their startup work ([Djokovic and Soutaris, 2008](#)). But even as they do so, their choices are likely to reflect their own individual knowledge, preferences, connections, and constraints, which can vary considerably ([Mosey and Wright, 2007](#); [Stuart and Ding, 2006](#)). As research in other entrepreneurial settings has shown, these individual considerations can influence not only *whether* a person acts but also *how* entrepreneurs assemble their initial resources (e.g., [Burton, 2001](#); [Cliff et al., 2006](#); [Clough et al., 2019](#)). Accordingly, by focusing on the pre-formation intentions of individual scientist-inventors, we seek to build on past research and expand our theoretical understanding of how ETs form in academic startups.

When we refer to “entrepreneurial teams” in this study, we mean something more primitive and emergent than what most past definitions capture. Some scholars have defined ETs to include the individuals who participate in founding a venture (e.g., [Cooper and Daily, 1997](#)) and/or those who share equity ownership in a venture (e.g., [Kamm et al., 1990](#)). Given our focus on individual cognition during the pre-formation period, combined with the fact that academic startups typically formalize their legal and organizational status later than other ventures ([Wright et al., 2008](#)), we define ETs to include any people a focal scientist considers including as collaborators in forming a startup. However, following [Cardon et al. \(2017\)](#), we draw outer boundaries to the team and do not include advisors or investors on the team itself, even though these are sometimes included in broader, more “layered” definitions (e.g., [Kim and Longest, 2014](#)). Still, our definition is more inclusive than most in that it does not require ownership or founder status and is most akin to what [Lazar et al. \(2019\)](#) recently labeled the “incipient team.”

#### 4. Research methods

In the U.S., academics who develop an invention with commercial potential typically file an Invention Disclosure (ID) with their university’s TTO. The ID is often the first indication there is more than academic knowledge in an invention, and IDs are filed before concrete decisions about forming a company happen. Thus, IDs allow systematic identification of potential ventures and ETs in their earliest stages. Building on this advantage, we used IDs to identify technologies around which teams were likely to form and before teams or ventures had been fully assembled.

This study is part of a larger project examining university-based startups. To identify a broad set of nascent academic entrepreneurs for the project, we used data from the Association of University Technology Managers to identify the 12 U.S. universities most active in generating startups. We then contacted the TTOs of these universities to solicit involvement in the study; nine agreed to participate. We supplied each TTO with our screening survey, which the TTO sent to the first filer listed on recent IDs. The first question on the survey asked, “Do you intend to use this invention to have a new company started?” In 2003 the TTOs sent 1000 screening surveys, and we received 564 responses. Most of the surveyed inventors did *not* intend to form a startup, a finding consistent with past research indicating that most university-based technologies are commercialized through licensing arrangements rather than startups ([Siegel and Phan, 2005](#)). But in 96 of the surveys (17%) the inventor answered “yes” to the first question. We invited these inventors to participate in our study.<sup>2</sup> In some cases, efforts toward a start-up were already abandoned, we could not contact the inventor, or the inventor declined. In 2004 and 2005, we conducted initial interviews representing 62 inventions meeting our criteria for the larger research project. Consistent with our interest in studying pre-formation cognitions, these interviews were conducted in “real time” as inventors considered starting a company and forming an ET. These were semi-structured interviews with a common question protocol about the invention itself, the status of the startup effort, and the people (actual or desired) involved in that effort. (The protocol is provided in an Appendix.) Interviews lasted 30–60 min and were audio-recorded and professionally transcribed.

##### 4.1. Case sampling

For this study, we sought in-depth, longitudinal comparative case analyses that would enable us to begin our observations early in the process and still allow some actions and events to unfold toward the formation of an ET. Because collecting and analyzing such data

<sup>2</sup> We refer to our respondents as inventors and scientists, using those terms interchangeably. Also, although multiple people can be listed on a disclosure, we do not have complete information about those listed on each disclosure. Finally, inventors who answered “yes” to the first question sometimes also considered alternative commercialization pathways besides forming a startup (e.g., licensing), and we discuss several instances of this in the Findings.

demands considerable time and attention, we selected a small number of cases to follow longitudinally to “maximize opportunities to discover variations among categories” (Strauss and Corbin, 1998: 201). Consistent with prior studies (e.g., Graebner and Eisenhardt, 2004), we selected cases from our larger set of initial participants based on key variations in the academic context.<sup>3</sup> Specifically, informed by prior findings (Ucbasaran et al., 2003; Bercovitz and Feldman, 2008), we used the respondent’s university setting as well as his/her professional position and prior startup experience to identify nine cases for in-depth analysis. We wanted to identify scientists with a mix of startup experience and professional positions at a single university to hold constant the institutional setting. In examining cases within each of the nine universities in the larger study, we identified one university that had sufficient variation on these dimensions and selected four inventors from that location (i.e., one tenure-track, one non-tenure track, one with startup experience, and one with no startup experience). We then chose four cases with similar experiences and positions, along with one post-doctoral researcher, from other universities chosen to provide geographic variation within the U.S.: in total, four were on the West Coast, four were in the Midwest, and one was on the East Coast. All were at major research universities producing a significant number of startups each year.<sup>4</sup> Variational sampling makes our dataset more representative of the population of startup firms at leading U.S. universities; however, it is not meant to ensure statistical generalizability to the larger population but to render analytical generalizations in the form of emerging theoretical insights (Yin, 1994: 37).

The nine inventors came from a variety of disciplines, including chemistry, engineering, medicine, and physics.<sup>5</sup> To preserve their anonymity, we refer to the scientists using descriptive labels based on the inventions for which they filed their IDs. The inventions represented a variety of technologies, including a treatment for eye disease (EyeMed), a chemical coating technology (StickyChem), an emergency medical monitoring device (DisasterMed), a novel-movement robot (RobotTech), seismic-related software (QuakeTech), computer audio technology (AudioTech), molecular interaction prediction software (BioMed), cellular-level transmission processes (CellMed), and cellular assay test support (CellTech). We conducted two to three follow-up interviews with each inventor over a five-year period between 2005 and 2009 to monitor their thinking over time and capture developments in the team formation process. Five inventors (DisasterMed, QuakeTech, AudioTech, StickyChem, and CellTech) formed an initial team during our study period; the rest did not. An online supplement provides detailed information about each of the cases and interviews. Our dataset included twenty-five interviews totaling 319 pages of single-spaced transcripts. We also gathered archival data (e.g., websites, CVs) to analyze with the interview data to better understand the scientists’ positions, contexts, and backgrounds.

#### 4.2. Analytical approach

Following a grounded theory approach, we began with open coding of data and continued with iterations between data and existing theory through which we elicited a set of concepts and relationships (Locke, 2001). We began by individually identifying text fragments within each case that revealed founder intentions about ET features or formation. We coded text fragments with a “name,” later comparing and grouping similar names into categories described by a one- or two-word “label” (Locke, 2001). Employing within- and cross-case analyses (Eisenhardt and Graebner, 2007), we compared labels and additional text fragments to refine and integrate findings. For example, one early name was “firefighter,” invoked to refer to a type of team member who could solve problems as they arise. Initially, this seemed to us to reflect composition, a widely-studied team attribute; however, in comparing this name with others and with additional text fragments around it, we concluded it was best understood as a subsidiary element of a an emergent idea, “scope,” referring to activities that founders expected to be carried out by the team.

Each author spent several hours analyzing each case, coding and writing memos to capture interpretations. Initially, memos were simple notes in which we captured our individual reflections on particular ideas or text fragments as we encountered them. Later, we wrote memos collectively to describe the emergent categories and their properties. These analyses formed the basis for an iterative comparison process completed in over 30 meetings, wherein we discussed and refined our coding and identified relationships among concepts forming the basis for our findings. Through our discussions we grouped concepts based on similarities and differences among the cases, and we captured these groupings within tables that included memos and sample quotes.

In the course of our analyses, we noticed that the scientists did not focus primarily on specific attributes of their teams, such as those past research has linked to team performance. Instead, the scientists generally had a strong sense of how they wanted their technologies to be commercialized, and they exhibited considerable variation in those desires. As we explored this further, our analyses revealed they focused on the purpose of the team and on forming teams that were able to deliver on their commercialization objectives. We iterated between data and literature to explore these observations.

These analyses prompted us to turn to studies framing management as a design process (e.g., Romme, 2003; Schon, 1983; Simon, 1996) and writings on visual design (e.g., Norman, 2013), which informed our subsequent analyses. For example, the design perspective focuses on the relationship between designers and the things, or “artifacts,” they are creating. Artifact here simply refers to

<sup>3</sup> During our initial interviews we learned that eleven of the inventions disclosed were associated with existing startups and, therefore, outside our study’s focus on pre-formation startups. Thus, our case sampling focused on selecting cases from the remaining 51 inventions.

<sup>4</sup> We indicate the inventors’ locations by designating their universities with regions and numbers in the online supplement. To preserve their anonymity, however, we do not name the institutions. We also use pseudonyms instead of the names of specific people named in their interviews.

<sup>5</sup> All nine inventors were male, as was an overwhelming majority of the ID-filing faculty who indicated they were exploring a startup firm. As Thursby and Thursby (2005) documented, female faculty disclose inventions at a lower rate than do male faculty, and the absolute number of ID-filing female faculty is very small. Also, although the role of the inventor was not a selection criterion, interviews revealed that eight of the nine inventors considered themselves the lead inventor; the last inventor was part of an equal partnership.

the result of a creative process, where in this case an ET is the artifact of a team formation process. In addition, the design literature often distinguishes between “features” and “principles” in a way that seemed to parallel what we were observing. *Design features* are elements that make up a product or artifact, and in our case these are the observed attributes or characteristics of teams (e.g., a team’s functional heterogeneity). *Design principles*, meanwhile, guide decisions about which features matter or how they ought to be arranged, and they reflect the beliefs and values that guide what a designer hopes to achieve with or through the artifact (Barry and Rerup, 2006; Norman, 2013). Building on this distinction, we defined ET design principles as a set of beliefs that scientists held about what they expected from their teams, and we distinguished these from the team features that are more commonly used to describe and analyze fully-formed teams. We also took note of the larger commercialization objectives scientists wanted to achieve with their teams, and later we accounted for these objectives in drawing an additional distinction between design *principles* and design *models*.<sup>6</sup>

But first, continuing with our case analyses, we grouped lower-level concepts capturing specific beliefs and intentions into a limited set of principles that captured broader themes. For example, the design principle “dynamism” emerged from lower-level categories that included “milestone,” which captured instances in which inventors discussed specific expectations for team changes, and “member change,” which captured the anticipated addition or departure of members. Through this process, we settled on a limited set of concepts providing a clear and complete – although not exhaustive – account of the principles nascent founders used in designing ETs (Locke, 2001, pp. 44–55). Our analyses revealed four principles: *control*, *scope*, *entitativity*, and *dynamism*. Each principle captures a distinct dimension along which scientists intended to shape their teams. Generally we drew conclusions about the scientists’ intentions by comparing explicit statements about how their teams would behave, but in some instances we observed differences between what the scientists did and did not say. In the case of dynamism, for example, as we explain below, variation arose based on the extent to which scientists’ statements indicated that they anticipated change in their teams (i.e., some did, and some did not). Ultimately, by examining the similarities and differences that emerged among the scientists’ stated beliefs and intentions, we discerned distinct dimensions along which scientists sought to shape their teams.

Having identified the design principles, we wrote longitudinal case summaries and conducted cross-case analyses comparing the nine cases, examining how the design principles related to one another. Through these analyses, we concluded that the four design principles clustered into three distinct groups, where the groups corresponded to alternative commercialization pathways, or models, the scientists wanted to pursue. We labeled these groups the *Lab Model*, the *Enterprise Model*, and the *Gig Model*. The principles associated with each model are summarized in Table 1.

Taken together, we concluded, the design principles and design models we identified represented elements of the scientists’ lay theories of academic entrepreneurship (Kruglanski et al., 2009), and that understanding the way scientists intended to form teams entailed specifying the elements and implications of these lay theories. Early studies of lay theory focused on “implicit” theories of personality and related psychological concepts (Furnham, 1988), but more recently scholars have used the term lay theory to characterize the belief structures people invoke in making sense of various non-psychological aspects of the world (Heath, 1999; Kuwabara et al., 2018; Levy et al., 2006). In our context, given that decisions to engage in commercialization are concurrent with decisions about whom to work with (Lazar et al., 2019), the inventors’ lay theories encompassed team-specific ideas as well as broader ideas about how their technologies might be commercialized. And they focused on ways in which their ETs could advance – or inhibit – their inventions’ progress down their preferred pathway of commercialization.

