ROADS TO INSTITUTIONALIZATION: THE REMAKING OF BOUNDARIES BETWEEN PUBLIC AND PRIVATE SCIENCE

Jeannette A. Colyvas and Walter W. Powell

ABSTRACT

We analyze the process of institutionalization, arguing that it is the outcome of the self-reinforcing feedback dynamics of heightened legitimacy and deeper taken-for-grantedness, using novel techniques to document and trace this change over a 30-year period. Our focus is the remaking of the boundaries between public and private science, an institutional transformation that joined science and property, two formerly distinct spheres. The setting is Stanford University, an early adopter and pioneer in the formulation of policies of technology transfer. We illustrate how archival materials may be systematically assessed to capture notable changes in organizational practices and categories, reflecting both local and field-level processes. The paper concludes with a set of indicators that gauge low, medium, and high elements of institutional change. We argue that this approach allows for more precision in measurement and enables

Research in Organizational Behavior: An Annual Series of Analytical Essays and Critical Reviews
Research in Organizational Behavior, Volume 27, 305–353

ISSN: 0191-3085/doi:10.1016/S0191-3085(06)27008-4

comparisons across studies, two standard critiques of the institutional approach.

1. INTRODUCTION

Despite broad appeal and wide application in studies of the diffusion of managerial practices, the adoption of organizational structures, and even the global spread of managerialism, institutional theory has lacked agreement about several of its core concepts. This approach to organizational analysis has had a "big tent" attitude, welcoming social scientists with interests as varied as discourse analysis and critical realism to comparative researchers studying the world polity. While having galvanized interest, this broad embrace comes at the expense of precision in measurement (Haveman, 2000). This difficulty in conceptual fidelity is not surprising, given that institutionalization is both a multi-level process as well as an outcome. Nevertheless, several of the core ideas associated with the institutional approach, specifically legitimacy and taken-for-grantedness, have not been characterized in a way that allows for ready comparisons across studies. Thus, our goal in this chapter is to facilitate agreement about these central concepts in institutional analysis.

We argue that institutionalization is driven by the self-reinforcing feedback dynamics of heightened legitimacy and enhanced taken-for-grantedness. Consequently, the expansion and deepening of these constructs are the motors of a wider process of institutionalization, which we break down and analyze. We illustrate how practices can be more or less legitimated and assess how taken-for-grantedness changes through time, as well as show how both can be assessed and measured. To accomplish this, we use archival materials from the technology transfer office at a leading research university, Stanford, and draw on these materials in a way that provides metrics of low, medium, and high legitimacy and taken-for-grantedness. One of the criticisms of institutional research has been a lack of attention to how elements of the social order can be pre-, semi-, or fully institutionalized (Tolbert & Zucker, 1996; Strang & Sine, 2002). We address this shortcoming directly by spelling out the gradations and scale of a process of institutionalization.

Our empirical focus is the remaking of the boundaries between public and private science, and the joining of science and property, two spheres that were formerly distinct. The subject of the commercialization of science is highly apt for our theoretical aims because of the institutional transformation that has transpired over the past four decades. We begin in an era, the

1970s, when academic entrepreneurship was unfamiliar, technology transfer practices were highly idiosyncratic and not formalized, and the commercialization of science was even actively resisted. Over time, entrepreneurial activity became more familiar and commonplace on some university campuses, and was eventually buttressed in the early 1980s by federal law encouraging these efforts. By the late 1990s, technology transfer was celebrated and championed. Consider two indicators of this institutional change. Technology transfer offices on U.S. campuses numbered only in the 20s in 1980, but exceeded 200 by the year 2000 (Mowery, Nelson, Sampat, & Ziedonis, 2004). From 1980 to 2000, the number of patents assigned to research universities rose 850% (Owen-Smith, 2003). The great majority of this increase is driven by patenting in the biomedical field (Ganz-Brown, 1999; National Science Board, 2000); hence our focus is on the life sciences.

Stanford University was an early champion of technology transfer, which was initially pursued by multiple units on the campus, ranging from the sponsored research office, to the technology licensing office, to the laboratories of individual researchers. Through time, the practices were consolidated in a single high-profile office, and greatly elaborated and routinized, making this office a critical site for the locus of institutionalization. We make extensive use of rich archival materials from this office, and illustrate how researchers can draw on documents to provide concrete evidence of the changing nature of organizational practices, and to gauge how familiarity with specific practices evolves and is reproduced through time. We show how the development of categories and classifications at Stanford had ramifications well beyond the boundaries of the university.

The chapter is not intended as an empirical analysis of the commercialization of university science; we take up that task in related work. Rather, our aim is to demonstrate how archival materials from the university office that helped pioneer the field of technology transfer can be utilized to study paths to institutionalization. We offer our argument both as a theoretical contribution, where we analyze taken-for-grantedness and legitimacy as constituent components of a sequence that can lead to institutionalization, and a methodological exemplar, which shows how primary documents can be used and indicators derived from careful readings.

Through analysis of the practices of technology transfer, we enrich the conception of legitimacy by showing how procedures and definitions that initially require a great deal of effort, explanation, and translation become more codified over time, as the range of possible options becomes narrower. In a cognitive sense, a great deal of compression occurs, which allows participants to understand both meaning and nuance in a rapid fashion.

We show how taken-for-grantedness is the outcome of purposive action, the refining of skills, and the development of reflexivity on the part of participants. Our view of taken-for-grantedness is very much embedded in practices and categories that are associated with different degrees of understanding that change through time.

We turn next to a discussion of our key concepts – legitimacy and taken-for-grantedness, highlighting their central features. The research site, the Office of Technology licensing at Stanford University, which served as a bridge between the worlds of the academy and commerce, is then described. We review the archival materials next, then turn to a detailed analytical narrative of source materials. We conclude the narrative discussion with more general observations on the institutionalization of academic entrepreneurship. We then discuss implications of our approach, suggesting possible applications of our tools to other empirical settings. To encourage such efforts, we abstract from the context of science and commerce and suggest a number of more general organizational indicators of the process of institutionalization. We offer at the end a framework based on our findings that provides a foundation for comparative and complimentary research.

2. CORE CONCEPTS

Legitimacy is perhaps the most central concept in institutional research (Meyer & Rowan, 1977; Zucker, 1977; DiMaggio & Powell, 1983; Scott & Meyer, 1983) and has been crucial to various lines of work in organizational theory more generally (Hannan & Freeman, 1989; Hannan & Carroll, 1992; Aldrich & Fiol, 1994; Dacin, Goodstein, & Scott, 2002). As defined by Suchman (1995, p. 574), legitimacy is "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions." Given the centrality and importance of legitimacy in organization studies, it is curious that more attention has not been devoted to analyzing its constituent elements, and capturing how legitimacy is acquired, replicated, and even lost (Baum & Powell, 1995).

A first step involves specifying the core components of legitimacy. Almost all institutional theories argue that once particular practices or outcomes become legitimated, they are "built into" the social order, reproduced without substantial mobilization, and resistant to contestation (Jepperson, 1991). Greif (2006) captures this endogenous element nicely with his definition of an institution a "as system of rules, beliefs, norms and organizations that

can jointly generate a regularity of behavior in a social situation." Thus, a key feature of legitimacy is its self-reproduction, reflected in the conception of a practice, belief, or rule as desirable, appropriate, and comprehensible. As people act collectively toward a common purpose, legitimated activities are reciprocally interpreted and become habitualized.

Selznick (1957, p. 17) observed that tasks can become imbued with social meaning, "infused with value beyond the technical requirements of the task at hand." Organizational ecologists have also drawn on this cognitive conception of legitimacy, arguing that legitimacy stems from endogenous population dynamics and represents a stage when "there is little question in the minds of actors that it serves as a natural way to effect some kind of collective action" (Hannan & Carroll, 1992, p. 34). A central feature of legitimacy, then, is that it resides in collectivities as a widely shared presumption. The basis for the presumption can vary – it can be embedded in culture, sanctioned by law, or championed by proselytizers – but the collective consciousness element is critical.

The extant literature highlights several aspects of legitimacy, which should, in principle, be analytically separable. One idea is relational embeddedness, referring to the extent to which a practice or rule is in use within an organizational field, and how such diffusion generates interdependence and self-reinforcement (Baum & Oliver, 1992). Aldrich and Fiol (1994) draw a useful distinction between socio-political legitimacy, where practices or rules are either permitted, mandated or sanctioned by the state, and cultural-cognitive legitimacy, in which ideas are more constitutive, laden with meaning, and used widely in sense-making. In her study of the evolution of technology transfer at Stanford University, Colyvas (2007) observed three stages of legitimation. There was an initial period, 1970–1980, of idiosyncratic, variegated practices, or pre-legitimacy. The second stage, 1980–1993, was marked by the passage of the Bayh–Dole Act in 1980 (formally referred to as Public Law 96–517, the Patent and Trademark Law Amendment Act), which permitted universities to retain intellectual property rights to inventions that resulted from government-funded research. This legislation was based on a rather diffuse notion that technology transfer would enhance U.S. competitiveness against foreign competition (Mowery et al., 2004). This era was a period of growing standardization, marked by the stamp of socio-political legitimacy. The third stage, 1994 to the present, is a period of broad institutionalization ushered in by a growing cultural-cognitive legitimacy, reflected in the acceptance that academic entrepreneurship is desirable and to be venerated.[1] While Stanford was a leader in promoting academic entrepreneurship, during this period technology transfer became

an accepted managerial activity on university campuses, and this professionalization greatly increased relational embeddedness.

Berger and Luckman (1967, pp. 94–95) describe legitimation as a process whereby comprehensibility deepens and crystallizes. In their work, the initial stage represents incipient legitimacy, or a growing awareness that "this is how things are done," and these routines take on a persistent or enduring quality. The second involves the development of causal imageries, as lay theories in a rudimentary form are developed and elaborated more formally. The third involves expanded legitimation by reference to a differentiated body of knowledge. The fourth level entails creation of a symbolic universe, so that symbols, beliefs, and practices are deeply situated and take on moral force. We add that as this crystallization process unfolds, vulnerability to social intervention lessens. Moreover, we stress that the practice or structure that is becoming legitimated can be transformed in the process. An important aspect of this transformation is the degree and form that taken-for-grantedness can take.

Taken-for-grantedness has been central to sociological institutionalism, providing the cognitive element in explaining the reproduction of the social order (Zucker, 1977). Berger and Luckman (1967) stress, for example, the taken-for-grantedness of language, and one's mother tongue, and the extent to which many of the realities of everyday life become objectified. Jepperson (1991) emphasizes standardized interaction sequences or chronically repeated activities as having strong taken-for-grantedness features. In their elaboration of a logic of appropriateness, March and Olsen (1989) describe how individuals inculcate duties and expectations of conduct. Long ago, Veblen (1899) discussed settled habits of thought, in which surely he had in mind a form of taken-for-grantedness.