Through continued iteration among the literature, our data, and our emergent theoretical ideas, we developed a framework that explains ET formation in academic startups. We elaborate the structure and content of that framework in the next section.

## 5. Findings

We found that the scientists made thoughtful and varied choices about team formation. They employed both resource-seeking and interpersonal attraction-based ET formation strategies, and in doing so they often drew upon broad professional networks that included people with both technical and commercial skills. Moreover, in contrast to what some past literature might suggest, the scientists’ approaches to ET formation were not uniform, naïve, or unreflective. Rather, they appeared to be influenced by broader ideas they held about what they wanted their teams to do and what they wanted their ventures to achieve. In effect, the scientists were working with their own lay theories of academic entrepreneurship, and these theories shaped the way they thought about specific ET formation decisions.

Although some scientists were working with their TTOs and with investors, the scientists did not rely on these external actors to drive the ET formation process. Nor was it clear that scientists were forming obviously “deficient” teams that would later need to be reconfigured by such actors. In fact, the scientists’ lay theories often encompassed relatively sophisticated ideas about whether, when, and how TTOs and investors should be involved in their ETs. For example, several of the scientists were openly skeptical of the TTOs’ expertise and expressed caution about ways the TTO and investors might hinder their commercialization efforts. For example, StickyChem thought his TTO staff lacked competence at launching startups and were less commercially savvy than he was.

<sup>6</sup> Although we found certain design concepts helpful in making sense of our observations, we do not fully adopt a design perspective in our analyses. In particular, our approach differs significantly from that of “systems design”, which has been characterized as “hyperrational and undersocialized” (Weedman, 1998: p. 319). For example, although our scientists are often purposeful, we do not claim that their thinking is “rational” or that their ideas are necessarily accurate. We also acknowledge that founders’ social contexts enable and constrain their behavior in important ways. As Garud and Karnøe (2003) observed: “In being entrepreneurial, actors cannot do anything they please. As embedded actors, they can entertain certain possibilities and not others” (p. 281).

**Table 1**

Overview of the cases.

Inventor	Role	ET design principles					
		Design model	Control	Scope	Entitativity	Dynamism	Startup?
CellMed	Untenured Asst. Prof.	Enterprise	Low	Broad	Moderate	Moderate	No <sup>a</sup>
CellTech	Researcher (Postdoctoral)	Enterprise	Low	Broad	High	High	Yes
DisasterMed	Researcher	Enterprise	Low	Broad	High	Moderate	Yes
StickyChem	Tenured Full Professor	Enterprise	Low	Broad	High	High	Yes
AudioTech	Tenured Full Professor	Lab	High	Narrow	Moderate	Moderate	Yes
BioMed	Tenured Full Professor	Lab	High	Narrow	Low	Moderate	No
EyeMed	Tenured Full Professor	Lab	High	Narrow	Low	Low	No
QuakeTech	Researcher	Gig	Low	Narrow	Moderate	Low	Yes
RobotTech	Researcher	Gig	Moderate	Narrow	Moderate	Low	No

<sup>a</sup> Denied tenure and moved with licenses to a large firm, so the invention was commercialized that way.

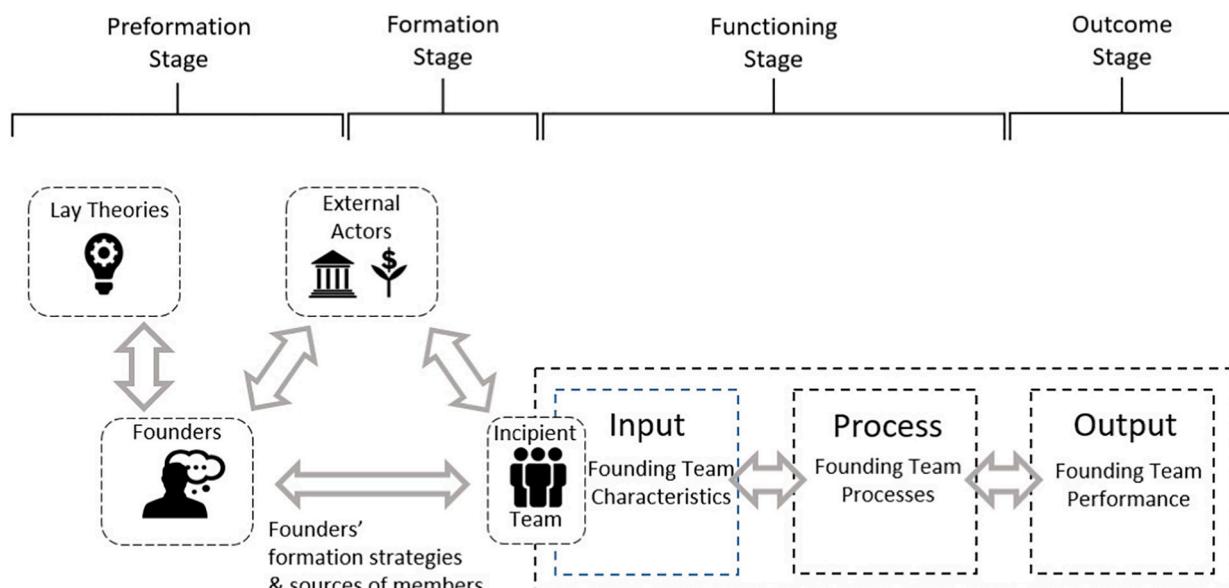
*The problem with universities is they can be very good at licensing technology if they are realistic in operating within market norms for terms. But they are not very good at starting companies. If they were, they wouldn't be at the university is the old story ... I see the terms that [the TTO] frequently propose and I see those as being untenable. They make it difficult for a real investor to later come in. [Interview 1].*

Accordingly, StickyChem identified prospective ET members by drawing primarily on his own network of contacts, which included people with both technical and commercial backgrounds. AudioTech, meanwhile, was concerned that the TTO followed a model of venture development that led to premature and excessive investment, which he believed would ultimately derail the proper development of his company. He explained his reservations this way:

*Sure, you get a chunk of money [through the university's model]. Then immediately you say, great, here is this guy, this guy, and this guy. But I'll tell you, that again is not healthy for the company, because I've seen it so many times where, OK, we've got the money. We need a VP; let's go find him. You still own these stupid little boxes. That's not going to make a company. [Interview 2].*

Based on these and other views they held about commercialization, some scientists we spoke with sought to postpone the involvement of TTOs and investors, or even to bypass them altogether.

In short, the scientists we spoke with did not think and behave in ways consistent with our existing understanding of academic startup team formation. Rather, these scientists were playing an active and deliberate role in assembling their early stage ETs. In this general sense, they resembled the private sector entrepreneurs whose individual ET formation strategies have been documented in the broader literature on ET formation. However, the scientists also expressed ideas and intentions that reflected their academic context. In contemplating the addition of specific team members, for example, they employed varied and complex ET formation strategies that were shaped by their ideas about how university-based technologies ought to be commercialized, and they often drew upon their own professional networks, which included people with both technical and commercial knowledge. Moreover, their ET formation

**Fig. 1.** A framework for ET formation in academic startups.

approaches were often linked with ideas about whether and when specific external actors, such as TTOs or investors, ought to be involved.

Fig. 1 presents a graphical depiction of the academic startup ET formation process that highlights the actors and processes that our findings illuminate. In the sections below, we elaborate the sets of ideas scientists used in forming their ETs, and we explain some ways these ideas appeared to influence specific aspects of ET formation.

As we noted earlier, the scientists' ET formation intentions were shaped by broader sets of ideas they had, which we characterized as lay theories of academic entrepreneurship. We identified two key elements of the scientists' lay theories: Design principles and design models. Design principles are considerations about what a designed product should provide; in the case of ET formation, design principles guide choices about the characteristics of nascent ETs. We identified four design principles capturing key variations in what the scientists hoped to achieve through their early-stage teams: *control*, *scope*, *entitativity*, and *dynamism*. We further found that these ET design principles clustered into three distinct models of commercialization, which we termed *Gig*, *Lab*, and *Enterprise*. In the sections below, we briefly describe each of the principles and then each of the models into which the principles cluster.

### 5.1. ET Design Principles

**Control** concerns the extent to which the ET can facilitate an inventor's invention trajectory. High control means the inventor wants a team that will develop the invention in the way s/he had in mind when making the discovery. Low control reflects that an inventor is agnostic as to how the team applies the invention, wanting a team that can get it "out there" to some commercial application. In some ways, the control principle is consistent with work recognizing control as a key consideration in new venture creation (Ruef, 2010; Wasserman, 2012). However, control in that sense refers to direct managerial power over the venture – for example, "being king" in Wasserman's (2012) rich-or-king framework. Here, control was not about personal hands-on direction but rather the founder's desire to instantiate control over the development of the invention through the team in his stead. This may reflect the fact that academic founders often do not join their ventures (Wright et al., 2008) and may therefore believe different mechanisms, such as the ET, are necessary to achieve control.

Scientists were mixed with regard to control: Five exhibited low control, one was moderate, and three were high. BioMed provides an example of high control. He had a specific application for his invention in mind, and it was paramount to him that the team not alter this path. He explained:

*From my point of view, I want to make sure the device is far enough along, the clinical trials are far enough along, that it's sort of like a point of no return ... This is a lifetime quest for me, so we're not going to stop that or introduce anything that really would short-circuit that plan. It's the holiest of grails. [Interview 3].*

He wanted a team to ensure that even if the company were acquired, the technological path would be predetermined: "so if somebody decides to make an offer or take it over, they really can't just put the kibosh on it." [Interview 3] In contrast, CellTech and CellMed were low on the control principle. CellTech described the aim of his work as "doing cell-based assays for drug discovery" explaining, "the core discovery can be applied to... different applications" and the exact application remained "kind of up in the air." [Interview 1].

**Scope** concerns the number and types of activities an inventor believes the ET needs to engage in, and it varies from *narrow* to *broad*. When scope is narrow, the inventor envisions that the team needs to perform a relatively small number of closely-related activities. When scope is broad the inventor desires a larger number and range of activities from the team. Often narrow scope was associated with the belief that the team should be assembled to accomplish a limited purpose, such as moving the IP further along, whereas broad scope implied the belief that a team should have the capacity to identify and pursue multiple courses. Scope is related to the concept of roles (e.g., Wasserman, 2012), but whereas roles are generally attached to individuals, scope is a property of the team. And whereas the firm-level concept of "functional structure" is concerned with the functional roles or positions within a venture (Beckman and Burton, 2008; p. 4), scope has to do with the range of activities an inventor envisions for an incipient ET – activities that are often more primitive and fluid than the functional roles or titles of a later-stage firm.

The scientists were mixed on scope, with five preferring a narrow scope and the rest preferring a broad scope. QuakeTech provides an example of narrow scope. He wanted a team capable of developing and marketing a software product to support risk management for earthquakes. His intended team has narrow scope, because it only needs the ability to produce a single, focused product. For broad scope, inventors envision that the activities of the ET need to be multiple and diverse. StickyChem, for example desired a team that had "reach," meaning one that could adapt to unforeseen challenges and opportunities and carry out many functions of an early-stage company.

**Entitativity** captures beliefs about whether and how members of the team fit together and the extent to which scientists viewed the team as an aggregate. For this principle we applied an existing term in the groups literature, because the beliefs and intentions expressed in this principle aligned with its meaning. Entitativity captures the extent to which a "group is perceived to be a coherent unit bonded together in some fashion" (Lickel et al., 2001: 131) as well as the degree to which a group exhibits "interdependence" and "cohesiveness" (Levy et al., 2006). Entitativity has recently been recognized as a key dimension of many startup team definitions in the entrepreneurship literature even though scholars have tended to adopt different labels for this dimension (Knight et al., 2020). In our case, the entitativity principle captures scientists' desire for their teams to be coherent, collaborative units. Entitativity reflects a founder's beliefs about the degree of cognitive-behavioral integration and affective connections that ought to exist among members of an ET to promote collaborative capacity.

The scientists we interviewed generally valued at least some entitativity: three were high, four were moderate, and two were low. Those with high entitativity believed it was vital for ET members to be configured into a distinct collective entity – a whole different

from the sum of its parts. They tended to think about how team members' knowledge and skills would *work together*, as well as picking people to support group-level processes and properties. CellTech exemplified high entitativity, describing his vision of a team with several people who could combine their skills in collaborative way: "*There would be four or five or six people that are high-level managers. That's what I envision.... a semi-democratic, small group of people*" [Interview 1]. This reflects the behavioral integration aspect of entitativity. He goes on to say, "*Probably the biggest challenge is having people get along well and have good communication between one another*" [Interview 1], reflecting his desire for a team with strong affective connections.