The key to developing a metric of taken-for-grantedness is to not view such activity as unreflexive, and thus portray humans as over-socialized cultural dopes, but to recognize that skill, effort, and practice are necessary elements in the process by which an activity or convention becomes taken-for-granted (DiMaggio & Powell, 1991). The institutionalization of principles and practices initially requires the mindful engagement of individuals in organizations. Our intention is to reveal the manner in which complicated mosaics of routines, categories, and identities are converted into rules of action in particular situations. We also note that even as taken-for-grantedness deepens, it can still be subjected to external scrutiny.

Whether taken-for-grantedness represents pre-conscious understandings, pre-set expectations, a schema or script for guiding interaction, a highly efficacious routine, a deeply felt value, or a widely prevalent and strongly

embedded practice, the resilience of an activity or belief is enhanced through practice and replication. In Berger and Luckman's (1967) formulation, becoming taken-for-granted entails search for pre-existing templates for thought and action. Such sense-making efforts can be efficacious as they reduce the cognitive load associated with decisions, as well as decrease risk by providing well-rehearsed modes of communication and action and ready-made categories for resolving uncertainties (Weick, 1995).

Thus, a key metric of taken-for-grantedness is the extent to which practices become embedded in organizational routines and become largely unquestioned. This is the process we illustrate in this paper. But it is important to stress that experience with routines does not necessarily equate with competence or with consensus. Nelson and Winter (1982) emphasized that routines can represent organizational memory, a political truce, a target, or a skill. Routines may embody accumulated or organizational experience, a "ceasefire" between opposing coalitions, an aspiration level, or an organizational capability.

An apparent tension that exists in the literature is the assumption that institutionalization often represents greater codification, more specification of rules or procedures or more pages in a manual, while taken-for-grantedness can entail condensation as practices are so well understood they can become unspoken. We suggest that compression and elaboration complement one another, with elaboration expanding before compression can set in, and compression, in turn, enabling further elaboration. In his magisterial treatment of the history of manners from the 13th century to the present, Elias (1978) used etiquette guides to extract descriptions of table manners, bodily functions and sleeping habits.[2] One of the compelling points he illustrates is that in early guides there was extensive discussion of how to use a fork, but by the 19th century, such discussion had grown silent. In our view, this dropping off of the discussion reflects taken-for-grantedness. In contrast, notes about bedroom manners and whether adults should sleep with children and how people of the same sex should appropriately share a bed became more detailed. The abbreviation of table manners and the expansion of bedroom manners were both part of the rise of an ethos of Western civility. By the 1800s, table etiquette had been mastered by the literate middle classes and hence further explanation was no longer necessary. But the creation of conventions for rearing children and interacting 'appropriately' with other adults in the bedroom needed more attention. Thus, compression suggests a widely shared symbolic or moral universe, while elaboration of more capacious rules and procedures reflects attempts to formulate that symbolic or moral code.

Similarly, some practices can be routinized and taken-for-granted through compliance to external pressures, but fail to become deeply cognitively embedded. In such cases, there may be widespread public compliance, but privately individuals or organizational representatives can challenge or grumble over the value of particular practices. For example, we will see in our case that the taken-for-granted assumptions about the convention of who deserves to be listed as an author on a scientific paper are not congruent with the legal requirements for who qualifies as an inventor on a patent. In contrast, normative pressures, which rely on cultural and moral understandings, can operate in a proselytizing manner, enrolling more members of a community in a practice or belief in a cooperative, collective endeavor, even if the activity is not formally permissible. Such normative effort is very much facilitated by discursive claims (Suddaby & Greenwood, 2005; Lawrence & Suddaby, 2006). Consequently, we do not expect that taken-for-grantedness and legitimacy always advance at the same pace or to the same degree. Our goal is to capture a process of institutionalization, with all of its fits and starts and partial steps and missteps, through which legitimacy and taken-for-grantedness advance and reinforce one another. In our case, university practices evolved into routines and became taken-for-granted, and were replicated with relative ease. As these activities became widely accepted and considered legitimate, they were deemed desirable and appropriate.

3. THE RESEARCH SETTING: UNIVERSITY–INDUSTRY INTERFACES AND TECHNOLOGY TRANSFER

Technology transfer at Stanford is an apt setting for analyzing levels of legitimacy and taken-for-grantedness. First, the development of technology licensing at U.S. universities is a reflection of a broader process of institutional change whereby the realms of public and private science have become integrated into a common domain (Owen-Smith, 2003; Sampat & Nelson, 2002). Technology transfer offices are boundary spanning units that join together the academic and commercial worlds, providing a ripe context for observing the mixing of public and private science (Guston, 1999; Owen-Smith, 2005). Second, this transformation takes place both at multiple levels (i.e. individuals, departments, and organizations) and across multiple organizational forms (i.e. university, industry, and government sectors). The ramifications of these changes enable us to consider both local

and field-level processes. We are able to observe the importation and development of new practices into existing organizational forms, as well as the reconstitution of an organizational field.

While U.S. universities have a long history of relations with industry (Geiger, 1993; Nelson & Rosenberg, 1994), the commercialization of basic science is a fairly recent phenomenon. Acquiring resources and financial incentives are a component of this development, but not a primary factor. Powell and Owen-Smith (1998), for example, demonstrate that large-scale entry by universities into attempts at income-generating activities is more an effort to signal legitimacy than a sign of commercial acumen. Most university technology offices barely break even, and the majority of invention disclosures do not culminate into a license (Mowery et al., 2004). Nor is legislation the driving factor that many casual observers claim. Even though the *Economist* (2002, p. 3) proclaimed that federal legislation authorizing university technology transfer was "possibly the most inspired piece of legislation to be enacted in America over the past half century," more informed scholars have shown that this legislation was only a small part of overall government involvement in basic research, and more an authorization than a catalytic intervention (Eisenberg, 1996; Mowery et al., 2004; Powell, Owen-Smith, & Colyvas, 2007).

Stanford was among the first initiators of a technology transfer program, long before federal legislation in the early 1980s mandated such activity. We focus on the life and medical science disciplines to control for variation in disciplinary, market, and institutional environments.[3] Moreover, in the early 1980s the biotechnology industry was just emerging. We are thus able to observe the earliest features of an institutional transformation, precisely when states of legitimacy and taken-for-grantedness were very low. Stanford became one of the more successful technology transfer offices, frequently touted as a model for emulation in both the U.S. and abroad. According to the 2002 annual survey of the Association of University Technology Managers, Stanford University rates among the top 5 universities across numerous key technology transfer performance metrics, including license income received, invention disclosures, U.S. patents issued, start-up companies formed, and licenses executed with equity (AUTM, 2002).

Stanford's Office of Technology Licensing (OTL) was founded in 1969 by an engineering-trained industrialist, Neils Reimers, who had worked for a short time in the university sponsored research office and believed that there were numerous opportunities where the university would be able to capture the commercial benefits of academic research (Reimers, 1997; Weisendanger, 2000).[4] In the life sciences, faculty were only just beginning

to become involved in consulting with fledgling commercial enterprises, many of which emerged from university discoveries and a healthy number were founded by academicians (Powell, 1996). Within the university, much of the impetus behind disclosing inventions was driven by the sponsored research office because life science-related federal funding agencies had developed institutional patent agreements that required notification of any potentially patentable invention. At this time, federal research agencies had requirements that universities report inventions, state a plan for dissemination, and request permission to patent.

While involvement with commercializing science today is attributed to entrepreneurship and part of an overall professional *modus operandi* of involvement with industry (Shane, 2004), early participation in the technology transfer program came largely through coincidence with other professional activities. Typically, life science faculty who submitted invention disclosures became involved through consultative ties to industry and the resultant company interest in acquiring proprietary access grew out of this relationship. On occasion, some scientists were approached by the technology transfer office with a query about marketing their inventions. Most of the early inventions at Stanford came from just a handful of research programs. Thus, early steps toward commercial involvement were not triggered by prospects of monetary gain, but stemmed from the ongoing relationships of laboratory leaders and their means of involving their technicians and collaborators in the goals of the research (Colyvas, 2006). Only over the past 15 years, with the explosion of the biotechnology industry, has commercial involvement on the part of biomedical faculty become the norm rather than the exception.[5]

The OTL had modest beginnings with only two staff, but grew rapidly. By 1975, it had a gross annual revenue of over $1 million and had already received two invention disclosures that would be among their most lucrative and well-known patented inventions. Today, the OTL has more than 25 employees with annual gross royalty income of almost $50 million.[6] Despite high profile breakthroughs and lucrative licensing agreements, financially successful technology transfer as measured through licenses and income is, nevertheless, relatively unusual. The Stanford OTL reports that only 20–30% of invention disclosures make it to the stage of a license, and among these, most active licenses do not earn any net income. In fiscal year 2003–2004, of the 436 inventions that generated funds, only 44 made over $100,000, and but six of these produced $1 million or more (Stanford, 2004).[7] Tech transfer is clearly a process involving a good deal of luck, as a few winners generate the bulk of the revenues.

4. METHODS AND MATERIALS

We follow the suggestions of Ventresca and Mohr (2002) and Schneiberg and Clemens (2006) who call for a more considered approach to archival analysis and historical inquiry. Schneiberg and Clemens (2006) argue that accounts of institutions are "discursive constructions that incorporate cultural models in their telling." Consequently, researchers must infer meanings as authors frequently reveal habits of mind and assumptions only indirectly, through their use of emphasis, quotations, and questions. They also caution that once a practice or regime acquires legitimacy, debates cease and conflicts or questions wither (Zelizer, 1979; Schneiberg, 1999). Thus, the presence, absence, onset, and cessation of commentary can be utilized to periodize the development of an institutional rule or organizational form and to develop simple categorical measures of legitimacy.

Mohr (1994, 1998) has been in the forefront of efforts at illustrating how cultural meanings and social structures are mutually constitutive. Drawing on organizational records at four key time periods, Mohr and Guerra-Pearson (2006) analyze how charitable organizations developed vocabularies that both interpreted social problems as well as staked claims to solve problems. They demonstrate how social work bureaucracies won out in a battle with settlement houses to become the dominant force in social welfare services in the early 20th century. Ventresca and Mohr (2002) champion a new archival tradition characterized by formal methods that treat archives as data to be collected, analyzed, and measured directly.

Several recent empirical studies advance these new methodological claims. In their analysis of the decline of classic French cuisine and the growth of nouvelle cuisine, Rao, Monin, and Durand (2003) link changes in cooking to broader social transformations while simultaneously using texts and interviews to chart the redefinition of French cuisine. Suddaby and Greenwood (2005) analyze rhetoric at public commissions over the appropriateness of combining the accounting and legal professions into a multi-professional organization, and vividly capture the heated contests between competing professional logics. We enter this line of research by using correspondence to trace the changing meanings and organizational practices associated with technology transfer.

We utilize an archival dataset based on a systematic review of life science discoveries that were inventions submitted to Stanford from 1970–2000 (Colyvas, 2007). The sample of disclosures by faculty, staff, and students affiliated with a basic life science department, as well as co-inventors from other departments, total 218 inventions between 1970 and 2000.[8] The

university's inventions are organized into dockets, reflecting an instance of disclosing an invention by a scientist to the university. The dockets contain a chronology of the commercialization process, including legal and contractual documentation as well as hand written notes, notations in the margins, personal correspondence, and recordings of personal interactions and opinions. While the legal correspondence is often documented and preserved in its final form and may include public records (i.e. patent or licensing agreements), the informal side is often reflected in letters and memoranda written to the file, and, more recently, e-mails. The dockets also reveal many failed alternative ideas and approaches as well as disputes that are not included in the final results of a commercialization arrangement. For example, there is evidence of numerous licenses and interactions with industry that did not result in a completed agreement. Finally, particularly in the early years when practices were not fully formed, the advisory and consultative aspects of handling sensitive issues or making sense of new situations comes through in archival documentation, such as memos written to the files.

We utilize correspondence we have selected from the OTL, identifying letters and memos from these dockets as "exhibits" for our purposes. The letters and memos represent traces of organizational memory. We think of them as a longitudinal conversation. We select correspondence about administrative procedures involving relationships with individuals and organizations that are central to the tech transfer process. These artifacts have been modified, with the identifying information removed to preserve the anonymity of the participants. We use only the relevant parts of letters and memos to avoid unnecessary length. The correspondence was chosen to illustrate the concepts of legitimacy and taken-for-grantedness, not as a documentary representation of the larger body of materials in the Office of Technology Licensing. This analysis is offered as an existence proof of the features and processes we wish to highlight, not as a comprehensive sampling of the university archives.

The initial coding scheme classified invention disclosures in terms of practices and meanings associated with features of the technology transfer process, including the reduction of a research finding or program into a description of an invention, the determination of inventorship, the terms of licensing, and the conditions for disbursement of real or potential income. This initial classification suggested three time periods: (1) idiosyncratic, when practices and arrangements were determined on a case-by-case basis; (2) standardized, as rules and routines became developed and codified; and (3) institutionalized, once commercializing science was self-replicating and

Table 1. Invention Disclosures by Time Period.

Year	Practice of Commercializing Academic Research	Stage of the Technology Transfer Program	Number of Invention Disclosures	Number of Individual Inventors
1970–1980	Introduction	Idiosyncratic	31	47
1981–1993	Implementation	Standardized	64	85
1994–2000	Expansion	Institutionalized	123	150

largely invulnerable to contestation. Table 1 provides the frequency counts of invention disclosures and inventors within each period. The growth in numbers did not trigger more personnel and more formalization in the OTL, rather the process worked in reverse. The OTL "scaled up" and developed standards under the leadership of Niels Reimers, the organization's founder, so that it could more proactively tutor and educate campus inventors in hopes of securing more invention disclosures.

We reviewed the disclosures from each time period and extracted exhibits that reflected critical features of legitimacy and taken-for-grantedness. Our analytic approach was to identify the definitions and debates found in the disclosures (Suddaby & Greenwood, 2005), and to discern patterns in the development of practices and their meanings (Mohr, 1998).

5. NARRATIVE ANALYSIS

We begin with a discussion of legitimacy, using the correspondence to illustrate how the commercialization of university science at Stanford became more accepted, comprehensible, and diffused across the university over time. We then discuss how discrete elements of this process became taken-for-granted. We begin with specific pieces of correspondence, and build our analysis directly from them, then conclude with a more general abstract assessment. Our goal is to detail an analytic narrative that interprets the documents and provides more general insights into how legitimacy and taken-for-grantedness can be gauged through textual analysis.

Legitimacy and the Commercialization of University Science

We first address the initial contact between public and private science, and turn to the growing acceptance of commercializing university science. The

first set of documents (Exhibits A, B, and C) are internal university correspondence dealing with faculty and commercial engagements regarding licensing opportunities. We offer them as examples of low to high levels of legitimacy of technology transfer at Stanford. Exhibit A is a 1971 memo written to the disclosure file by the director of the OTL, documenting a meeting where terms of interaction with a company are discussed with respect to its effects on faculty and their research. Exhibit B is a late 1970s memo from a faculty member to an OTL associate expressing specific concerns about the university's licensing of an important technology, wherein he attempts to draw clear personal boundaries between the university and his science. Exhibit C consists of two letters, both having to do with conflict of interest guidelines for faculty and start-up companies. Both address the respective scientists' high degree of involvement in the commercial transfer of their research. These exhibits illustrate both organizational and field-level emergence of language and shared understandings that become embedded in the norms and practices of the academy.

Standards of Desirability and Appropriateness

Perhaps the clearest indicator of the novelty of commercializing basic science, and its attendant low level of legitimacy, is the difficulty that participants had in categorizing or labeling behaviors as acceptable or routine in the context of academic research. The first memo (Exhibit A) contains extensive discussion of contingencies and procedures, from how potential disputes with respect to revenue disbursement may be resolved, to the degree of involvement of faculty members with the licensing organization. "... *(N)o person connected with the project would receive personal remuneration. The "inventor's" share of royalty income would be added to the standard department share* ... " (quotation marks in original). The explicit elaboration of these details reflects the extent to which the organization and the individuals within it sought to mitigate the tension between what may be beneficial and what may be objectionable. As Suchman (1995) noted, the pragmatic element of legitimacy depends on rendering activities unsurprising. For example, the frequent mention of the word "appropriate" indicates that there is a question over whether this activity is suitable from the perspective of the university and the faculty, hence the status of commercialization demanded explicit justification. "*It was considered appropriate that the proposed program be entered into* ... " and "*necessary in this specific case for development of a beneficial and useful [technology] for the public.*" Entering into an agreement with a company required a clear rationale and, notably a statement of necessity, rather than just a statement of benefit. Furthermore, the

Exhibit A. Commercialization of University Science.

Code: Low legitimacy

Source: July, 1971 Memo to file written by Director of Technology Licensing program

Dr. [Department Chair Name], Dr. [Faculty Member in the Department], Dr. [Principal Investigator] and Mr. [Technology Licensing Associate] met on Tuesday, July 20, to discuss the above proposed license agreement between university and [company name].

The [Department] research personnel, along with Dr. [Faculty Collaborator] (who would provide research inputs in regard to ... properties), agreed that no person connected with the project would receive personal remuneration. The "inventor's" share of royalty income would then be added to the standard department share. It was agreed that only specifically named individuals could be bound by this arrangement, and it was agreed that it would be appropriate to list these specific people in the agreement with [Company Name]. It was discussed and considered inappropriate in connection with the project for any individual to have a separate consulting agreement with [company] in the specific technological area of the proposed research program.

The question of maintaining [Company Name] marketing, trade secrets, manufacturing, or other proprietary information confidential was discussed at length. It was agreed that for the personnel involved on the project to maintain such information confidential it would have to be so indicated by [Company Name] prior to disclosure to the individual. Scientific information would be openly exchanged without any restriction on further dissemination. No express or implied restrictions by [Company Name] on publication of scientific discoveries in scientific journals would be accepted. It was acknowledged that the portion of the project concerning properties of cells was largely conceptual at this time, and it was therefore not clear the extent of contribution of this portion to the total program. This posed a problem regarding the division of royalties between [Department] and the [Laboratory]. It was agreed that third parties, namely Mr. [licensing associate] and possibly an outside attorney, would adjudicate the division of departmental royalties if the proper division of royalties was not clear from the extent of contribution of the two groups.

It was considered appropriate that the proposed program be entered into since such a collaboration between a scientific [company field] and the University would be necessary in this specific case for development of a beneficial and useful [technology class] for the public. Mr. [Licensing Associate] agreed to contact [Company Name] to commence detailed negotiations and will coordinate appropriate reviews or consultations during the progress of discussions.

Copies to: [7 faculty members in the department]

Exhibit B. Commercialization of University Science.

Code: Medium legitimacy

Source: Late 1970s memo from faculty member to OTL associate regarding notable invention

Dear [Name],

Several months ago when Stanford began discussions with [Name] Corporation and with one of their competitors about possible licensing of the [Named invention], I indicated my wish to remain uninvolved in and uninformed about the University's activities in this area. As you know, I made this request because I have been serving as a scientific consultant to [Company Name], and I was eager to avoid any appearance of potential conflict of interest.

Subsequent events have led me to reconsider this earlier position. The extensive discussions about patents that have been held both within and outside of the university have persuaded me that any steps taken by the University in licensing this patent will unavoidably have significant fallout on me. I believe that my potential risk from the University's licensing activities is greater risk than the risk from the appearance of conflict of interest; therefore, I now ask to be completely informed about University's plans, goals, proposed licensing arrangements, etc. with regard to this patent – as is the standard practice with other patents at Stanford.

Our recent discussion in which you indicated that Stanford has been considering an exclusive short-term licensing agreement with one

particular company provides an example of the basis for my concern. The question of exclusivity is perhaps the most sensitive issue associated with this patent so far as the scientific community is concerned. If Stanford were to proceed with an exclusive agreement, I believe that both the University's image and my personal image as a scientist would be affected. Until our recent telephone discussion, I had no information about these plans, which have a potential for being detrimental to me.

For the record, I want to state that my relationship with [Company Name] is as a scientific consultant; I hold no equity in the company and I do not give [Company Name] business advice. My scientific consultations to date have been primarily in areas other than [named invention] and [science related to named invention]. I expect that it will be possible for me to effectively separate my relationship with Stanford as the inventor, from my relationship with [Named Company] as a scientific consultant. I am acutely sensitive to the potential problems inherent in this situation; for this reason, I plan to be especially scrupulous in avoiding any action whatsoever that might possibly be construed as involving a conflict of interest.

Sincerely,

[Scientist Name]

criteria for partnering with a company included an invocation of the greater social good, as opposed to mere personal or university gain. Here the perception of science as an opportunity for serving the public is invoked to justify this particular engagement with industry (Sarewitz, 1996). This move represents considerable reach into the larger society to attempt to justify a new practice. Note also how the message was made clear that this situation was more an exception rather than a rule. This letter reflects that technology transfer is new, unfamiliar, and not well established within the university. Thus, when legitimacy was low, there was a need to draw from outside the university and buttress the activity with an argument about public benefit.

As the practice of technology transfer becomes more legitimate, the existence of the activity requires less justification. A set language begins to emerge to identify which features of the activity are deemed desirable and

Exhibit C. (C1, C2) Commercialization of Science.

Code: High legitimacy

Source: June, 1993 memo from OTL licensing associate to department head

This memo is provided as background relating to the licensing of inventions from Prof. X's lab to [company name], pursuant to the conflict guidelines for licensing arrangements involving faculty holding equity in a prospective licensee. We feel licensing all three inventions to [company] is most appropriate for developing this technology effectively for a number of reasons.

[Company] has proven to be a good licensee. They are progressing rapidly with the commercialization of this technology. They began Phase 1 clinical trials, and appear to be fully committed to the projects associated with Professor X's technology. [Company] was founded in 1988, and has since completed 3 rounds of venture financing, one round of exercised warrants, and a corporate partnership with [a large pharmaceutical corporation]. They are planning an initial public offering later this year. All of these activities should put them on strong financial footing to continue to aggressively develop the technology.