RobotTech, who planned on a small team with just one partner, has moderate entitativity. The entitativity principle is evident in his concerns for both cognitive/behavioral complementarity and affective connections: "*That is the most important thing... complementary skills*," he observed, while also noting, "*Sometimes you go, this guy has a lot of attractive things, but I don't like him that well, we don't get along. You pay for it ten times*" [Interview 3]. Scientists low on entitativity considered potential members in a kind of free space, without valuing whether or how individuals interact or integrate. For example, AudioTech described his plan this way: "*I'm trying to see ...where we can kind of form these teams that are really disaggregated, individual consultants*" [Interview 2].

**Dynamism** concerns the inventors' expectations about ET changes. Low dynamism reflects a desire to "work with what we've got" or that "what we've got is all we need," whereas high dynamism reflects a belief that the ET will need to change. Low dynamism is evident when inventors believe the ET they form would be complete, at least for the foreseeable future. That academic startup teams change is well documented, of course (Ucbasaran et al., 2003; Vanaelst et al., 2006). However, we observed that academic founders vary in the degree to which they desire or anticipate such changes at the outset. To some extent this principle is consistent with Wasserman's (2012) observation that founders have varying degrees of comfort with the changes others may introduce.

Dynamism levels were mixed across the sample: Two scientists were high, four were moderate, and three were low. Inventors with high dynamism envisioned change in the ET. For example, StickyChem recognized that the changing needs of the venture would eventually require different ET characteristics from those needed at startup. "*My highest value to the company is in the first two to three years*," he explained, "*and then if we do everything right it's time [for me] to have more of an honorary position in the company*." [Interview 1] In contrast, QuakeTech focused on what he could achieve with a single co-founder and did not actively desire further evolution of the team. In between the two extremes of anticipating many changes and expecting none is moderate dynamism. For example, AudioTech foresaw slow, deliberate change through which he would "*grow it at the right rate*" [Interview 1].

## 5.2. Design models

As we noted earlier, the scientists' beliefs with respect to the four design principles cluster into three distinct models, each of which represented an alternative commercialization pathway. These models exhibit strong internal consistency, with the principles complementing one another. For example, control, scope, and dynamism consistently covary, with high control associated with narrow scope and relatively low dynamism, and low control associated with broad scope and high dynamism. Entitativity also co-varies, but with less consistency.

*The LAB Model* is characterized by high control, narrow scope, low entitativity, and low-to-moderate dynamism. In the LAB model, inventors intend to form an ET that provides an extension of their laboratory with the purpose of translating their invention from basic research to a more marketable state. Maintaining close control over the invention is of central importance in this model. Because the ET supports technology development, it is narrow in scope, with a limited set of activities deemed important. The central goals for LAB ETs involve getting the invention developed further along the path the inventor intended. Commercialization is important, but the priority for the ET is to ensure technical integrity. There is relatively low emphasis on dynamism in this model, since turnover could dilute or change team values and goals. Entitativity is also low in the LAB model, perhaps because the high control and narrow scope lead inventors to prioritize the technical contributions of individual members.

*The Enterprise (ENT) Model* is characterized by low control, broad scope, high entitativity, and moderate-to-high dynamism. This model places the lowest emphasis on the team providing control over the invention's commercial trajectory relative to the other two models. It emphasizes greater breadth in activities and goals relative to the LAB model. Low control and broad scope reflect a belief that the ET needs experts in many facets of business. In the ENT model, there is also a general emphasis on the team as a collective (i.e., entitativity) and high dynamism. This is true in part because of the broad scope: The ET is seen as responsible for a broad set of goals to take on the effort of building an enterprise that can adapt as commercial options evolve, so the team needs to change as it progresses through milestones.

*The GIG Model* is characterized by moderate control, narrow scope, high entitativity, and little-to-no dynamism. The signature attribute of this model is that inventors want a team able to quickly develop a clearly defined, applied product idea within a narrowly-scoped "side gig" that could support their academic work and even offer a safety valve if their academic job changed or was eliminated. Thus, in the GIG model the ET is more focused on immediate commercial product success than in the LAB model. But the GIG model also captures a simpler, more direct pathway to the marketplace relative to the ENT model. GIG teams, which feature narrow scope and low dynamism, facilitate the straightforward application of a clearly-defined invention, as opposed to the more expansive and complex product development and market identification efforts undertaken by ENT teams. Control is moderate within GIG, because there is less concern for technical integrity relative to the LAB model, and high entitativity is perceived to facilitate the rapid integration of technical and market considerations.

## 5.3. Implications of the models for ET formation

Through longitudinal observations and inferences, we drew conclusions about what each of the models implies for the way

scientists form ETs. In each case we observed that the models had implications for how the scientists planned to implement specific team formation strategies as well as for whether and how they intended to solicit the involvement of external actors. In some cases, our longitudinal design allowed us to observe actions taken toward ET formation, further highlighting the value of the models. Fig. 2 presents a graphical summary of the elements of the ET formation models and what the models imply for ET formation.

Scientists holding the ENT model sought to simultaneously add several members possessing a relatively heterogeneous set of knowledge and skills, including business-specific skills. By contrast, scientists holding the LAB and GIG models sought a single team member – but for different reasons. Those with the LAB model sought a single trusted team member who could coordinate further technical development, including the assembly and management of additional team members. Those with the GIG model, meanwhile, sought a single partner with complementary skills who could help them rapidly create a product from a clearly-defined technology.

In addition, scientists with the ENT model sought to add members in a way that would facilitate – or at least leave room for – the involvement of external investors and, in some cases, the TTO. But scientists with the LAB and GIG models sought to postpone or bypass these outside actors altogether. Those with the LAB approach, for example, tended to think further technical development was needed before it was possible or desirable to attract outside investment, while those with the GIG approach tended to think external investment was unnecessary.

Thus, scientists with different models exhibited different approaches to team formation. This was evident in the number and types of people they sought to add to their teams, in how they planned to find those members, and in the roles they expected external actors to play in developing their teams and ventures. Table 2 summarizes these differences, and we elaborate on them in the following sections.

### 5.3.1. ET formation by scientists holding the Enterprise Model

The ENT model was held by CellTech, CellMed, StickyChem, and DisasterMed. CellMed, StickyChem, and DisasterMed formed ETs, but CellMed left academics during our study to work on his invention in a large pharmaceutical firm through a licensing deal.

Inventors with the ENT model wanted a team to provide broad capacity to identify and pursue multiple development paths for their inventions, and they recognized their teams would change in response to needs and options over time. The low control and broad scope principles in the ENT model led to a focus on knowledge variety across members achieved through a “bunched” approach that involved seeking several members at a time instead of a single critical member, as scientists holding the other two models did. To the extent the ENT model led scientists to assemble a group of people reflecting a relatively heterogeneous set of knowledge and skills, it led to a resource-seeking formation strategy. At the same time, scientists holding the ENT model also employed interpersonal attraction strategies insofar as they sought entitativity through the presence of mutual trust and familiarity among ET members. Not surprisingly, scientists with the ENT model tended to have favorable views of investors and to work closely with their TTOs.

Consistent with a resource-seeking strategy, scientists with the ENT model deliberately sought team members with both technical and business-related knowledge. In fact, scientists with this model sometimes went beyond valuing business knowledge in general and anticipated needs associated with specific business functions. We saw this play out when CellTech selected a team member explicitly for his strong business experience and emphasized that functional expertise in marketing and operations were vital, noting that he added specific people “*because we thought we would need experience in a couple of different areas*” [Interview 2]. Likewise, StickyChem planned for team members with business knowledge who could handle a range of activity including operational and business development work, including an “*executive of R&D*” [Interview 2] as well as someone who could “*line up a lot of these proof of concepts and do a lot more of the market analysis and customer relations*” [Interview 1]. The broad scope desired in the ENT model also produces an expectation that differentiated knowledge will be distributed *among* people. As CellTech explained, “*we kind of identified the major functions and hired one person to kind of lead [each] area*” [Interview 2].

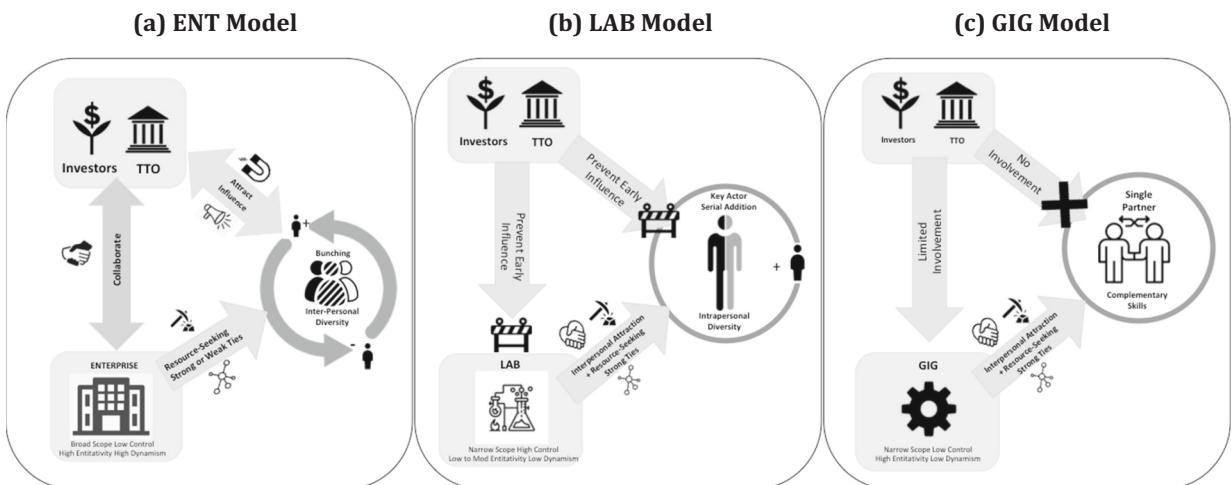


Fig. 2. Implications of the models for ET formation.

**Table 2**

Implications of the models for ET formation.

	Enterprise	Lab	Gig
Number & sequence of additions	Multiple, “bunched” members.	Single member, then others.	Single member only.
Formation strategy: Resource-seeking?	Yes. Business and technical skills are sought, and knowledge variety is sought among people.	Somewhat. Seeks a trusted partner with both technical and commercial knowledge.	Somewhat. Complementary skills are valued.
Formation strategy: Interpersonal attraction?	Yes. Trust and culture are valued, given the high entitativity.	Yes. Trust is valued, given the high control.	Yes. Trust and compatibility are valued.
Sources of new members?	Personal and impersonal.	Close personal ties only, at least for the key member.	Close personal ties only.
Working with the TTO?	Varied.	No.	No, not needed.
Interested in investors?	Yes.	Not now, but later.	No, not needed.

At the same time, ENT founders simultaneously employed formation strategies that emphasized interpersonal attraction. For example, StickyChem underscored that it was important “*to set the culture right at the start and make sure we are bringing in people who know one another, who ideally have worked with one another, who have the same sense about how these things go*” [Interview 1]. Likewise, CellTech observed, “*probably the biggest challenge is having people get along well*” [Interview 1], and he later expressed satisfaction that, “*in general, we’re pretty open as a management team.... there is no knocking of heads*” [Interview 2]. Thus, concern for entitativity led these scientists to look beyond the degree or type of knowledge team members possessed and even beyond their own personal affinity for each member. They were concerned with enhancing members’ ability to interact successfully with each other, to share a sense of motivation, and to engage in complex and intimate forms of collaboration. DisasterMed described the kind of early-stage team he sought by underscoring their productivity and sense of shared purpose: “*You’re all on a mission from God at that point. You’re all crammed into a tiny little place. You’re fighting for your lives because you probably don’t have much money, and productivity is huge*” [Interview 1]. The desire to form a team with collaboration capacity was also consistent with the bunching formation strategy these scientists favored. Hiring a bunch of people together was important even at the very beginning of the startup process, as it helped to foster the desired interpersonal connections.

Scientists with the ENT model identified team members “at hand” using their personal networks when their networks were strong enough to support this approach. This was the case for the more senior, experienced scientists, such as DisasterMed, who explained his approach in the following way.

*I’m pretty well connected in the community. I already know the team I would bring together. One of them is a very high uppity-up in [a large firm]. I already talked to him and he said, ‘Okay, that’s new and original. That should be of interest.’ He’d be CEO. Then for engineering guys to start putting together the prototype, there are guys I have worked with in the past as consultants. Those guys were really good.* [Interview 1].

Like DisasterMed, StickyChem also had a large personal network and drew on it in forming his ET. But CellMed and CellTech were more junior scientists with less commercial experience, and they had fewer personal ties to businesspeople. For example, CellMed underscored the importance of getting high-quality businesspeople, but he also admitted he could not find such people within his own network.

*You try to get the very best people ... The critical thing is all the management types of folks. You need people with track records, the people who know about those things with their past. I would have no idea how to identify those people. I wouldn’t know where to go to get those sorts of people.* [Interview 1].

CellTech, meanwhile, maintained a resource-seeking strategy but looked for potential team members from a wider network, utilizing weak ties and unfamiliar people, as he did when he recruited business students by contacting an entrepreneurship professor on campus.

Other ENT members also used impersonal sources alongside personal ones. In fact, in stark contrast to scientists with the LAB model, scientists with an ENT model expressed willingness to pursue team members through wide-ranging sources, such as advertising and executive search firms. This was consistent with the dynamism inherent in the ENT model, which implied that members were less “permanent”. “*If the VCs give a good chunk of money, like ten million dollars,*” CellTech reasoned, “*they’re going to want to put their own people in*” [Interview 1]. Likewise, StickyChem expressed openness to seeing his team evolve in different ways.

*I’m comfortable with what makes sense. If the company really decides that its best opportunity is to raise more money and continue investing in itself and if that leads to the point where one brings in an associated set of senior management and that it makes the most sense for me to get off the board, I’m fine with that.* [Interview 1].

Thus, even as scientists with the ENT model tended to seek a diverse team from the outset, they left open the possibility that their team would identify and fill additional resource needs as time went on.

Finally, as we noted earlier, scientists with the ENT model held more favorable views of TTOs and investors. All four of these scientists planned to seek outside investment for their ventures, and two of the four were working closely with their TTOs. DisasterMed

believed that working with the university offered the shortest path to investors. “*Getting capital coming out of the university*,” he observed, “*is probably a lot easier than being on the outside*” [Interview 1]. CellTech and CellMed both spoke enthusiastically about their plans for attracting venture capital. In an early interview, CellTech explained: “*Our main thing is doing the business plan competition right now and trying to do well in that. There is a token cash prize, but more importantly we get to interact with VCs and get some feedback.*” [Interview 1].

At the same time, StickyChem and DisasterMed, being the more experienced scientists with the ENT model, had quite specific and strongly-held views about the proper roles of external actors in university-based startups. Both had experienced or witnessed prior situations in which scientists were “burnt” by the missteps of external actors and were determined to avoid such problems with their current startups. StickyChem sought venture capital investment and eventually obtained it, but he was careful to set up his venture without the involvement of the TTO by focusing his commercialization efforts on technologies that were “*a couple steps removed*” from the work of his lab. He did this partly out of concern that TTOs were ineffective and unreasonable in working with ventures.

*The unsophisticated faculty member will often go along with [the TTO’s guidance in forming a company], because they don’t know what the norms are, they don’t know how these things go. Two years later as they’ve grown in sophistication they realize that the 25% cut the University got and the 3% cut they got are hideously out of line, and I think the thing is set up to fall apart at that point.* [Interview 1].

Accordingly, StickyChem identified prospective ET members by drawing primarily on his own broad network of contacts, which included investors and industry executives as well as a former doctoral student who was now pursuing an MBA. StickyChem did leverage some university resources, such as the university’s MBA program and its business plan competition, to find prospective team members. But he did not involve the TTO in the formation of his ET or his venture.

DisasterMed, meanwhile, was comfortable working with his university’s TTO and did seek funding from angel investors. But he was very skeptical of venture capital investors (VCs), as distinct from angels, and he distrusted the VCs’ practice of bringing in professional managers to run the ET. He had observed a number of situations in which VC-backed academic startups hired professional managers, who then wasted money and derailed the success of the technology.

*I’ve heard this from headhunters: Ninety percent of the so-called CEO-level people out there that are trying to get into companies are frauds. They have made up their backgrounds, they are complete frauds top to bottom. Literally, and I can cite fifty cases of it. Basically, they’re con men. They roll into town out of New York and say, ‘Man, I’ve got this and I did that, and I have all these contacts’ and everything. Basically they move in and bleed a company dry.* [Interview 2].

Venture capitalists, too, were generally fraudulent in DisasterMed’s view.

*VC is really the art of the con. Really it’s a double con. You con the founders of the company and then you con the people you are going to sell your shares to. So venture capitalists are really looking for founders who are easily manipulated and willing to lie and say anything about their products.* [Interview 3].

Like others holding the ENT model, DisasterMed still pursued external investment. But he believed angels were the right investors to move his technology forward along the path he envisioned.

*Private investments, angels are the way to go, particularly if the money comes from people in that area that know that stuff. It gives you a thousand legs up. It boosts you to the point where if you eventually do need the funding, you just bypass the VCs and go directly to the manufacturers, the banks, or whatever.* [Interview 1].

In summary, ENT scientists sought to form diverse, flexible ETs that were capable of attracting external investment, and they sought to do so using a particular combination of resource-seeking and interpersonal strategies. At the same time, experienced scientists with this model also held strong preferences about how external actors ought to be involved in their teams and ventures, and they stuck to these preferences in forming their ETs. These implications are summarized in Fig. 2, panel (a).

### 5.3.2. ET formation by scientists holding the Lab Model

BioMed, AudioTech, and EyeMed held the LAB model. Only AudioTech moved forward with starting a company. BioMed considered founding a company for some time but failed to do so during our study period. EyeMed, meanwhile, became department chair and was elected president of a major professional association in his field, so he lost momentum and interest in pursuing a startup.

These scientists wanted a team that would develop their invention along tightly defined parameters with little turnover or change. This led them to focus much of their attention on finding a single “keystone” member whom they could trust to translate their invention in a manner consistent with their intentions. LAB inventors pursued a very specific form of resource-seeking insofar as they wanted this person to possess a mix of commercial experience and deep technical knowledge. By simultaneously ensuring – through an interpersonal strategy – that this person was also a known and trusted member of their professional network, they could set in motion an ET that reflected the high control and narrow scope they desired. Such a team would be filled out later by members who would develop the technology as though it were under their direct control in their laboratories, they reasoned, but without their having to manage it directly. This arrangement enabled them to maintain their busy faculty positions while moving the technology forward.

In addition, scientists with the LAB model tended to be skeptical and cautious in contemplating the involvement of TTOs or investors in their ventures. In fact, their ET formation strategies were partly motivated by a desire to keep these external actors away so they would not derail the commercialization process they had in mind for their inventions.

Some degree of resource-seeking is evident in LAB inventors’ efforts to find a team member who had deep knowledge of the relevant technology as well as business-related experience. BioMed labeled this actor a “*technical business person*.” AudioTech called the kind of person he desired “*interdisciplinary*”, meaning someone with deep technical knowledge who had been “*layered by the marketplace*.” He described a specific person he was considering for his team:

*[T]he core has to be some understanding of what the hell we're doing technologically ... [But] they have a technical core that has had layers added by the marketplace, and they are getting more interdisciplinary every day. [Interview 1].*

Thus, AudioTech values a requisite level of technology knowledge, but also wants the team member to have a seasoned understanding of the commercialization process. Likewise, EyeMed underscored that his preferred actor would have a commercial background in an industry close to his own area of research:

*I really need someone to show me the ropes. I need someone to not make the mistakes that a person like me would likely make without spending a year or two studying how not to make those mistakes ... I've had a lot interaction with industry. A lot of industrial contacts with advisory boards ... So I sort of understand the [needed] mentality. [Interview 1].*

Even as they sought a key actor who could fill these particular resource needs, however, LAB inventors also relied strongly on an interpersonal attraction formation strategy that included looking to their professional networks to identify the trusted partners they were looking for. For example, AudioTech offered this explanation for the advantages of forming a company with a former PhD student:

*With former students, because we work so closely on their PhDs for a long time, we have plenty of common values – all kinds of things – and we relate to each other very well. To me that's the only successful way. [Interview 4].*

BioMed offered a similar perspective, noting “*I couldn't imagine hiring somebody based on an ad or something like that for this kind of job*” [Interview 2]. He favored an interpersonal, network-based approach, which had worked for him in the past.

*You know, we have a continual turnover and flux of Ph.D. students here, right? And some of them are inherently interested and would be good at this ... So the way I get to know the potential partner is by their work habits as Ph.D. students, and I have plenty of Ph.D. students who aren't interested or who wouldn't do well at this and do well at other things and so on. So that's worked out in the previous three cases. [Interview 1].*

He contrasted this approach with an alternative approach he observed being employed by a colleague.

*I have a colleague two floors down here ... He was convinced by somebody to hire a CEO. Put an ad in the newspaper and so on and spent a year trying to find somebody, a person he didn't know prior to this. Anyway, within a year they discovered that this person had a lot of legal issues with his previous job that he carried along. And when they confronted him with it, he fired them and kept the technology. So there's a little office down the street here with one guy in it, and he's a non-technical person sitting on top of a patent that I'm certain is going nowhere. I didn't want that to happen, right? [Interview 1].*

Apart from considerations of trust and affinity, however, their reliance on an interpersonal formation strategy also reflected their belief that the right person would need a certain mix of commercial experience and specialized technical knowledge that would only be held within a relatively small circle of people whom they already knew. As BioMed put it: “*I simply know everybody in this field. I've been in the field twenty-plus years, and everybody in the world who's working in this area I know personally*” [Interview 1]. AudioTech and EyeMed made similar claims. “*I know every semiconductor company on the planet*,” AudioTech observed, “*It's hard for me to say, because I'm a technologist, but probably eighty percent of my contribution in this particular thing right away is the connections*” [Interview 1].

For the LAB inventors we studied, therefore, an interpersonal ET formation strategy did not mean the team would be comprised entirely of research scientists. Rather, their networks encompassed many people with industry backgrounds. Some of these people they knew from prior startups, some they had met through advisory boards, and some were former Ph.D. students who pursued non-academic careers. As BioMed explained, “*Many of the people I know are former students who have gone on to have their careers and so on*” [Interview 2]. Key actors drawn from such sources could be expected to have commercial knowledge, which the inventors valued. Beyond that, these key actors could be expected to have industry contacts that would enable them to continue assembling and managing an ET with the requisite mix of skills so the inventor wouldn't have to. AudioTech explained the approach this way:

*In a small [startup]... you're still doing more roles than you would if you're brought in to be one of a thousand. So [interdisciplinary] people are kind of interesting, because they have a technical core where they can understand everything from atoms to the marketplace, depending on how long they've been adding layers to them. [Interview 1].*

Thus, although it was clear that the near-term focus of the LAB inventors' ETs would be on the technical development of their inventions, they also intended to use their networks to set in motion ETs that would ultimately attend to both the technical and commercial considerations of their nascent ventures.

EyeMed, like BioMed, contrasted his preferred approach of hiring a trusted partner with an alternative “model” of startup formation he had seen colleagues adopt:

*There is the model when the investigator decides, 'Oh I'm going to go for this and be the head of the company, and I'm going to set up this laboratory, and I'm going to manage this all myself, and I'm going to do a business plan and pick up the phone and rent the office space' ... Why? I work 80-hour weeks as it is ... Let somebody else run the business and oversee the personnel and all of that stuff. As opposed to my having to manage another infrastructure. [Interview 1].*

BioMed generally agreed. “*It's very clear that professors shouldn't be presidents of companies*,” he noted, “*because we are not trained for that, we haven't got time for that*.” [Interview 3].

At the same time, their desire to avoid directly managing the company was accompanied by a desire for control over the ET, and to some extent this control was manifested in a sense of caution regarding the involvement of external actors. In particular, these scientists were determined to avoid accelerated startup processes that relied on quick access to venture capital or unscrupulous managers. Instead, they wanted a team with narrow scope focused tightly on developing the technology, along with lower dynamism based on their belief that commercialization would take time and should not be unnaturally accelerated. To the extent these scientists were

interested in investors, it was to support their specific technology vision.

For instance, BioMed's interest in pursuing a startup was based in part on a determination to avoid letting his technology fall into the hands of large corporations that could obstruct its development out of a desire to protect their firms' existing products. He recounted with visible dismay a past experience where this had happened:

*We developed 8 patents, a portfolio of 8 patents, on [a certain technology] ... And the university licensed them to a company which I didn't care for against my explicit written instructions. And there was tremendous turmoil as a result of that. The company didn't pursue the technology for about 14 years. Eventually they were sold to another company which did pursue the technology and it returned a fair amount of capital, but I was very unhappy about the whole thing. [Interview 1].*

Owing to this experience, BioMed became suspicious of both large corporations and his university's TTO. This time, he sought to commercialize the technology through a startup company on his own terms.