Please let me know if I can provide any further information, which would help your evaluation.

Cc: Professor X, Head of OTL

Source: September, 1996 letter from assistant professor to associate dean asking for conflict of interest permission

Dear [ ],

As you are aware we have had previous discussions regarding my starting of a company surrounding technology developed in my laboratory. As you are also aware I disclosed the essential aspects of this technology in the Spring of 1993. Since that time I have started a company around the technology and have assigned my interest in the patent to the Company. For conflict of interest it is necessary for you to know that I am a Founder, hold equity in the Company, and will serve as Consultant and the Chair of the Scientific Advisory Board for the

Company. I am fully aware of the time limitations inherent in my obligations to Stanford and will uphold them appropriately.

I am also aware that my laboratory is not to become the research arm of the Company. I can assure you I fully understand the need to separate my lab from the Company. It is for this reason that I have hired only the most able CEO and law firm to represent the Company and to seek significant financing to ensure that the Company can stand alone, independent of research efforts from my group. The targets for the company are those defined by the market place. The targets of interest to my lab group are those defined academically and will be kept distinct.

Please let me know if there are any other issues that need to be addressed.

Sincerely,

[Faculty Name]

what context or contingencies make the practice appropriate. Viewed more abstractly, an institutional vocabulary develops. As Mills (1940) noted long ago, language provides a vocabulary of motives in which words and expressions carry and articulate distinctive logics of action. Consider the study of the transformation of health care by Scott, Reuf, Mendel, and Caronna (2000), where they illustrate a change in logics with the shift of the doctor/patient relationship to health care provider/consumer. Similarly, in the second letter (Exhibit B) the discussion of propriety turns from the overall general activity to the particular nature of engagement, detailing case-specific aspects of the practice. Whereas in the first letter (Exhibit A), there is a clear articulation of broad (normative) concerns associated with secrecy and potential constraints that may be associated with an industrial partner, this letter from a faculty member to an OTL associate highlights the move toward classification of problems and the standardization of solutions. The clear language around "conflict of interest" and the "question of exclusivity" exemplifies this shift. As the scientist writes, "*[t]he question of exclusivity is perhaps the most sensitive issue associated with this patent so far as the scientific community is concerned.*" The tone of the discussion changes from a broad debate about the appropriateness of the activity to a somewhat narrower one of whether the license should be open or exclusive. More

specifically, in this context, the debate is over whether a single company can have the license, and potentially preclude others from using the technology, or whether any company could license the technology for a fee. The faculty member refers to the issues with little elaboration, yet places extensive emphasis on the personal hazards: "*I believe that my potential risk from the University's licensing activities is greater than the risk from the appearance of conflict of interest ...* " Thus, the faculty member redraws the line between science and commerce: "*therefore, I now ask to be completely informed about University's plans, goals, proposed licensing arrangements, etc. with regard to this patent – as is the standard practice with other patents at Stanford.*"

Efforts at mitigating concerns over a potential spoiled identity, or the new problems that arise in the context of commercial involvement, emerge through trial and error learning. The letter from the scientist (Exhibit B) shows that technology transfer routines were becoming standardized. The individual 'offended' scientist's actions and the meanings associated with them in the context of the wider community of science are not well understood, hence the situation causes him considerable concern. Although the practice of patenting and licensing university research has become more familiar within the university, the scientist attempts to create an arms-length distance from this process to preserve his academic reputation and to signal disassociation from the university's efforts. The scientist begins with a strategy of remaining "*uninvolved and uninformed about the University's activities in this area,*" and then through an assessment of risk to his personal reputation, as the university proceeds with licensing efforts, requests to be "*completely informed.*" Thus, while the perception of the problems are increasingly clear, the solutions are still very much in flux.

We regard this correspondence as indicative of middle-stage legitimacy because the activities are becoming both more explicated and familiar within the organization, and the scientist is cognizant of possible risks to his reputation. Yet the means by which to deal with controversy and possible damage to one's reputation are not apparent. But rather than choose distance and deflection, he opts for deeper knowledge and engagement. Moreover, this is a highly prestigious scientist, and had he chosen to disengage or deflect, such a move would have been consequential. More generally, we know that the greater the prestige of a defector, the more an activity is delegitimated (Podolny, 1993; Strang & Soule, 1998; Rao et al., 2003). But the growing legitimacy of the commercialization of science is signaled by this scientist's decision to closely monitor the university's actions and to attempt to account for them in the wider republic of science.

As an activity becomes more legitimated, the standards become more available, contingencies articulated, and responses much more scripted. Consider the high-level of candor and transparency in the second letter in Exhibit C (C2). This is a letter from á young professor to an associate dean, which emphasizes that the process has been bureaucratized and pushed down to lower levels in the university. "*For conflict of interest it is necessary for you to know that I am a Founder, hold equity in the Company, and will serve as Consultant and the Chair of the Scientific Advisory Board for the Company.*" Whereas the letter in Exhibit B evinced awareness of specific problems, this letter reflects that conflicts are now standardized through a reporting procedure and a statement of the type of interactions that a scientist has with companies. Note also the compact nature of the language: "*I am fully aware of the limitation inherent in my obligations with Stanford and will uphold them appropriately... I am also aware that my laboratory is not to become the research arm of the Company.*" Two decades earlier, such engagement would have required pages of documentation and debate, and involved top university officials. Now it appears in two short sentences. When legitimacy is high, very little articulation is necessary to accompany the reference to which behaviors are acceptable. The language in Exhibit A discusses at length the features of the situation that would or would not be "appropriate," while Exhibit B draws the distinction between norms governing action for the individual scientist compared to the university. The culmination of the process is illustrated in the two Exhibits C1 and C2, where what is appropriate is determined by the best way to achieve success in commercializing a technology. Thus, once the legitimacy of an activity is high, norms are compressed into succinct pre-set routines and procedures.

The letters reveal discussion about not only the specification of actions, but contain debate about whether such actions are normatively suitable in the context of academic science. There are numerous invocations of appropriateness, even though its meaning and origin varies. In the early years, the criteria for what is or is not suitable commercial engagement by the university is hammered out in the context of individual cases, involving scientists and practitioners in the details of each specific interaction. By the middle stages of legitimacy, as more standards for commercializing science are instantiated, the early tone of propriety based on ideas about necessity turns to questions of risk, harm, and detriment. The scientist avers that "*... I believe that both the university's image and my personal image as a scientist would be affected.*" As legitimacy grows and deepens, what is appropriate moves from a question of whether or not to commercialize to which industry partner is preferred. Thus, the activity is no longer

problematic, only the mechanics of whom to commercialize with are. This transformation is nicely illustrated in Exhibit C1, a letter from an OTL associate to the department head, where the language focuses on the capability of a startup firm: "*We feel licensing all three inventions to [company] is most appropriate for developing this technology effectively for a number of reasons ...*" Previously, attention was focused on whether a university invention should be marketed, now the concern is whether the company is a model startup firm with venture capital backing.

These examples suggest that the process of legitimation may not necessarily be smooth or linear. Early case-specific congruence can be challenged as a practice spreads and gains credibility. But rather than defection or opposition, a notable scientist opts to be engaged and regulative. A possible breach is lessened, and subsequent contests are over details, not fundamental debates over appropriateness. Thus, as a practice achieves an initial state of legitimacy and is codified into a set of standards that identify what constitutes desirable action, perceived problems and issues congeal and can possibly become amplified. If contestation is to occur, the middle period is a likely stage. But when a practice becomes highly legitimate, problems and issues become embedded in organizational routines and procedures, designed to mitigate concerns and render them tractable and comprehensible. In effect, the concerns become institutionalized as they are labeled, clarified, and hashed out, and become less vulnerable to contestation.

Boundary Formation and Development

Another element of legitimation concerns the maintenance and dissolution of boundaries. When the legitimacy of technology licensing was low, the boundaries between university and industry were sharp and coherent. Within the ivory tower, both the activities of individual scientists and the university were perceived as a common set of practices, representing the same institutional field (Merton, 1973; Gieryn, 1983). In contrast, industrial science was regarded as a different domain, with distinctive career ladders, incentives, and reward structures (Marcuson, 1960; Kornhauser, 1963; La Porte, 1965; Allen & Katz, 1986; Lam, 2005). As the legitimacy of commercializing science grew, however, there emerged a cleavage between the individual scientist and the university as an organization interacting with companies. Note how in Exhibit A, faculty consulting activities were considered linked to the commercialization of science on the part of the university. In Exhibit B, the scientist draws a distinction between himself and the university, signaling his membership in a larger community of academic science, concerned that the university has traversed into the domain of

industry. Nevertheless, in this middle stage of legitimation, consulting activities do not constitute a boundary as they represent a separate, unrelated activity for the scientists. By the latter stage, consulting is one of the many forms of engagement that a scientist openly has with a company. The boundary with industry has been bridged, as the university licenses, partners, and collaborates, while the individual scientist is now a scientific advisory board member and even founder.

When the legitimacy of commercializing science was low, the idea of a scientist consulting in the same area to a licensing company was anathema. The memo (Exhibit A) states, "*It was discussed and considered inappropriate in connection with the project for any individual to have a separate consulting agreement with [company] in the specific technological area of the proposed research program.*" When legitimacy develops and reaches the middle stage, such extreme steps were less necessary, as the technology licensing office grew more autonomous and scientists could separate themselves as individuals from the technology transfer process. Serving as a scientific consultant to a licensing company is no longer inappropriate, yet engagement in the negotiations of the terms of technology transfer signals a distance and means of avoiding perceived conflicts of interest. Note also the shifting locus of decision-making – from a collective discussion among peers to a dyadic conversation between two individuals representing different parties with deep knowledge of the interaction rituals. By the final stage of legitimacy, transparency becomes the currency for mitigating problems. The scientist lists multiple forms of involvement with the licensing company, reflecting a deep engagement with industry that needs no apologies and is widely accepted.[9]

Taken-for-Grantedness

A critical component of legitimacy is taken-for-grantedness, a micro-level process that complements legitimacy, and, in turn, furthers institutionalization. The idea was developed by Berger and Luckman (1967) as a means by which the social order is reproduced as human activity is shaped into patterns and shared meanings and becomes repeated, habitualized actions, which are subsequently externalized as objective reality. Scholars in organizational analysis drew on these insights to develop their ideas about cognitive aspects of legitimacy, whereby a behavior or a practice becomes embedded in taken-for-granted routines and assumptions (Zucker,1977; Meyer & Rowan, 1977; DiMaggio & Powell, 1983). The key element of taken-for-grantedness is the development of shared activities and conventions

that define the way things are or should be done (Scott, 1987).[10] We elaborate below on these themes, demonstrating their manifestations in both practice as well as social and technical categories.

Interaction Rituals Between the University and Industry

We begin with letters (Exhibits D, E, and F) between the university and companies, using them to illustrate the development of routines and norms of engagement between the worlds of university science and commerce. The letters selected from the OTL files concern initial efforts to market and license university inventions. This "shopping" correspondence captures, we believe, the process by which an activity moves from a state of ambiguity and unfamiliarity to highly routinized, prescribed, and well-understood. We code steps along the process as low, medium, and high taken-for-grantedness. Exhibit D is a letter from the OTL manager to the president of a technology company expressing confusion around the norms of disclosure prior to a licensing agreement. Exhibit E is a letter from a company to the technology licensing manager stating their understanding of the terms of disclosure when evaluating a university invention. Finally, Exhibit F is a more contemporary, standard exchange between the OTL and a company, exemplifying a highly scripted mode of contact. Together, these letters reflect the changing patterns of interaction among faculty, administrators, and companies as the university technology transfer program develops and becomes institutionalized.

In the early period of university–industry contact, there is a lack of clarity and common agreement about key terms of engagement with industry in the context of technology transfer. Over time, rules and conditions become standardized and interaction highly routinized. The concern over confidentiality when disclosing university inventions to industry illustrates this process. Initially, the form and amount of information about a scientific technology that should be shared with potential licensees was not agreed upon, rendering the distinction between what is or is not confidential unclear to the university. Also unfamiliar were the guiding principles of when to provide confidential information and when to offer non-confidential information. See, for example, the tone of perplexity as the technology licensing associate questions the non-compliance of the company to which the university tried to market an invention: "*I am curious to learn why [company name] did not sign and return the confidential disclosure agreement promptly*" (Exhibit D). This letter from the technology licensing associate

Exhibit D. Relations between University and Companies.

Code: Low taken-for-grantedness

Source: February, 1979 letter to president of a technology company from OTL Manager

Subject: [title of invention]

Dear [Name]:

I am responding to your letter of January 24 [which declined interest due to lack of evidence of commercial utility]. We did not receive from [company name] our copy of the Confidential Disclosure Agreement provided to you during our meeting in November. We assumed a lack of interest on [company name] part and are now in the process of concluding license arrangements with another company. I will appreciate your returning the material, which we provided to you.

It is not often that we will have completely adequate data when we submit an invention disclosure to a company so that it can make a no-risk decision regarding collaboration with the University. Of course, that means that many of our option and license agreements eventually do not result in a commercial product or process, and expenditures at risk of time and money by a company are thereby lost. That is simply the nature of a university technology licensing situation.

I am curious to learn why [company name] did not sign and return the confidential disclosure agreement promptly. In retrospect, it may not have been prudent on my part to provide the invention disclosure without first obtaining the signed confidential disclosure agreement. As Dr. [X's] work has not yet been published, I would appreciate very much your doing what you can to have the invention disclosure returned.

I'm sorry things didn't work out. Perhaps we can do better next time.

Best Regards,

[Name]
Manager, Technology Licensing

Exhibit E. Relations between University and Companies.

Code: Medium taken-for-grantedness

Source: December, 1979 letter to OTL Manager from large corporation

Dear [Name],

You have indicated a willingness to display an apparatus termed [description of invention] to myself and other representatives from our firm. I have contacted Dr. [professor's name] and we shall shortly be visiting her laboratory in the Stanford School of Medicine where the apparatus is in operation.

We require that for this visit the conditions of non-confidentiality contain:

1. Stanford University will not submit any information to us in confidence.
2. No confidential relation shall exist between us.
3. Stanford University has the sole and legal interest in and is free to disclose to our company any information, which you may discuss with us.
4. We will have the sole and unrestricted right and license to use any information so disclosed by you as it may see fit.
5. Your sole legal remedy against us for allegedly unauthorized or unlicensed use of ideas, which you may disclose to us shall be only as provided by applicable patent laws.

If Stanford University agrees to the foregoing, please indicate your acceptance of these conditions by signing in the space below and returning a signed copy to me.

Sincerely,

[Name]
[company name]

expresses regret at having approached the interaction informally by sending the invention disclosure before obtaining what was perceived to be the appropriate documentation. "*In retrospect, it may not have been prudent on my part to provide the invention disclosure without first obtaining the signed*

confidential disclosure agreement." Ironically, the informality is not at issue, rather the choice of routines and prescribed interactions. Note the vocabulary: "*curious, promptly, prudent.*" The etiquette of exchange is nebulous and not well worked out. In that same year, a company provides an explicit listing of the terms of engagement, written in almost contract form, signaling that a first-step interaction involves the disclosure of non-confidential information: "*Stanford University will not submit any information to us in confidence ... no confidential* relation *shall exist between us*" (Exhibit E). While the university side seeks confidentiality in disclosure and informality in exchange, the industry side requires non-confidentiality in disclosure and formality in exchange.

As the practice of marketing academic technologies becomes routinized, university and industry develop considerable congruence in their *modus operandi*. University technologies are shopped to a designated individual within a company, by providing proscribed abstracts containing only non-confidential information. The letter from a large pharmaceutical firm is to the point: "*Thank you for the opportunity to review the information you forwarded to me at [company name]. I have forwarded the information to our scientists for their review and response ... Please forward all future non-confidential disclosure to me at [email address]*" (Exhibit F). Compared to the first two letters, little is explained or made explicit with respect to the nature of technology transfer or the terms or conditions involved in the exchange. Confidentiality and its ramifications, which initially required a good deal of explication, over time become well understood and the discussion highly compressed.

Social Learning and the Development of Collective Understanding

A key feature of taken-for-grantedness is the development of common patterns of communication among members of a field as information is filtered and attended to in comparable ways by individuals in different organizations (DiMaggio & Powell, 1983). Such field-level learning greatly enhances the ability to transmit information across organizational boundaries without extensive discussion, and dampens contestation as well. As practices become habitual across organizations, and reciprocally interpreted, a common mind set evolves that deepens commitment to such activities by members of a field (Galaskiewicz, 1985; Miner & Haunschild, 1995).

Thus, as university and industry were pulled together in a common pursuit, routines, norms, and terms of engagement were imported and interacted with extant logics in the context of the Office of Technology Licensing. Network ties among inventors, companies, and licensing associates help

Exhibit F. Relations between University and Companies.

Code: High taken-for-grantedness

Source: June, 2001 letter from licensing staff member to staff member at large pharmaceutical company

[Name],
Licensing Liaison
Stanford University
Office of Technology Licensing
[address]

Dear [First Name],

Thank you for the opportunity to review the information you forwarded to me at [company name]. I have forwarded the information to our scientists for their review and response. Should there be any interest on the part of our scientists, I will contact you directly.

Thank you for your time and consideration in this matter. Please forward all future non-confidential disclosures to me at [email address]. Please feel free to contact me at [phone number] if you wish to discuss this matter further, or identify other potential opportunities, which you believe may be of interest to [company name].

Best regards,

[Name]
U.S. Academic Coordinator
Genetics and Discovery Alliances
[company name]

***Letter also has hand written note that reads as follows: [first name], Thanks again for the high-priority status! Talk to you soon. [first name]

thicken the infrastructure of technology transfer (Powell, 1996). Thus, despite starting from different locations and understandings in their respective organizational environments, companies and universities became involved in a joint activity, eventually developing common understandings and shared membership. Consequently, a community of common interests formed and

the daily practices of how to transfer university technologies became well understood. As the taken-for-granted understandings deepened, the field was drawn more and more closely together. In this respect, these shared typifications help knit the licensing field together.[11]

The first letter (Exhibit D) demonstrates the initial discordance between the university and a company over an evaluation of an invention. The company, apparently concerned about risk and expenditures, requests further data and demonstration of validity of the research findings. The OTL responds with a statement about the inherent uncertainty associated with university technology transfer. "*Of course ... many of our option and license agreements eventually do not result in a commercial product or process, and expenditures at risk of time and money are thereby lost.*" The tone of the message reflects current knowledge at the time: "*That is simply the nature of a university technology licensing situation.*"

Similarly, the potential licensee imparts information about norms of appropriate exchange from a commercial perspective. For example, Exhibit E, a letter from a potential industrial licensee, demonstrates a clear articulation of the terms of engagement around confidentiality, reflecting a standard set of criteria and routines common among commercial enterprises. Exhibit D, however, written in the same year, demonstrates the university's growing pains in both conforming to these norms of appropriate exchange among companies and asserting matter-of-factly the uncertain nature of "a university technology licensing situation." Exhibit E demonstrates a clear sense of a convention from the company's point of view, emphasizing that they review technologies on a non-confidential basis and that there are sharp, codified rules that information is not submitted to the firm "in confidence."

Here we observe medium taken-for-grantedness as categories are distinguished (confidential and non-confidential disclosure) and steps taken to match them to specific rules of exchange. The level of taken-for-grantedness is not highly established, however, as both consequences and enforcement require an explicit specification. "*Your sole legal remedy against us for allegedly unauthorized or unlicensed use of ideas which you may disclose to us shall be only as provided by applicable patent laws*" (Exhibit E). Exhibit F reflects the development of a concise exchange whereby categories are distinct, practices are mutually understood, and the interaction, to borrow from Selznick (1957), is infused with meaning and value.

In these letters we observe the mutual learning taking place between university and industry as this new mode of interaction between the two realms emerges and becomes institutionalized. In the first decade of the program we see industry's request for a more compelling demonstration of the scientific

findings or value of a technology, prompting a response from the university about the uncertain nature of early stage basic research. Similarly, note the subsequent absorption by the university of norms of secrecy and routines that are already established within industry. This transfer of standards and norms suggest that field-level learning and diffusion is occurring. Not only is there learning inside the technology transfer office, but these new practices are transmitted to university officials and diffused to faculty as well. Even faculty in disciplines that do not patent come to accept patenting as a routine part of academic life.[12] Moreover, this new competence is not a simple case of organizational learning because the rules of engagement with industry are being co-created and reflect a deepening joint involvement in a common endeavor.[13]

Elaboration of Roles and Activities

Another mechanism that promotes taken-for-grantedness and provides coherence to an emerging organizational field is the establishment of comparable job positions in different organizations (DiMaggio & Powell, 1983). These common career statuses greatly facilitate communication and lubricate exchange among members of a field. We see in the correspondence files that, by the year 2000, exchanges now occur between staff members who are counterparts within their respective organizations and designated to conduct this particular activity. The university licensing 'liaison' corresponds with industry's 'academic coordinator' (see Exhibit F). A position has been established whose task is to notify companies about new technologies and an industrial counterpart either expresses interest or declines. Moreover, responsibility has been delegated well down the hierarchy of the respective organizations. The task at hand is now well defined to the point that the terms of engagement require little explication. Whereas in Exhibit D, there is an extensive articulation of risk and the low likelihood that licenses will result in a commercial product, the same practice two decades later indicates no discussion of risk, no reference to data or demonstration of value.