Likewise, AudioTech was skeptical of venture capital investors and was concerned they would actually derail the proper development of his technology. *"There's a question whether, for certain kinds of inventions and stuff, a venture [capital] model really works. I have my own opinion on that. After doing [everything from] atoms to chairman, I have my own philosophy on that."* [Interview 1] His "philosophy", as he put it, led him to prioritize technical development based on the belief that premature investment poses a danger to young firms:

*We are screwing things up by not growing things organically ... People have forgotten that too much capital is as bad as too little capital... In this early stage, the progress isn't really dependent on capital ... What [external capital] does is it forces the company to pick a market that could ultimately be inappropriate for the technology, because you're kind of solidifying it early. ... I think that a long stewing time where you can experiment with all sorts of things and let the vector kind of search for the right market pull is absolutely critical. So that's what I'm doing. [Interview 2].*

This shaped AudioTech's determination to develop his technologies slowly by letting them "nucleate" without external investment for many years. He holds this preference even though at least one of his prior ventures was ultimately a success and he has easy access to funding, because he believes he is better able than financiers to assess whether and when to advance development. As he put it:

*I can see that the people in the investment game today are absolutely clueless, the vast majority of them, and they'll never make money ... I have people throwing venture money at me because of the first company, so they know who I am ... But I look at it now in a different way than I did before. ... What I want to do is actually create something and grow it at the right rate. [Interview 1].*

Although EyeMed did not have first-hand startup experience, he had observed others involved in startups and had been involved in university-industry partnerships. His experiences convinced him that his technology was too early to attract the attention or interest of large firms or venture capitalists.

*The problem with big pharma these days is that companies want a producer and they want things at a certain stage. They want things to be a certain distance down the pathway. From concept to cell data, live animal data, to pre-clinical talks. They don't want all that risk. [Interview 1].*

EyeMed was open to taking outside investment, but he wanted to wait for the right time to pursue it.

In summary, scientists holding the LAB model sought to form narrowly-scoped ETs led by a single trusted partner who possessed both deep technical knowledge and commercial experience. And they relied heavily on interpersonal strategies to find this person so they could be assured of the interpersonal trust and ET control they sought. Moreover, their desires to form ETs with high control and low dynamism were associated with a cautious posture toward TTOs and investors, and in general they sought to postpone the involvement of these external actors in their teams and ventures. These implications are summarized in Fig. 2, panel (b).

### 5.3.3. ET formation by scientists holding the Gig Model

QuakeTech and RobotTech held the GIG model. During our study, QuakeTech formed a team and started his company; RobotTech did not.

These inventors wanted a team with moderate control: They planned to participate actively in the team, and they wanted a narrow scope that would enable them to execute a well-defined product idea. More than in the other models, the inventors espousing this model seemed to think the technical development of their inventions was largely complete and that the market opportunity was relatively straightforward. What they wanted in a team, therefore, was simple: They sought a single partner with complementary skills who could help them quickly apply their business idea, and they didn't anticipate a need for change in this team or its purpose.<sup>7</sup> Finally, these inventors did not involve the TTO and did not seek external investors, because they considered both to be unnecessary.

The formation strategy of GIG inventors emphasized interpersonal attraction. In fact, interpersonal compatibility was deemed essential, as GIG inventors sought a partnership of just two people. *"Everything boils down to trust,"* RobotTech observed, *"It's not so much skill"* [Interview 3]. QuakeTech agreed, noting, *"We like and respect each other. I think that's crucial"* [Interview 2]. Both GIG inventors had a specific person in mind as a partner, and in both cases the person was someone the inventor had known for years. For QuakeTech, the prospective partner had been his boss during a previous stretch of his career when he was working in industry. For RobotTech, the prospective partner was a former college classmate who had gone into industry and later developed a successful startup. In both cases, too, the partner offered valued complementary skills. It was critical to RobotTech, for example, that he find

<sup>7</sup> Both inventors with this model were Ph.D.-level researchers but not tenure-track faculty; they had "soft money" positions. In fact, QuakeTech described his role as "precarious". Thus, they may have had more flexibility and incentive to pursue a more immediate opportunity.

someone “from the business side” to complement his own academic background. QuakeTech, likewise, observed, “*We have complementary skills and interests ... so we can divide up work into two different sort of domains*” [Interview 2].

But the GIG inventors’ partner choices seemed to hinge less on the specific skillsets their partners brought and more on whether these known, trusted individuals were ready to “jump” at the opportunity being considered. QuakeTech put it this way:

*The partnership was not actually about this product. The partnership was, we were both looking for business opportunities that would steam up. He said, ‘This is what I’ve got to bring to the company, and what do you have?’ I said, ‘Well, I’ve got this invention.’* [Interview 1].

RobotTech, meanwhile, initially doubted that the opportunity he had in mind was attractive enough to merit the full-time attention of his prospective partner.

*From a business point of view, anybody that’s serious about it would say, ‘this is the number of units we expect to sell, this is what we’ll do’. Is it a hobby or is it a business? That what it boils down to. At this point I have to say it’s a little bit of a hobby until it transitions to where you could get a financial statement to get somebody on board to give up their day job.* [Interview 1].

In a subsequent interview, RobotTech conceded he was unable to draw the partner’s interest.

*Since we last talked, he finished his last venture and he’s starting three other ventures right now. He’s at the point and position to move forward. He sold his company and he can do that. We actually bounce around ideas every once in a while, and on a few of them he’ll say, ‘Hey, that would be a good idea to pursue,’ and this is not one of them.* [Interview 2].

Neither scientist worked closely with the TTO, and neither pursued external investors. QuakeTech received patenting help from his university, but he neither sought nor received any further TTO support in forming his partnership or building the business. External investment was unnecessary too, he thought, because the company could “bootstrap” its way forward.

*I think we could start this company by ourselves, ultimately, and I think we could productize this invention without any additional help. If we need any programming done, we could hire somebody ... I don’t think we need to go to venture capitalists for this. It’s too easy. I figure a week or two of programmers’ time would have this thing up and running.* [Interview 1].

Even later, when the business had generated “a big backlog” of work, QuakeTech did not change this approach. He and his partner enjoyed the technical work the business provided them, and he anticipated that this workflow would continue for the foreseeable future. “*We are thinking now in terms of what we are going to be doing over the next three years,*” he noted [Interview 3]. He considered hiring a single business manager for the “the nitty-gritty paperwork”, but he expressed discomfort with writing a business plan, and neither he nor his partner aspired to manage a larger firm.

*We think we need a business manager. We think we need someone who can handle all the stuff we don’t like doing. We don’t like arranging for insurance; we don’t like doing the invoicing and all that unpleasant management stuff. We’re both technical people, and we like doing the technical work. We like coming up with the methodologies and implementing them, and so on. We’re engineers. We like to do engineering stuff, and neither of us like to do the managing stuff.* [Interview 3].

RobotTech initially explored commercialization opportunities with his TTO but ultimately worked independently. A TTO manager proposed developing his robot into a weapon, which he rejected:

*The guy at [the TTO], he saw it and said this would be a great grenade, like a little bomb. He was ex-military, and he would throw it over a wall and it would kind of hop around corners and stuff or up buildings, and then find somebody and blow up ... After thinking about his ideas a lot, I thought, you know, realistically, yes, that is an application, but I asked him not to [pursue that] ... I guess I made a decision not to pursue that. It wasn’t something I was interested in.* [Interview 2].

Ultimately, the TTO concluded the technology had only limited licensing potential, and they declined to pay for the patent. So RobotTech pursued the patent on his own and, for a time, pursued a venture that would market his robot technology to companies in the entertainment industry. But his patenting efforts encountered legal complications, and he was unable to convince his partner to pursue the venture. So he “consciously” moved away from the robot venture and instead pursued a different opportunity.

In summary, GIG inventors sought a simple, narrowly-scoped team that would quickly commercialize their technology. To this end, they relied on an interpersonal, network-based strategy to find a single, trusted partner with complementary skills. They undertook these efforts largely on their own and saw little need to involve others. These implications are summarized in Fig. 2, panel (c).

#### 5.4. Summary of theoretical conclusions

Our analyses yield several broad theoretical conclusions. First, our findings highlight the active and conscious role scientist-inventors play in the formation of ETs in academic startups. As we have noted, past research has emphasized the roles of TTOs and investors as external drivers of ET formation in academic startups while downplaying the role of academic scientists. Our findings suggest, however, that the scientists and those they choose in the early stages of ET formation can represent important *internal* drivers of ET formation. This implies that our theoretical understanding of ET formation in academic startups must account more fully for the intentionality and magnitude of scientists’ own influence and for a broader range of possible ET formation trajectories than is reflected in most studies.

For example, although scientists may cede control of ET formation to TTOs or investors in some cases, our study illustrates that scientists often exert significant influence on ET formation alongside, prior to, or instead of these external actors. They may do so either directly through their own involvement (as with the ENT inventors) or indirectly through other ET members they have chosen (as with the LAB inventors). In still other cases (e.g., GIG inventors), scientists form ETs on their own while bypassing both TTOs and investors

altogether. Thus, ET formation in academic startups can be driven by internal actors, external actors, or some combination over time. And to the extent that scientists' lay theories include ideas about whether and when to involve TTOs and investors, scientists may determine whether, when, and how such external actors become involved with nascent ETs.

Second, our findings illuminate the heterogeneity of scientists' ET formation strategies as well as the cognitive sources of that heterogeneity. Past research has tended to "work backwards" from the observed homogeneity of many scientist-led ETs and infer that scientists generally rely on an interpersonal attraction strategy that operates within (and is constrained by) their limited social networks (e.g., Colombo and Piva, 2012). However, the scientists in our study employed a variety of formation strategies, including combinations of resource-seeking and interpersonal strategies. And in doing so they often drew from relatively broad social networks that included people with substantive and varied commercial backgrounds. At the simplest level, therefore, our findings reveal that scientists' formation strategies within academic startups are more complex and heterogeneous than prevailing theory suggests. But our findings also help explain *how* and *why* scientists apply specific strategies.

How did scientists apply their formation strategies? This depended on what kinds of ventures they sought to form. We found that the formation strategies and network approaches tended to combine in particular ways across the three models and that the models differed in the relative emphasis they placed on resource-seeking versus interpersonal attraction.

ENT inventors came closest to adopting an idealized version of the resource-seeking model in their pursuit of broadly-scoped teams, for example, and initially they looked to close ties within their network. The inventors' own networks could be quite large and diverse, too, encompassing ties with former students pursuing private sector careers and other industry executives. In addition, as Kotha et al. (2018) observed, university-based licensing arrangements often reflect a history of collaborative relationships among inventors, TTO licensing managers, and outside firms, and such relationships may further broaden experienced inventors' networks over time. If ENT inventors' professional networks did not provide access to the kinds of people they desired, however, we found that ENT inventors were also willing to look to a broad range of sources, including extended impersonal networks and weak ties. LAB and GIG inventors, meanwhile, relied more heavily on interpersonal attraction strategies to identify trusted partners within their networks. LAB and GIG inventors also sought partners who possessed knowledge or experience profiles that would enable them to advance their intentions. But if these inventors could not identify a trusted person in their close professional network who met these requirements, their ET formation efforts were liable to stall, and in some cases (e.g., as in BioMed) ventures were abandoned on this basis.<sup>8</sup> Taken together, these findings expand our theoretical understanding of the range of formation strategies scientists employ in forming ETs, the range of prospective members scientists have available to them within their networks, and the ways in which scientists combine formation strategies and network considerations in selecting and identifying prospective team members from among people within their networks.

In addition, our findings showed that the scientists' formation strategies differed in a way that went beyond the traditional distinction between resource-seeking and interpersonal attraction. Specifically, scientists with different models exhibited differences with regard to the *number* of initial team members sought as well as the *sequence* or timing with which they would be added. ENT inventors sought to add a group of members at once, in a "bunched" fashion. But the LAB and GIG inventors focused their search on only one other team member. In the LAB cases, this search was accompanied by the expectation that this member would subsequently take responsibility for the identification and management of additional members. But the GIG inventors envisioned that their teams would be complete with the addition of one partner. These findings suggest that our theoretical understanding of formation strategies may need to be expanded beyond its traditional focus on the mechanisms of member addition (resource-seeking or interpersonal attraction) to include fuller consideration of the number and sequencing of the members who are sought (e.g., single partner, bunched additions, or serial additions).

Why did scientists apply the formation strategies they did? The variations we observed were not idiosyncratic. Neither did they seem to be rooted entirely in off-the-shelf "urban legends" as to how ETs should be formed (Kim and Aldrich, 2017). In general, the variations we observed corresponded to underlying differences in the scientists' lay theories of commercialization, which captured their intentions as to what they wanted their ventures to achieve and their beliefs about how their ETs could deliver on those intentions. The complexity and variability of the lay theories challenge our prevailing theoretical understanding of the knowledge scientists bring to ET formation. The prevailing view is that scientists are generally ignorant about commercial matters and therefore dependent on the commercial knowledge of TTOs and investors. But the lay theories our scientists worked with in navigating ET formation reflected a relatively detailed knowledge of many aspects of commercialization, such as market considerations and industry trends, and in some cases (e.g., StickyChem, AudioTech, and BioMed) an ability to actively critique the commercial knowledge held by "experts", such as TTOs and investors. This knowledge, in turn, was derived from a variety of sources, including their own past commercialization experiences and their observations of others' experiences. Taken together, these findings indicate that our theories of ET formation need to account more fully for variations in scientists' commercial knowledge and experience. Relatedly, theories of ET formation should more clearly specify ways in which they may encompass normative elements rooted in traditionally-prescribed goals or pathways (e.g., hiring a professional CEO to attract venture capital) in light of the reality that other actors involved in ET formation may hold well-informed goals or theories that are at odds with traditional prescriptions.

In summary, our analyses yielded several general conclusions relevant to our theoretical understanding of how ETs are formed in academic startups. They underscore that scientist-inventors play an active and conscious role in ET formation alongside – and

<sup>8</sup> The last column of Table 1 indicates whether an inventor formed a startup during our study period. Comparing these outcomes across cases suggests that scientist-inventors holding the ENT model were somewhat more likely to form a startup than those holding the LAB or GIG models. Thus, the inability of some inventors holding LAB or GIG models to find the single, trusted team member they seek may impede startup formation.

sometimes in place of – external actors, such as TTOs and investors. And they illuminate the heterogeneity of scientists' formation strategies while deepening our understanding of how and why scientists employ these formation strategies. In particular, they show that scientists' ET formation decisions are rooted in ideas and networks that are significantly richer than those commonly associated with university-based scientists.

## 6. Discussion

We set out to understand how academic scientists thought about forming ETs to commercialize their inventions. Past research on the formation of academic startup ETs has tended to downplay the decisions of individual founders while emphasizing instead the ways certain external actors, such as TTOs and investors, influence the assembly and evolution of ETs. This external focus has been predicated on the assumption that scientists generally lack commercially-relevant foresight and connections and therefore tend to form "deficient" teams with similar others. What we observed challenged this assumption in several ways.

The scientist-inventors we spoke with had substantive and in some cases quite elaborate ideas about ET formation. These ideas varied across the inventors and were linked with broader ideas they held about how their technologies ought to be commercialized, which we characterized as lay theories of academic entrepreneurship. We distilled these lay theories into a set of design principles that cluster into three distinct models of commercialization, and we elaborated the implications of these models for ET formation. Each model had distinct implications for the scientists' ET formation strategies, the sources through which they identified prospective members, and their openness to involving external actors in their teams. In general, however, we observed that the scientists used a mix of resource-seeking and interpersonal attraction formation strategies and made thoughtful use of their own occupationally diverse social networks. Taken together, our findings underscore that scientist-inventors represent important *internal* drivers of ET formation in academic startups alongside the external drivers whose roles have been more extensively documented. These findings have several implications for research and practice.

### 6.1. Implications for research on academic startups

Our findings change what we know about how academic startups are formed by highlighting the roles of scientists as varied, knowledgeable, and deliberate shapers of their nascent ventures. These findings, in turn, should prompt future scholars to broaden their perspectives with regard to the sampling choices and dependent variables they employ in studying academic startups and ETs.

We observed the formation of nascent startups prior to the kinds of events that can restrict the "radar screens" of researchers who select samples comprised of more fully-developed academic ventures (Aldrich and Ruef, 2006). For example, cases in which scientists choose to discontinue their ventures, proceed without TTO assistance, or postpone or forgo venture capital funding are liable to disappear from the sampling frames that scholars often apply in studying academic ventures. But we saw examples of all of these cases within our sample, and this enabled us to observe how academic founders shape ETs on their own prior to the involvement of external actors, as well as ways in which the founders determine whether, when, and how external actors are ultimately involved.

One implication of this is that future scholars should pay more attention to ET formation within "non-traditional" academic startups. To date, research on academic startup ETs has focused primarily on TTO-backed startups that are seeking funding from relatively formal and established sources, such as venture capital. Clearly, such startups represent a critical pathway for academic entrepreneurship. But academic founders can choose to pursue a variety of startup development trajectories, as our study shows and as other recent research has begun to document (e.g., Boh et al., 2012; Fini et al., 2018; Siegel and Wright, 2015). For example, academic startups that involve consulting, those supported by accelerators or grant programs (NSF, 2019), faculty-alumni partnerships (Åstebro et al., 2012; Roberts, 2020), and startups that prioritize community engagement or translation over commercialization (Fini et al., 2018; Kingma, 2011) are examples of non-traditional startups that merit more research attention.

Second, future research should pay more attention to those startups launched by non-tenure track researchers, such as graduate students and postdoctoral fellows (Hayter et al., 2017).<sup>9</sup> Scientists with STEM doctoral degrees often have great difficulty finding tenure track jobs nowadays (Kolata, 2016), and non-tenure track positions now account for a large percentage of the researchers at many universities. The GIG model we described, which emphasized quick commercialization through a simple organizational form, reflects the tenuous positions held by many of these university scientists. Startups launched under this model bear some resemblance to the temporary organizations Bechky (2006) studied, which emphasized swift exploitation, flexibility, and normative control. In light of Bechky's observation that the temporary forms of coordination she observed were shaped by the structural context in which they arose, future work could explore more fully how the changing structure of academic occupations may be shaping the way academic founders coordinate activity within university-based startups.

In addition, our findings should prompt scholars studying academic startups to consider a broader range of dependent variables. To the extent that academic startup ETs are being assembled by scientist-inventors with heterogeneous beliefs and purposes, it makes little sense for scholars to measure or theorize about the effectiveness of those teams solely with reference to investment-related outcomes, such as the team's ability to attract venture capital funding or generate revenue growth. Startups can generate significant "translational research" outcomes, such as constructive changes in medical practice or public health, without being commercially successful at a level that would satisfy venture capitalists (Woolf, 2008). Startups can succeed in other ways, too, such as by providing income and

<sup>9</sup> Boh et al. (2012) found that graduate students and postdoctoral researchers were involved in 77% of the academic startups they studied and that in 23% of the startups these researchers were the only participants (i.e., no tenure-track faculty were involved).

satisfaction to their participants, useful career inflections for untenured researchers, or learning experiences that inform participants' subsequent startup efforts. Outcomes like these may be harder to measure than those more commonly employed in the study of academic entrepreneurship, but scholars should still try to understand their prevalence and the ET attributes that promote and inhibit them. As [Sarasvathy \(2004\)](#) observed, "we need to develop questions that emphasize how the firm serves as an instrument in the toolkit of the entrepreneur, rather than casting the entrepreneur as always in the service of firm survival" (p. 713).

Finally, our findings suggest that in the academic context, as in other contexts, scholars should exercise care in interpreting instances of entrepreneurial exit. For example, the cases of RobotTech and BioMed illustrate that some academic startups are discontinued because their founders cannot identify ET members who satisfy their own requirements. From a certain perspective, such startups might be coded as "failures" based on their inability to attract resources. But sometimes certain available resources and resource pathways are being rejected by *founders* as well. In [Clough et al.'s \(2019\)](#) review of papers on entrepreneurial resource mobilization, they called attention to the common assumption that "entrepreneurs, as low-power actors, are assumed to engage with the first available resource holder that displays any interest in providing resources to a fledgling new venture effort" (p. 32). A fuller theoretical understanding of resource mobilization and exit in academic ventures (and other ventures), on the other hand, will account more fully for the fact that resource matching is a two-sided search process within which outcomes are critically influenced by founders' own cognitive criteria.

## 6.2. Implications for research on ET composition and its antecedents

Our findings help explain the characteristics of incipient ETs, which past scholars have widely recognized as embodying "genetic characteristics" that exert a highly consequential imprinting effect on venture development ([Colombo and Piva, 2012](#); [Nikiforou et al., 2018](#)). Even though past research has shown that academic ETs are, on average, more homogeneous than other ETs (e.g., [Ensley and Hmielewski, 2005](#)), there still exists variation among academic ETs, and our findings provide an internally-based explanation for how such variation arises. In particular, our work provides context-specific insights that complement and extend past work showing that ET formation is shaped by the interplay between cognitive and social factors (e.g., [Forbes et al., 2006](#); [Grossman et al., 2012](#)).

Going forward, scholars should be attentive to ways in which the composition of academic ETs reflect founders' intentions, not just their limitations. For example, consider our finding that LAB inventors, because they value tight control over the technology's trajectory, are more likely to form teams that feature technical experts. From some perspectives such teams might be classified as "homogeneous". As we observed, however, LAB inventors did not simply seek scientists with redundant or overlapping knowledge; rather, they carefully sought people with what [Bunderson and Sutcliffe \(2002\)](#) called "intrapersonal functional diversity" in that they had a mix of relevant technical expertise and commercial experience. Thus, if scholars look carefully at why scientists assemble teams as they do, they may identify ways in which the resulting teams reflect purposeful assemblies of knowledge and skill that are not readily captured by commonly-measured team characteristics.

In addition, scholars should explore the antecedents of scientist-inventors' ET formation beliefs, which may lie in the scientists' own experiences, roles, identities, and motivations, among other factors. For example, [Jain et al. \(2009\)](#) found that scientist-inventors engaged in complex identity modification behaviors, which included delegating activities to others while "buffering" or protecting their academic work from certain commercial norms. Future studies could explore ways in which scientists' identities influence their approaches to ET formation. For example, scientists favoring the LAB model may regard it as a way to delegate and buffer commercial activities while simultaneously shaping those activities (e.g., by ensuring technical integrity) in ways grounded in their academic identities. Alternatively, building on past work that has distinguished between more and less experienced inventors (e.g., [Kotha et al., 2018](#); [Mosey and Wright, 2007](#)), future work could examine whether scientists' ET formation beliefs are influenced by their prior experience with commercialization. Given that we also observed cases in which negative experiences (i.e., being "burnt") intensified scientists' determination to avoid certain external actors, however, future research might also consider how ET formation is influenced by the content – as well as the volume – of scientists' past commercialization experience.

Our findings with respect to the LAB model further suggest that some scientists may transfer practices from their university research laboratories to their ETs. Many university research laboratories are characterized by a centralized decision-making process headed by principal investigators (PIs), and competition among lower ranking lab members, such as doctoral students and post-doctoral researchers ([Maestre, 2019](#)). Relatedly, many science laboratories seem to suffer from unhealthy work cultures and are led by professionals with little or no training in personnel management ([Van Noorden, 2018](#)). At the same time, laboratory organization is heterogeneous, and variations in structure and management are associated with varying performance outcomes ([Carayol and Matt, 2004](#)). Future research could investigate the connection between academic entrepreneurs' research lab structures and their ET models, as this could provide insights into whether and why some scientists approach ET formation as they do.

## 6.3. Implications for research on the development of academic ventures over time

Scholars should explore ways in which the varied beliefs and intentions of individual academic founders interact with other forces to shape venture development over time. We focused on the very earliest ET formation steps, when founders' own ideas are especially influential, and on the intentions of a single lead inventor. Over time, however, the effects of founders' cognitive models will depend on the behaviors of other internal and external stakeholders of the venture. For example, early-stage team members who share the founder's intentions may fortify the long-term strength and coherence of the founder's influence. More broadly, to the extent that firms' capabilities are based on managers' human capital, social capital, and cognition ([Adner and Helfat, 2003](#)), academic founders' lay theories will affect the eventual development of their ventures' capabilities. Future research could elaborate these links by

connecting our findings about founders' lay theories with recent studies exploring the cognitive roots of capability emergence in new ventures (e.g., [Bingham et al., 2007](#); [Felin and Zenger, 2017](#)).