Thus, a critical element of taken-for-grantedness is the extent to which roles develop to handle particular types of knowledge and information (Berger & Luckman, 1967, pp. 72–79). Roles are developed and elaborated as a common stock of knowledge expands and becomes more "objective." In the early years of technology transfer, the correspondence takes place between senior executives – the presidents of companies and the executive director of the OTL. In Exhibit F the formalities of job titles are softened and personalized with a hand-written note at the bottom of the page: "*thanks again for the high-priority status! Talk to you soon*" (Exhibit F). The

two junior-level correspondents acknowledge their similar status and roles and add a personal touch to the formalities and boiler-plate language of the correspondence.

Social and Technical Categories

Our analysis of how routines became taken-for-granted illustrates how initially there was variety and ambiguity, then this heterogeneity was negotiated and encoded through the creation of categories and typifications, and eventually condensed into clear routines that are infused with meaning and value. A similar process occurs with important social and technical categories. We turn to a discussion of the development of the norms and routines of technology transfer in the context of the establishment of intellectual property in academic science. Specifically, we show how the idea of what constitutes an invention and who is an inventor follows a comparable process from variability into compression.

This group of letters (Exhibits G, H, and I) is a series of interactions within the university between scientists and administrators over particular inventions. Exhibit G contains two memos.

The first is from the OTL manager to university scientists and the legal council within the Sponsored Projects Office about funding agencies' requirements for intellectual property. The second memo documents a conversation between an SPO administrator and a scientist trying to ascertain the appropriate list of inventors for a patent. Taken together, these memos demonstrate considerable lack of understanding and confusion around the definitions of inventor and invention. Exhibit H is a letter from a faculty scientist to a technology licensing associate referring to an explanatory discussion about intellectual property and suggesting additional work that may be patented. Exhibit I is a letter from the OTL to a scientist assigning tasks necessary to begin marketing an invention. As with the development of organizational routines, the crystallization of categories entails heightened understanding of expectations and values. Thus, we demonstrate how the classificatory features of technology transfer become condensed and infused with meaning, value, and expectations.

From Ambiguity to Compression

In the early stage of low taken-for-grantedness, the classifications of invention and inventor were vague and arbitrary. No common institutional vocabulary was in place as a reservoir for participants to draw on. In exhibits

Exhibits G. (G1, G2) What is an Invention? Who is an Inventor?

Code: Low taken-for-grantedness

Source: March, 1979 memo from Director of Office of Technology Licensing to lawyer in Sponsored Projects Office and two faculty in Life Science Department.

Regarding the above invention sent to you on March 1, 1979, the clause covering patent rights is contained in our [government agency] Institutional Patent Agreement. The IPA requires that Stanford submit a written invention report of each subject invention promptly after conception or first actual reduction to practice and that the report specify whether or not we intend to file a patent application.

Invention disclosures do not necessarily have to be on a patentable item. We are required to submit a disclosure on any "subject invention," which means any process, machine, manufacture, composition of matter or design, or any new or useful improvement thereof, which is or may be patentable. Also, to be recognized legally, a coinventor must have conceived of an essential element of an invention, or contributed substantially to the general concept. It is not sufficient to have merely participated in creation of the system as a whole. This may help you to determine appropriate persons to be listed as coinventors.

Source: April, 1980 memo to invention file from university patent engineer, concerning a discovery that subsequently proved to be instrumental in the development of the biotechnology industry.

I spoke with [professor A]'s secretary, who conveyed to me that [professor A] thought [technology] was "an invention" so I proceeded to obtain the information necessary for a disclosure. [Professor B] said that he developed the technique, [professor C] helped, but wasn't sure whether [professor D] or [professor A] should be listed as "inventors." Then, I spoke with [professor C] who was trying to get a hold of [professor A] to see what [professor A] thought about being an "inventor"... [professor C] hadn't gotten in touch with [professor A] but had gotten some message that [professor A] didn't feel this should be patented (something like that). I have not heard from either of them and am sending [professor B] the disclosure without [professor A]'s name. I have asked that he check all information, including inventors, on the form.

Exhibit H. What is an Invention? Who is an Inventor?

Code: Medium taken-for-grantedness

Source: October, 1986 letter from faculty member to OTL licensing associate

Dear [First Name],

Thank you for the informative discussion regarding patents. I have an appointment to talk with [a colleague] this afternoon. I will keep you informed of my plans as they develop.

I have an idea for another patent which I would like to pursue with the office of Technology Licensing. It is an algorithm, which I have developed for characterizing [organ mechanism]. I have enclosed a paper, which describes it. This paper has been accepted for publication but has not been published yet.

The acceptance of the paper should give some indication of the validity of the technique. However, I do not really know whether or not companies would be interested. I imagine that this idea would be similar (in terms of company interest) to another patent which we discussed, that characterizes the [organ with technology].

I would be glad to discuss this idea with you.
Sincerely,

[Faculty Member]

D1 and D2, we see extensive use of quotations marks around the words invention and inventor. "*I spoke with [professor A]'s secretary, who conveyed to me that [professor A] thought that [technology] was "an invention" ... [professor B] said that he developed the technique, [professor C] helped, but wasn't sure whether [professor D] or [professor A] should be listed as "inventors ...*" Eventually (Exhibit F) the quotations disappear, suggesting the development of a common vocabulary and shared meaning. "*We'd like to begin marketing your invention to companies ... please send me a list of companies that you think might be interested .... [w]e have found that our inventors are often our best source of licensees.*"

Exhibit 1. What is an Invention? Who is an Inventor?

Code: High taken-for-grantedness

Source: August, 2000 letter from OTL licensing associate to university inventors

Dear [Name] and Dr. [Faculty Name],

We'd like to begin marketing your invention to companies to get some feedback, gauge interest, and find potential licensees. Can you please create a non-confidential marketing abstract for your invention and send me an electronic copy? Also, please send me a list of companies that you think might be interested in this technology. We have found that our inventors are often our best source of licensees.

If you have any questions, please let me know. For your reference, I've attached a sample marketing abstract.

Thanks,

[First Name]
Licensing Associate

The correspondence suggests that initially there was considerable latitude in interpreting who was an inventor or what constitutes an invention. In the first two letters (Exhibits G1 and G2), the scientists themselves are asked to determine first whether or not their scientific finding or artifact is an invention. Then the scientists are consulted over which of their collaborators are actually co-inventors. The OTL is searching for an authoritative source to assist in this classification. For example, the guidelines from the government funding agency provide some basis for establishing what determines an invention: "*Invention disclosures do not necessarily have to be on a patentable item. We are required to submit a disclosure on any "subject invention," which may mean any process, machine, manufacture, composition of matter or design, or any new or useful improvement thereof, which is or may be patentable.*" But the government criteria are amorphous and almost contradictory, reflecting more the idiosyncrasies of administrative routines than a specific regulatory (e.g. legal) definition or convention. The labels and categories of "subject inventions" have very little purchase in the new field

of the life sciences. Scientists confronted with the task or opportunity of commercializing their science had few anchors, especially in new areas such as biological materials or process-related techniques, such as cloning, that had scant legal precedent.[14]

The definition of inventor is similarly plagued initially by a lack of clarity or standard definition. The scientists are not only consulted to adjudicate a concept they hardly understand, but also are provided with vague and indistinct criteria for doing so. "*Also, to be recognized legally, a coinventor must have conceived of an essential element of an invention, or contributed substantially to the general concept. It is not sufficient to have merely participated in the creation of the system as a whole.*" Despite the elaborate language, there is little in terms of analogy or prior examples to guide these scientists. Compare this memo to Exhibit I, which provides an attached example of the "marketing abstract" the licensing associate requests.

Eventually, we see the emergence of a finite range of possible definitions that are contingent on a set of particular circumstances or examples. In Exhibit H, the scientist refers to a tutorial from the OTL, which provided a basis for determining what other inventions may be generated from one's research program. The scientist remarks, "*thank you for the informative discussion regarding patents ... I have an idea for another patent which I would like to pursue ...* " The scientist here draws on specific guidelines to formulate what may be a potential invention – something patentable, not yet published, and an indication of validity. "*I have enclosed a paper which describes [the idea]. This paper has been accepted for publication but has not been published yet. The acceptance of the paper should give some indication of the validity of the technique.*" A scholarly paper serves as the currency for codifying and sharing the potential invention (compared to a marketing abstract in Exhibit H), and analogy directs attention to what also may be commercializable: " ... *I do not really know whether or not companies would be interested. I imagine that this idea would be similar (in terms of company interest) to another patent which we discussed, that characterizes the [functioning of a specific organ].*" The professor is not sure whether his research output is commercially viable, but he is certainly interested in developing connections.

In the latter period, the bandwidth of definitions narrows and becomes less contingent, or associated with context. In the letter to a scientist (Exhibit I), the OTL associate conveys very explicit expectations to the faculty member with respect to the role of the inventor. "*We would like to begin marketing your invention to companies ... Can you please create a non-confidential marketing abstract for your invention and send me an electronic copy?*" Moreover,

there is no longer any elaboration of the term invention, the details have disappeared. Rather, the word now invokes a set of practices and routines associated with technology transfer, including the generation of a marketing abstract and contacting companies. Minimal explanation of the procedures are necessary; there is no discussion of what non-confidentiality in the context of a marketing abstract would entail. In the early stage, when taken-for-grantedness was low, there was a broad, expansive search for how to classify what an invention was and who ought to be included as an inventor. In the middle stage, tutorials are developed and enthusiastic faculty attempt to match their research output against the criteria specified for eligibility for a patent. Once the concepts of invention and inventor become highly taken-for-granted, they became reified and more abstract, and encode a good deal of information. An inventor should do certain things and an invention has particular characteristics.

A distinguishing feature of high taken-for-grantedness is the inter-subjectivity that is involved. Descriptions are concise and packaged. Inventor and invention are meaningful terms in multiple senses now – legally, procedurally, and the categories are increasingly celebrated as both commercially valuable and prestigious within the university. The last letter captures how the schemas for the commercialization process have become set: "... *[P]lease send me a list of companies that you think might be interested in this technology. We have found that our inventors are often our best source of licensees.*" The label of inventor has become central to the technology transfer process, infused with value as the source of not only patentable knowledge, but also a means of identifying a licensee. Furthermore, the status of an inventor carries a set of understood and accepted expectations in the commercialization process. Compare this status to Exhibit H, where the mention on the part of the scientist to any potential industrial interest was a basis for identifying an invention – an invocation of analogy and reference, rather than an enactment of a role in a known and understood process.