In addition, future research on how internal and external drivers affect academic ET formation may benefit from drawing on recent research on "entrepreneurship as design" (e.g., [Berglund et al., 2020](#); [Sarasvathy, 2004](#)). This approach, which is rooted in organization theory ([Simon, 1996](#)), highlights the need to connect inner and outer systems in managerial activities. For instance, a manager's goals (which are part of the inner system) must account for competitive realities (in the outer system) when developing a strategic plan. In this example, design theorists would call the strategic plan an "artifact" of the design process, and the design process is a gradual formation of an object or thing that must fit with, and thereby connect, inner and outer systems ([Simon, 1996](#)). Applying this to ET formation, the ET is the artifact, and a design perspective suggests that what ultimately emerges as an operating ET "cannot be reduced to the independent effects of individuals, artifacts, or environments, but entwines all three in ongoing negotiations over what as well as why" ([Berglund et al., 2020](#): p. 834). This observation dovetails with our finding that the prevailing external view of academic ET formation does not tell the whole story.

Linking ET formation research to design theory may yield insights regarding the relative influence of scientists (internal) and TTOs and investors (external) in academic startups. Design theory differentiates abstract and concrete artifacts ([Berglund et al., 2020](#); [Hevner et al., 2004](#)). This distinction parallels the distinction we have drawn between scientists' cognitions about forming teams, which remain abstract at the outset of ET formation, and the concrete, functioning ETs that may later emerge. Existing research on academic startup ETs has tended to regard ETs in their concrete form. The heuristic design principles underpinning the ET models reveal the individual scientist's desired affordances of the incipient ET, and these in turn influence succeeding stages of action ([Simon, 1996](#)). Design theorists show that artifacts – particularly abstract artifacts like ET design models – enable certain behaviors and constrain others ([Goel, 1995](#)), and so it is with ET design principles and models. They reveal the inner perspective and can be consequential in the ET formation process. Further work, therefore, could clarify how ETs and startups reflect the negotiated interests of internal and external actors.

#### 6.4. Implications for practice

We also expect that our findings will be of practical importance to academic entrepreneurs and those who work with them. For example, our findings can help TTO administrators, advisors, financiers, and others to better understand how scientist-inventors think about academic entrepreneurship. In particular, our findings underscore that there is considerable heterogeneity in what scientists know – or at least believe – about startup-based commercialization. Thus, practitioners who work with scientists in connection with commercial affairs must recognize that they are not working with a "blank slate". Rather, they should be prepared to engage with ways of thinking that are more variable and, in some cases, more sophisticated than traditional stereotypes of scientists might lead them to expect.

At the same time, our findings also revealed certain common patterns of thought among the scientists' lay theories. Practitioners can leverage these commonalities to help make sense of their own "in-the-field" observations of what scientists say and do, and they may integrate them with the findings of other psychologically-grounded studies in designing interventions and systems intended to support academic entrepreneurship (e.g., [Auster-Gussman and Forbes, 2019](#)). Scientists, for their part, might find our framework useful in reflecting on their own goals and intentions as well as in stimulating them to seek out knowledge and advice on specific commercialization issues they confront.

#### 6.5. Boundary conditions and limitations

Our findings are derived from scientists within major research-oriented universities in the U.S. This context offers insight into the kind of setting within which many U.S.-based academic startups emerge, and it helps broaden the geographic and institutional focus of research on academic startup ET formation beyond European universities, where most past studies have been conducted. However, it is not clear to what extent our findings would generalize to scientists in other settings, such as those in other countries or even in U.S. colleges or universities that are smaller or less research-intensive. Future research should continue to explore the ET-related intentions and behaviors of scientists in different types of universities around the world.

Looking further afield, it is clear that aspects of the lay theories we identified are rooted in the academic context and that, therefore, many of our findings would not apply to non-academic entrepreneurship. Founders of non-academic startups may approach ET formation by invoking other cognitions grounded in alternative contexts, such as family business or social entrepreneurship. Nevertheless, certain elements of lay theory that we identified, including design principles such as *scope* and *control*, could prove relevant in a range of settings. Future research could clarify such matters by exploring how non-academic entrepreneurs think about ET formation in various settings.

Finally, our study was based largely on interviews with scientists, and this approach rests on certain assumptions. For example, our approach assumes the scientists are willing and able to tell us accurately about their behaviors, beliefs, intentions, and reasons, and, of course, this assumption does not always hold. We also acknowledge that some intrusiveness is possible. For example, our conversations may have affected the way scientists thought or spoke. We tried to mitigate this latter possibility by asking relatively open-ended questions, following the scientists over time, and talking with them repeatedly. Nevertheless, our findings should be interpreted in light of these limitations.

## 7. Conclusion

Academic research generates inventions that can improve the well-being of people around the world. Such inventions are often commercialized through startup firms, and, as in many settings, the success of an academic startup is often critically influenced by its ET. Through in-depth interviews with nine academic scientists leading nascent startups, we developed a framework that illuminates the intentionality, foresight, and sophistication with which individual scientist-inventors navigate this process. Our findings facilitate an expanded explanation of ET formation that accounts more fully for the knowledge, connections, and agency of individual scientists, whose intentions can affect whether, when, and in what form nascent academic ventures ultimately present themselves to external actors.

### CRediT authorship contribution statement

**Mary E. Zellmer-Bruhn:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition. **Daniel P. Forbes:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition. **Harry J. Sapienza:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition. **Patricia S. Borchert:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition.

## Appendix A

### Interview Protocol – First Interviews.

The research team followed this general template for the first interviews with each of the scientists in the study. These were semi-structured interviews. Thus, all participants were asked these general questions, but in any particular interview emergent topics were pursued.

In subsequent interviews, we asked about specific people and plans that respondents had mentioned in the first interview, and we asked about what had happened since then in relation to the company.

#### Introductions.

We began with introductions and the informed consent process.

#### Status of effort.

We then shared brief information about the invention disclosure that they filed and referred to on our screening survey.

*“Please tell me a little about this invention and what you think its commercial potential might be.”*

*“What is the current status of this effort?”*

*“Can you tell us a little about when and why you might want to start a company with this invention?”*

#### Team.

*“Who else, if anyone, is currently involved in starting a company with this invention?”*

*“If you were to pursue this as a company [or as you do so], are there other people you plan to have involved in the effort?”*

*“If there aren’t any specific people you have in mind, are there other kinds of people you plan to have involved?”*

We would ask follow-up questions on any current or potential team members mentioned in response to the last three questions. For example, we would ask about people’s backgrounds, their current roles, and about their relationship with the interviewee. We would also ask how or why those people would be involved, and, if it wasn’t clear, how they would be identified.

*“What role, if any, would you play in the company?”*

#### Next Steps.

*“What will your next efforts be?”*

*“Are there milestones or challenges coming up related to this company?”*

#### Closing.

In closing, we would thank the participant and ask if we could contact them at a future point for a follow-up interview.

## References

Adner, R., Helfat, C., 2003. Corporate effects and dynamic managerial capabilities. *Strategic Management J.* 24, 1011–1025.

Agarwal, R., Moeen, M., Shah, S.K., 2017. Athena’s birth: triggers, actors, and actions preceding industry inception. *Strateg. Entrep. J.* 11 (3), 287–305.

Aldrich, H., Cliff, J., 2003. The pervasive effects of family on entrepreneurship. *J. Bus. Ventur.* 18, 573–596.

Aldrich, H., Kim, P., 2007. Small worlds, infinite possibilities? How social networks affect entrepreneurial team formation and search. *Strateg. Entrep. J.* 1, 147–165.

Aldrich, H., Ruef, M., 2006. *Organizations Evolving*, 2nd ed. Sage, London.

Aldridge, T., Audretsch, D.B., 2010. Does policy influence the commercialization route? Evidence from National Institutes of Health funded scientists. *Res. Policy* 39 (5), 583–588.

Âstebro, T., Bazzazian, N., Braguinsky, S., 2012. Startups by recent university graduates and their faculty: implications for university entrepreneurship policy. *Res. Policy* 41 (4), 663–677.

Auster-Gussman, L., Forbes, D., 2019. When do scientists commercialize their inventions? Insights from the Theory of Planned Behavior. *Entrepreneur & Innovation Exchange*. <https://doi.org/10.32617/378-5cab63f097c3a>. <https://eiexchange.com/content/378-when-do-scientists-commercialize-their-invention>. (Accessed 14 October 2020).

Balven, R., Fenters, V., Siegel, D.S., Waldman, D., 2018. Academic entrepreneurship: the roles of identity, motivation, championing, education, work-life balance, and organizational justice. *Acad. Manag. Perspect.* 32 (1), 21–42.

Baron, J., Hannan, M., Burton, M.D., 1999. Building the iron cage: determinants of managerial intensity in the early years of organizations. *Am. Sociol. Rev.* 64, 527–547.

Barry, D., Rerup, C., 2006. Going mobile: aesthetic design considerations from Calder and the constructivists. *Organ. Sci.* 17, 262–276.

Beckhy, B.A., 2006. Gaffers, gofers, and grips: role-based coordination in temporary organizations. *Organ. Sci.* 17 (1), 3–21.

Beckman, C., Burton, M.D., 2008. Founding the future: path dependence in the evolution of top management teams from founding to IPO. *Organ. Sci.* 19, 3–24.

Ben-Haifaiedh, C., 2010. Entrepreneurial team formation: any rationality? In: Zacharakis, A., et al. (Eds.), *Frontiers of Entrepreneurship Research*, 30(10), p. 1.

Ben-Haifaiedh, C., 2017. Entrepreneurial teams research in movement. In: Ben-Haifaiedh, C., Cooney, T.M. (Eds.), *Research handbook on entrepreneurial teams: Theory and practice*. Edward Elgar, pp. 11–44.

Bercovitz, J., Feldman, M., 2008. Academic entrepreneurs: organizational change at the individual level. *Organ. Sci.* 19, 69–89.

Berglund, H., Bousfiha, M., Mansoori, Y., 2020. Opportunities as artifacts and entrepreneurship as design. *Acad. Manag. Rev.* 45 (4), 825–846.

Bingham, C., Eisenhardt, K., Furr, N., 2007. What makes a process a capability?: Heuristics, strategy and effective capture of opportunities. *Strateg. Entrep. J.* 1, 27–47.

Boh, W.F., De-Haan, U., Strom, R., 2012. University Technology Transfer through Entrepreneurship: Faculty and Students in Spinoffs. Kauffman Foundation, Kansas City, MO.

Bolzani, D., Fini, R., Napolitano, S., Toschi, L., 2019. Entrepreneurial teams: an input-process-outcome framework. *Found. Trends Entrep.* 15 (2).

Bunderson, J.S., Sutcliffe, K.M., 2002. Comparing alternative conceptualizations of functional diversity in management teams: process and performance effects. *Acad. Manag. J.* 45 (5), 875–893.

Burton, D., 2001. The company they keep: Founders' models for organizing new firms. In: Schoonhoven, C., Romanelli, E. (Eds.), *The Entrepreneurship Dynamic*, pp. 13–39. Stanford U. Press.

Carayol, N., Matt, M., 2004. Does research organization influence academic production?: Laboratory level evidence from a large European university. *Res. Policy* 33 (8), 1081–1102.

Cardon, M.S., Post, C., Forster, W.R., 2017. Team entrepreneurial passion: its emergence and influence in new venture teams. *Acad. Manag. Rev.* 42 (2), 283–305.

Chukumba, C., Jensen, R., 2005. *University invention, entrepreneurship, and start-ups* (no. w11475). National Bureau of Economic Research.

Clarysse, B., Moray, N., 2004. A process study of entrepreneurial team formation: the case of a research-based spin-off. *J. Bus. Venturing* 19, 55–79.

Cliff, J., Jennings, P., Greenwood, R., 2006. New to the game and questioning the rules: the experiences and beliefs of founders who start imitative vs. innovative firms. *J. Bus. Ventur.* 21, 633–663.

Clough, D.R., Fang, T.P., Vissa, B., Wu, A., 2019. Turning lead into gold: how do entrepreneurs mobilize resources to exploit opportunities? *Acad. Manag. Ann.* 13 (1), 240–271.

Cohen, S.G., Hochberg, Y.V., 2014. Accelerating Startups: The Seed Accelerator Phenomenon. *SSRN Journal*, pp. 1–16. <https://doi.org/10.2139/ssrn.2418000>. March.

Colombo, M.G., Piva, E., 2012. Firms' genetic characteristics and competence-enlarging strategies: a comparison between academic and non-academic high-tech start-ups. *Res. Policy* 41 (1), 79–92.

Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R.R., Rosenberg, N., Sampat, B.N., 2002. How do university inventions get into practice? *Manag. Sci.* 48 (1), 61–72.