Summary

We have used the correspondence of the Stanford Office of Technology Licensing to show how scientific entrepreneurship became more legitimate, activities and categories taken-for-granted, and the overall process institutionalized. The correspondence reflects new vocabularies that convey important organizational changes. As the vocabulary evolved, the categories of invention and inventor shifted from diffuse to settled. Some topics that were

intensely discussed in the early years became conventional and were rendered silent and invisible, reflecting both their legitimation and the extent to which contested classifications were made ordinary (Bowker & Star, 1999). Faculty who did not patent did not know the details of specific OTL procedures or categories, but over time they took for granted that such things were properly in place. Thus, increased taken-for-grantedness and legitimacy permitted the expansion of the organizational reach of the OTL and its operations.[15]

During the OTL's early years, decisions were made on a case by case basis, and these decisions required the input of multiple units on campus, with top echelon approval usually needed to resolve matters. The categories of inventor and invention were inchoate, and the search for authoritative guidelines was continuous. New ideas proliferated, stemming from many sources, and many plans and schemes were considered and hatched but never followed through. As the legitimacy of technology transfer grew, attention turned to implementing a more standardized set of routines. Most licensing activity became consolidated within the OTL; and within this unit, a career ladder developed as the number of staff expanded. Decisions no longer needed the involvement of top executives as more standard activity could be delegated. As categories were established and data used as evidence, the bandwidth for disagreements narrowed. New situations or unfamiliar cases came to be viewed as an opportunity to expand the reach of existing routines or the occasion to create new standards. Consider the novel issue of how to share biological materials. Stanford had to redefine an older category called tangible research property, which previously referred to equipment, in order to facilitate and harmonize the sharing of biological research tools with other scientists. This routine extended the informal practice of scientific collaboration to a formal policy that applied the same rules to both academic and industrial scientists.

Once legitimacy became strong, and support for technology transfer diffused widely across the campus, the procedures for commercializing science became highly elaborated. Currently, all responsibility is consolidated within the OTL, which is highly visible on campus, and widely emulated nationally and even internationally. Key decisions are now made with dispatch by lower level personnel, and when anomalies occur, these staffers can handle exceptions readily. Surprises have become rare, as most situations and solutions have become classified and routinized and disputes are accommodated and contained. We see, then, that compression and elaboration through the development of categories and procedures are not contradictory trends, but rather complements. As the legitimacy of technology transfer

expanded, academic entrepreneurship became widely embraced and required little justification. Thus, acceptance triggered greater procedural rationality as various questions, challenges, and opportunities provided occasions to deepen and expand the repertoire of routines associated with technology transfer.

The analytic narrative we have presented is neither linear nor conflict-free. The institutionalization process was fraught with disputes, misunderstandings, and some effort at distancing. Legitimacy and taken-for-grantedness increased over time in this particular case, but this trend was neither inevitable nor without debate. Recall the case of the eminent scientist who initially did not want to be informed about the OTL's commercial efforts but then turned to active monitoring. He showed awareness of the possible risks that exclusive licensing might have to his scientific reputation. Put differently, he perceived that the identities of ivory-tower scholar and scientist entrepreneur were mutually exclusive. Moreover, people who attempt to cross categories or identities are often penalized, as Zuckerman, Kim, Ukanwa, and Ritter (2003) have shown in their study of Hollywood actors and film genres. But precisely because a number of high-status scientists became actively involved in commercializing science, a strong signal was sent that such activity did not detract from one's scientific reputation (Zucker, Darby, & Brewer, 1998; Owen-Smith & Powell, 2001). And concurrently with sending this signal, it was these prominent scientists that were able to provoke discussion, mollify disputes and concerns, and ultimately play a hand in constructing the normative architecture of participation in commercial activities.

The changes we discern in the correspondence over three decades underscore the growing legitimation and taken-for-grantedness of commercial applications of university science. With respect to legitimacy, we clearly see how the activity becomes more comprehensible (Suchman, 1995). Initially, when legitimacy was low, the move was to reach into the larger society and borrow the template of the public good (and mark the activity as an exception rather than a rule). This unfamiliar activity of commercializing science had to be justified by an argument that economic growth and job creation would be generated. In the middle stage, a new institutional vocabulary develops that incorporates private sector orientations and activities. In the high stage, routines are skillfully executed and their attendant meanings widely understood. The transformation moves from high elaboration (i.e. details, debates, clarifications) and low classification (e.g. categories, definitions) to low elaboration (i.e. little need to spell out how to do things, descriptions are highly condensed) and high classification (e.g. conflict of interest forms, job categories, and intellectual property).

At a more micro level, taken-for-grantedness deepens as the community of participants expands. Consider, for example, the discussion of confidentiality where the university absorbs practices from commercial partners. More broadly, as relations between the OTL and technology companies thicken, a shared sense of membership in a common technological community develops. In the 1990s, faculty begin starting companies based on their research discoveries, and a considerable number of licenses go to university spinoffs or startups where Stanford inventors hold key executive positions or serve on scientific advisory boards. The categories of inventor and invention become highly taken-for-granted, reified and celebrated as entrepreneurial activity is rewarded and becomes a basis for a common identity in the larger high-tech community of Silicon Valley.

6. DISCUSSION AND IMPLICATIONS

Much of the literature in institutional analysis has emphasized external influences and exogenous shocks as the key motor of institutional change. Whether the trigger is legislative mandate, as in affirmative action law or the creation of the European Union, political ideology, such as neo-liberalism or the oppositional role of social movements, or disputes over professional jurisdiction, as in studies of contests between physicians and managers or accountants and lawyers, much of the analytical weight for explaining institutional change has been placed on external forces. This attention is not surprising. If institutions are regarded as durable and self-reinforcing, then the question of what factors create change or rob them of their staying power is a vexing one. Hence the attention to outside influences that jolt institutions and prompt changes. Our contribution is to develop an endogenous account of institutionalization, by attending to how an activity moved from unfamiliar to accepted to venerated. We focus on internal work practices, attending to local processes in which routines and categories are developed through trial and error efforts, and borrowed with modifications from partners in the private sector. This local process proved to be highly consequential in creating a broader field of technology management, as Stanford's OTL became one of the most active participants in the building of this larger community.

Perhaps more than most other elite universities, Stanford has had a strong "knowledge-plus" orientation, and played an important role in the development of Silicon Valley's high-tech community (Kenney, 2000; Rowen, Hancock, Lee, & Miller, 2000). Nevertheless, the linkage between academic

science and technology application has not been without conflict. Consider the different vocabularies and role identities that had to be bridged – from unfettered inquiry, knowledge for knowledge's sake, science is not for sale, knowledge has a public purpose and ivory-tower academic to engaged scientist linking basic and translational science, solving pressing biomedical problems and curing diseases, academic entrepreneurship, and universities as engines of economic growth. Similar to Rao et al's (2003) study of the replacement of classic French cooking by nouvelle cuisine, we see new roles, language, and values emerge that help cement the institutionalization of technology transfer. Moreover, this compilation of roles, languages, and values becomes imbricated into a new identity of scientist-entrepreneur.

Thus, institutionalization produced a practical form of legitimacy in which statuses were formalized, boundaries redefined, access to resources reinterpreted, and even the nature of resources reconstrued. Taken-for-grantedness entailed the creation of routines and the classification of identities and discoveries. Recall the first set of exhibits where administrators and scientists tried to sort out appropriate contingencies together, then a middle level where the university as a corporate actor and the scientist as a member of an intellectual community were separate, eventually culminating into the third level with a new hybrid classification of scientist-inventor-entrepreneur. At this latter point, the proprietary features of academic work are handled through conflict of interest statements. This process is deeply mindful, and not a case of mindless replication. The activity becomes habituated, but only through considerable effort at creating standards and establishing norms of appropriateness.

One objective of our effort is to provide a framework for analyzing processes of institutionalization in other empirical settings. We recognize that other researchers may not have access to a treasure trove of documents spanning three decades. Nevertheless, other process studies with longitudinal data could draw profitably on our work. To this end, we highlight general features of taken-for-grantedness, legitimacy, and institutionalization, characterizing potential indicators of low, medium, and high states, in Fig. 1.

Recall that we argued that institutionalization is a product of the coincident expansion of heightened legitimacy and deeper taken-for-grantedness. To be sure, we are not claiming the two processes march in lock step with another. Below we discuss cases where the two could diverge. But in this context institutionalization occurs through the collated embedding of practices, meanings, expectations, and values. Fig. 1 abstracts from the technology transfer context and suggests an ensemble of indicators that reflect, in our view, a more general process of institutionalization. While these metrics may not apply in every context, we think they offer fertile tools for the

		Low	Medium	High
Institutionalization				
	organizational structure	decisions made by top-echelon	career ladder develops & delegation takes place	lower-level personnel afforded discretion to solve problems
	practical action	multiple means to achieve new goals	coherence around goals develops & means are restricted	means-ends calculation well-understood
	reproduction	learning by doing	tutorials, training programs, strong socialization	outreach & evangelism via flourishing professions & new identities
	self-reinforcement	vulnerable	anchored	resilient
Legitimacy				
	standards	symbols & vocabularies drawn externally to invoke support	institutional vocabularies develop	rich, local language becomes widely accepted & emulated
	norms of appropriateness	trepidation over adoption prompts high articulation	values become more clear but can provoke opposition	norms & values venerated & objectified
	boundaries	existing boundaries well-defined, cross-traffic requires approval	boundaries blur, cross-traffic more accepted	boundaries redrawn & integrated into community with common interests
Taken-for-Grantedness				
	practices	idiosyncratic & developed on a case-by-case basis	consolidation occurs	scripted & well rehearsed, little need for articulation
	roles	ambiguous	varying conventions offered, some trigger debate	defined & steeped with expectations
	categories	diffuse	classifications emerge	settled & infused with value

Fig. 1. Indicators of the Process of Institutionalization.

analysis of both thorough and extensive or incomplete and partial institutionalization. Our indicators are built out of our case, but the ambition of Fig. 1 is to make them portable.

Fig. 1 allows for examination of the multi-level process of institutionalization, its bottom-up emergence and top-down consolidation, as well as local manifestations of field-level processes. Reading down the columns, we see low, medium, and high states for each theoretical construct. We organize the figure in the context of elements associated with each construct based on our case. Our column descriptions should be useful for analyses of qualitative data at either one, a few, or many points in time. Reading the figure vertically captures the nested elements of the overall phenomenon, with taken-for-grantedness focusing on organizational routines, roles, and categories, and legitimacy a broader concept invoking public standards, norms, and the boundaries of a field. Institutionalization refers to the formal instantiation of organizational structures, reflected in careers and administrative levels, as well as mechanisms at each stage that sustain and reinforce the process.

Viewed horizontally, our indicators capture the processual aspects of institutionalization as the constituent elements change through time. Here we see the feedback dynamics as roles and categories develop, vocabularies are constructed, career ladders grow, and socialization expands. Reading the rows, then, provides stepping stones toward the settling of categories, the reconfiguration of boundaries, and the comprehension of clear means-end calculations. For example, at a low stage, institutionalization is not easily self-reinforced. As it grows it becomes anchored in specific practices, and as it deepens, it is resilient to alternatives and robust to challenges.

Again, we stress that the component parts and stages need not fit together as coherently as we have depicted. The process can be halted, for example, due to contestation. We suggest this is particularly likely at the middle stage as new practices or values can prompt reaction from incumbents. Or the constructs can evolve at different speeds. Consider an activity, such as internet pornography or organized crime, that may have acquired medium or high taken-for-grantedness but low legitimacy. In cases where such activities are not aligned in a nested fashion, we contend that institutionalization is incomplete. Indeed, social life is abundant with cases of partial institutionalization. Consider efforts at legalizing cannabis as medical marijuana, transposing organized crime into family business, attempts at clinical testing for herbal supplements, or on-line gambling.