Cooper, A., Daily, C., 1997. Entrepreneurial teams. In: Sexton, D., Smilor, R. (Eds.), *Entrepreneurship 2000*. Upstart, Chicago.

Discua-Cruz, A., Howorth, C., Hamilton, E., 2013. Intrafamily entrepreneurship: the formation and membership of family entrepreneurial teams. *Entrep. Theory Pract.* 37 (1), 17–46.

Djokovic, D., Souitaris, V., 2008. Spinoffs from academic institutions: a literature review with suggestions for further research. *J. Technol. Transf.* 33 (3), 225–247.

Edmondson, A., McManus, S., 2007. Methodological fit in management field research. *Acad. of Management Rev.* 4, 1155–1179.

Eisenhardt, K., Graebner, M.E., 2007. Theory building from cases: opportunities and challenges. *Acad. of Management J.* 50 (1), 25–32.

Ensley, M., Hmieleski, K., 2005. A comparative study of new venture top management team composition, dynamics and performance between university-based and independent start-ups. *Res. Policy* 34, 1091–1105.

Felin, T., Zenger, T.R., 2009. Entrepreneurs as theorists: on the origins of collective beliefs and novel strategies. *Strateg. Entrep. J.* 3 (2), 127–146.

Felin, T., Zenger, T.R., 2017. The theory-based view: economic actors as theorists. *Strategy Science* 2 (4), 258–271.

Fini, R., Rasmussen, E., Siegel, D., Wiklund, J., 2018. Rethinking the commercialization of public science: from entrepreneurial outcomes to societal impacts. *Acad. Manag. Perspect.* 32 (1), 4–20.

Forbes, D., Borchert, P.S., Zellmer-Bruhn, M., Sapienza, H., 2006. Entrepreneurial team formation: an exploration of new member addition. *Entrep. Theory Pract.* 30, 225–248.

Francis, D., Sandberg, W., 2000. Friendship within entrepreneurial teams and its association with team and venture performance. *Entrep. Theory Pract.* 25, 5–25.

Furnham, A., 1988. *Lay Theories: Everyday Understanding of Problems in the Social Sciences*. Pergamon Press, Elmsford, NY.

Garud, R., Karnaøe, P., 2003. Bricolage versus breakthrough: Distributed and embedded agency in technology entrepreneurship. *Res. Policy* 32 (2), 277–300.

George, G., Bock, A., 2009. *Inventing Entrepreneurs: Technology Innovators and their Entrepreneurial Journey*. Pearson Prentice Hall.

Goel, R.K., Göktepe-Hultén, D., 2018. What drives academic patentees to bypass TTOs? Evidence from a large public research organisation. *J. Technol. Transf.* 43 (1), 240–258.

Goel, V., 1995. *Sketches of Thought*. MIT Press.

Goldfarb, B., Henrekson, M., 2003. Bottom-up versus top-down policies towards the commercialization of university intellectual property. *Res. Policy* 32 (4), 639–658.

Graebner, M.E., Eisenhardt, K.M., 2004. The seller's side of the story: acquisition as courtship and governance as syndicate in entrepreneurial firms. *Admin. Science Quart.* 49 (3), 366–403.

Grossman, E., Yli-Renko, H., Janakiraman, R., 2012. Resource search, interpersonal similarity, and network tie valuation in nascent entrepreneurs' emerging networks. *J. Manag.* 38 (6), 1760–1787.

Hart, D.M., 2014. Founder nativity, founding team formation, and firm performance in the U.S. high tech sector. *International Entrepreneurship & Management Journal* 10, 1–22.

Hayter, C., Lubynsky, R., Maroulis, S., 2017. Who is the academic entrepreneur? The role of graduate students in the development of university spinoffs. *J. Technol. Transf.* 42 (6), 1237–1254.

Heath, C., 1999. On the social psychology of agency relationships: lay theories of motivation overemphasize extrinsic incentives. *Organizational Behavior & Human Decision Processes* 78, 25–62.

Heyner, A., March, S.T., Park, J., Ram, S., 2004. Design science research in information systems. *MIS Q.* 28 (1), 75–105.

Huyghe, A., Knockaert, M., Piva, E., Wright, M., 2016. Are researchers deliberately bypassing the technology transfer office? An analysis of TTO awareness. *Small Bus. Econ.* 47 (3), 589–607.

Jain, S., George, G., Maltarich, M., 2009. Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Res. Policy* 38, 922–935.

Kamm, J.B., Nurick, A.J., 1993. The stages of team venture formation: a decision-making model. *Entrep. Theory Pract.* 17 (2), 17–27.

Kamm, J.B., Schuman, J.C., Seeger, J.A., Nurick, A.J., 1990. Entrepreneurial teams in new venture creation: a research agenda. *Entrep. Theory Pract.* 14 (4), 7–17.

Kim, P.H. and Aldrich, H.E., 2017. Urban Legends or sage guidance: A review of common advice about entrepreneurial teams. In *Research Handbook on Entrepreneurial Teams*. Edward Elgar Publishing.

Kim, P.H., Longest, K.C., 2014. You can't leave your work behind: employment experience and founding collaborations. *J. Bus. Ventur.* 29 (6), 785–806.

Kingma, B., 2011. Academic Entrepreneurship and Community Engagement: Scholarship in Action and the Syracuse Miracle. Edward Elgar, Cheltenham, UK.

Klotz, A., Hmielecki, K., Bradley, B., Busenitz, L., 2014. New venture teams: a review of the literature and roadmap for future research. *J. Manag.* 40, 226–255.

Kolata, G. 2016. "So many research scientists, So Few Openings as Professors." *New York Times*, July 14.

Knight, A.P., Greer, L.L., De Jong, B., 2020. Start-up teams: a multidimensional conceptualization, integrative review of past research, and future research agenda. *Academy of Management Annals* 14 (1), 231–266.

Kotha, R., Crama, P., Kim, P.H., 2018. Experience and signaling value in technology licensing contract payment structures. *Acad. Manag. J.* 61 (4), 1307–1342.

Kruglanski, A., Dechesne, M., Orehek, E., Pierro, A., 2009. Three decades of lay epistemics: the why, how and who of knowledge formation. *Eur. Rev. Soc. Psychol.* 20, 146–191.

Kuwabara, K., Hildebrand, C.A., Zou, X., 2018. Lay theories of networking: how laypeople's beliefs about networks affect their attitudes toward and engagement in instrumental networking. *Acad. Manag. Rev.* 43 (1), 50–64.

Lazar, M., Spektor, E.M., Agarwal, R., Erez, M., Goldfarb, B., Chen, G., 2019. Entrepreneurial team formation. *Acad. Manag. Ann.* 14, 29–59.

Levy, S., Chiu, C., Hong, Y., 2006. Lay theories and intergroup relations. *Group Processes & Intergroup Relations* 9, 5–24.

Lickel, B., Hamilton, D.L., Sherman, S.J., 2001. Elements of a lay theory of groups: types of groups, relational styles, and the perception of group entitativity. *Personal. Soc. Psychol. Rev.* 5 (2), 129–140.

Locke, K., 2001. *Grounded Theory in Management Research*. Sage, Thousand Oaks, CA.

Maestre, F.T., 2019. Ten simple rules towards healthier research labs. *PLoS Comput. Biol.* 15 (4), e1006914.

Markman, G.D., Gianiodis, P.T., Phan, P.H., 2008. Full-time faculty or part-time entrepreneurs. *IEEE Trans. Eng. Manag.* 55 (1), 29–36.

Miller, K., Alexander, A., Cunningham, J.A., Albats, E., 2018. Academic entrepreneurs and entrepreneurial academics: a systematic literature review. *Int. J. Technol. Manag.* 77, 9–37.

Miozzo, M., DiVito, L., 2016. Growing fast or slow?: understanding the variety of paths and the speed of early growth of entrepreneurial science-based firms. *Res. Policy* 45 (5), 964–986.

Mosey, S., Wright, M., 2007. From human capital to social capital: a longitudinal study of technology-based academic entrepreneurs. *Entrep. Theory Pract.* 31 (6), 909–935.

Mowery, D.C., Nelson, R.R., Sampat, B.N., Ziedonis, A.A., 2004. *Ivy Tower and Industrial Innovation: University-Industry Technology Transfer before and after the Bayh-Dole Act*. Stanford University Press.

Nikiforou, A., Zabara, T., Clarysse, B., Gruber, M., 2018. The role of teams in academic spinoffs. *Acad. Manag. Perspect.* 32 (1), 78–103.

Norman, D., 2013. *The Design of Everyday Things*. Doubleday, New York.

NSF, 2019. National Science Foundation Innovation Corps Biennial Report. NSF, Alexandria, VA.

Parker, S., 2009. Can cognitive biases explain venture team homophily? *Strateg. Entrep. J.* 3, 67–83.

Rasmussen, E., Mosey, S., Wright, M., 2011. The evolution of entrepreneurial competencies: a longitudinal study of university spin-off venture emergence. *J. Manag. Stud.* 48 (6), 1314–1345.

Roberts, E., 2020. *Celebrating Entrepreneurs: How MIT Nurtured Pioneering Entrepreneurs Who Built Great Companies*. MIT, Cambridge, MA.

Romme, A.G.L., 2003. Making a difference: organization as design. *Organ. Sci.* 14 (5), 558–573.

Ruef, M., 2010. *The Entrepreneurial Group: Social Identities, Relations, and Collective Action*. Press, Princeton U.

Ruef, M., Aldrich, H., Carter, N., 2003. The structure of founding teams: Homophily, strong ties, and isolation among U.S. entrepreneurs. *Amer. Sociological Rev.* 68 (2), 195–225.

Sarasvathy, S.D., 2004. The questions we ask and the questions we care about: reformulating some problems in entrepreneurship research. *J. Bus. Ventur.* 19 (5), 707–717.

Schon, D., 1983. *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York.

Shah, S., Agarwal, R., Echambadi, R., 2019. Jewels in the crown: motivations and team building processes of employee entrepreneurs. *Strateg. Manag. J.* 40 (9), 1417–1452.

Shane, S.A., 2004. *Academic Entrepreneurship: University Spinoffs and Wealth Creation*. Edward Elgar Publishing.

Siegel, D., Phan, P., 2005. Analyzing the effectiveness of university technology transfer: implications for entrepreneurship education. In: Libecap, G.D. (Ed.), *Advances in the Study of Entrepreneurship, Innovation, and Economic Growth*, 16. Elsevier, pp. 1–39.

Siegel, D., Wright, M., 2015. Academic entrepreneurship: time for a rethink? *Br. J. Manag.* 26, 582–595.

Simon, H.A., 1996. *The Sciences of the Artificial*, 3rd ed. MIT Press, Cambridge, MA.

Strauss, A., Corbin, J., 1998. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 2nd ed. Sage Publications, Thousand Oaks, CA.

Stuart, T.E., Ding, W.W., 2006. When do scientists become entrepreneurs? The social structural antecedents of commercial activity in the academic life sciences. *Am. J. Sociol.* 112 (1), 97–144.

Thursby, J., Thursby, M., 2005. Gender patterns of research and licensing activity of science and engineering faculty. *J. Technol. Transfer.* 30, 343–353.

Ucbasearan, D., Lockett, A., Wright, M., Westhead, P., 2003. Entrepreneurial founder teams: factors associated with member entry and exit. *Entrep. Theory Pract.* 28, 107–125.

Van Noorden, R., 2018. Some hard numbers on science's leadership problems. *Nature* 557, 294–296.

Vanaelst, I., Clarysse, B., Wright, M., Lockett, A., Moray, N., S'Jegers, R., 2006. Entrepreneurial team development in academic spinouts: an examination of team heterogeneity. *Entrep. Theory Pract.* 30, 249–271.

Vohora, A., Wright, M., Lockett, A., 2004. Critical junctures in the development of university high-tech spinout companies. *Research Policy* 147–175.

Wasserman, N., 2012. *The founder's Dilemmas: Anticipating and Avoiding the Pitfalls that Can Sink a Startup*. Princeton University Press.

Weedman, J., 1998. The structure of incentive: design and client roles in application-oriented research. *Sci. Technol. Hum. Values* 23 (3), 315–345.

Woolf, S.H., 2008. The meaning of translational research and why it matters. *J. Am. Med. Assoc.* 299 (2), 211–213.

Wright, M., Clarysse, B., Mustar, P., Lockett, A., 2008. *Academic entrepreneurship in Europe*. Edward Elgar.

Yin, R., 1994. *Case Study Research: Design and Methods*, 2nd ed. Sage, Thousand Oaks, CA.