In our case, the expansion of the commercial application of science may well lead to the de-institutionalization of open science (Owen-Smith &

Powell, 2001; R. R. Nelson, 2005). As technology transfer becomes more conventional and appropriate, an older model of an ivory-tower, unfettered view of science is robbed of its hold on the academy. Indeed, the institutionalization of entrepreneurial science may signal the demise of disengaged science for science's sake (Powell et al., 2007). Thus, processes of institutionalization can also be cases of de-institutionalization.

Our objective with Fig. 1 is to establish proof of concept with respect to taken-for-grantedness, legitimacy, and institutionalization through direct examination of archival materials. While the sources from which the exhibits were drawn are rich in content and comprehensive over time, there are limitations to our analyses. We have emphasized developing abstractions from selected archival materials to derive indicators. We have not attempted to systematically code the entire set of OTL correspondence. We choose instead to select a diversity of letters and memos rather than focus on the same type of correspondence through time. More consideration could also be paid to the matrix of participants, notably the mix of faculty, students, and staff, and analyze whether increasing diversity among them prompts a return to earlier states of institutionalization, or whether new entrants enter the process at midstream. Similarly, two external aspects of institutionalization merit further attention. One feature is the involvement of Stanford in creating a professional association that serves as a canopy for the field and Stanford's active role in tutoring other universities, in the U.S. and abroad, in the mechanics of tech transfer. The other aspect concerns legislative decisions – both inside the university at the faculty senate, but more notably at the federal level, that legitimated and consolidated the efforts of such universities as MIT, Stanford, the University of California-San Francisco, and Wisconsin.

Our research calls for an application of contemporary tools of archival analysis toward more direct, process-oriented metrics for institutionalization, allowing for more conceptual precision in understanding both the endogenous dynamics of institutionalization and the roads that lead to it. A core issue here is the determination of what the 'units' of legitimation or taken-for-grantedness are, and the form they take in specific contexts. For example, in this study we follow discrete states of low, medium, and high taken-for-grantedness in the *practice* of marketing a technology, and the *social and technical categories* of inventor and invention as constituent parts of legitimacy. In our examples, the classifications were pre-existing and imported to the organization, requiring considerable sense-making and field-level learning. We show how practices and meanings develop recursively. We also demonstrate how the objects we observe are transformed as their degree

of taken-for-grantedness deepens. Further research could examine more internally developed practices and classifications such as the development of revenue disbursement models within universities, the growing use of for-profit activities to cross-subsidize charitable activities in nonprofit organizations, or considerations of outsourcing formerly core activities in commercial enterprises. We hope our approach provides further insight to how taken-for-granted understandings knit communities of participants together and provide institutional vocabularies that become the *lingua franca* of different fields.

NOTES

1. The period at Stanford was distinguished by the enactment of a rule requiring mandatory disclosure by all university personnel of all patentable inventing. Previously faculty disclosed on the basis of the requirements of federal funding agencies, thus the 1994 campus decision greatly expanded the mandate of disclosure and was not met with any protest. We take this acceptance as a clear sign that technology transfer had been integrated into the mission of the university. See, for illustration, the OYL's website: "The mission of Stanford University's OTL is to promote the transfer of Stanford technology for society's use and benefit while generating unrestricted income to support research and education." (http://www.otl.stanford.edu/about/why.html).

2. We thank Huggy Rao for suggesting the parallels between Elias' work and ours.

3. We draw from the larger research project of Colyvas (2007), which addresses the development and diffusion of commercialization activities among scientists at Stanford from 1970 to 2000.

4. From the university administration's perspective, the creation of an office of technology transfer was intended to recruit faculty, especially junior scientists, and build on the connections with industry that were developing in the computer and engineering sciences.

5. For example, in 1980, after a decade of the operation of the technology transfer program, there were only three faculty inventors from the life science department we are studying. By 2000, there were 20, more than 75% of the faculty in the department.

6. Interestingly, the OTL has never employed any attorneys, opting instead to rely on outside counsel when needed (Fischer, 1998).

7. While the earned income from the OTL is relatively modest compared to sponsored research expenditures ($50,176,009 in gross licensing income compared to $573,416,214 expended in sponsored research funds in fiscal year 2002), the amount disbursed to units within the university is not trivial. Fifteen percent of the total revenues are administered under the discretion of the technology transfer office in conjunction with the Dean of research. The remaining 85% of the gross royalties are disbursed in 1/3 increments to the school, the department, and the individuals that generated the invention. In fiscal year 2003–2004, $12.7 million went to departments, $12.5 million to schools (with more than $10 million to the school of medicine), and

$11.8 million was paid to individual inventors, including faculty, students, and staff of the university. Such funding is discretionary and not tied to a particular project or burdened with stringent reporting requirements or outcome measures as is the case with sponsored research at universities.

8. Of the 35 faculty members who held an appointment in the sampled department during this period, 24 appear as inventors. Including co-inventors on the disclosures, there are 250 individuals in total. Of course many faculty disclose multiple times. The most prolific inventor in the department had 35 disclosures.

9. Our colleague, Gili Drori, has observed that many contemporary discussions of transparency contain elements of modern secular religiosity. In her work on corporate social responsibility, she observes cases of corporate self-reports of labor code violations. Drawing on Jacques Ellul's work, she notes that such confession and ratcheting up of labor standards are steps on a path to "moral recovery."

10. We stress that this process of becoming more taken-for-granted is not deterministic or uni-directional, and need not lead to inevitable constraint. Contestation, as we discussed above, can certainly occur and shape how things come to be accepted as natural, and social meanings always have an element of plasticity, such that even enactment and reinforcement can lead to change.

11. At the field level, a professional association is formed – AUTM, Association of University Technology Managers, and MIT and Stanford play a critical role in its creation and development. The Association grows from 7 members in 1974 to more than 3000 by 2002. Such growth reflects the expansion of professional expertise, and the development of field-wide scripts and standards. Moreover, membership is not restricted to university personnel. Industry associates, government and nonprofit institutes, and non-U.S. members are welcomed. And, of course, academic researchers begin studying technology transfer as well.

12. At Stanford, the range and diversity of departments where patenting occurs is quite extensive. One of the more entrepreneurial units is the music department, and its program CCRMA, Center for Corporate Research in Music and Acoustics (A. J. Nelson, 2005). The founder of CCRMA, John Chowning, developed an algorithm for FM synthesis, which Yamaha developed into the DX synthesizer, the largest selling set of musical instruments ever made, and one of Stanford's most lucrative licenses. These early revenues were plowed back into subsequent multiple efforts at commercializing computer-generated music.

13. In other correspondence not presented here, we find cases of the university and long-term commercial partners working jointly to "tutor" younger start-up companies or non-U.S. companies on the mores of appropriate licensing behavior. Similarly, the Stanford OTL provides tutorials to U.S. and foreign universities, and the OTL and experienced faculty inventors run workshops for younger faculty and graduate students. More recently, the OTL has developed a training module available for purchase on DVD.

14. The parallels with Edelman's (1992) discussion of the legal ambiguity that surrounded equal opportunity law are striking. Here there was considerable confusion surrounding legal definitions and legislative dictates, which was mitigated through interpretive efforts by companies and universities, which then in turn reform the legal definitions of invention and inventor.

15. We thank John Meyer for emphasizing this point.

ACKNOWLEDGMENTS

We thank the States and Markets program at the Santa Fe Institute, supported by the Hewlett Foundation, the Columbia-Stanford Consortium on Biomedical Innovation, funded by the Merck Foundation, and the Association for Institutional Research for research support. We are especially grateful to the Office of Technology Licensing at Stanford University, which has afforded us unrestricted access to their archives. We are also grateful to Helena Buhr, Gili Drori, Hokyu Hwang, John Meyer, Andrew Nelson, Jason Owen-Smith, Charles Perrow, Huggy Rao, Marc Schneiberg, Laurel Smith-Doerr, Barry Staw, and David Suarez for comments on an earlier draft. We have benefited from comments made at seminars at MIT's Sloan School and the University of Alberta.

REFERENCES

Aldrich, H. E., & Fiol, C. M. (1994). Fools rush in? The institutional context of industry creation. *Academy of Management Journal, 19*, 645–670.

Allen, T. J., & Katz, R. (1986). The dual ladder: Motivational solution or managerial delusion? *R&D Management, 16*(2), 185–197.

AUTM. (2002). Licensing Survey: FY. Association of University Technology Managers.

Baum, J. A. C., & Oliver, C. (1992). Institutional embeddedness and the dynamics of organizational populations. *American Sociological Review, 57*, 540–559.

Baum, J. A. C., & Powell, W. W. (1995). Cultivating an institutional ecology of organizations: Comment on Hannan, Carroll, Dundon and Torres. *American Sociological Review, 60*, 529–538.

Berger, P. L., & Luckman, T. (1967). *The social construction of reality*. Garden City, NJ: Doubleday.

Bowker, G. C., & Star, S. L. (1999). *Sorting things out: Classification and its consequences*. Cambridge, MA: MIT Press.

Colyvas, J. A. (2006). From divergent meanings to common practices: The institutionalization of technology transfer at a research university. Working Paper, Stanford University.

Colyvas, J. A. (2007). Institutionalization processes and the commercialization of university research. Doctoral Dissertation, Stanford University School of Education.

Dacin, T. M., Goodstein, J., & Scott, W. R. (2002). Institutional theory and institutional change: Introduction to the special research forum. *Academy of Management Journal, 45*(1), 45–57.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review, 48*, 147–160.

DiMaggio, P. J., & Powell, W. W. (1991). Introduction. In: W. W. Powell & P. J. DiMaggio (Eds), *The New Institutionalism in Organizational Analysis* (pp. 1–38). Chicago, IL: University of Chicago Press.

Economist. (2002). Innovation's golden goose. Economist, December 14, p. 3.

Edelman, L. (1992). Legal ambiguity and symbolic structures: Organizational mediation of civil rights. *American Journal of Sociology, 95*, 1401–1440.
Eisenberg, R. (1996). Public research and private development: Patents and technology transfer in government-sponsored research. *Virginia Law Review, 82*, 1663–1727.
Elias, N. (1978). *The civilizing process: The history of manners*. New York: Urizen Books.
Fischer, L. M. (1998). Technology transfer at Stanford University. *Strategy and Business, 13*(4), 76–85.
Galaskiewicz, J. (1985). Professional networks and the institutionalization of a single mind set. *American Sociological Review, 50*, 639–658.
Ganz-Brown, C. (1999). Patent policies to fine tune commercialization of government sponsored university research. *Science and Public Policy, 26*(6), 403–414.
Geiger, R. L. (1993). *Research and relevant knowledge: American research universities since world war II*. New York: Oxford University Press.
Gieryn, T. (1983). Boundary work and the demarcation of science from nonscience. *American Sociological Review, 48*, 781–795.
Greif, A. (2006). *Institutions and the path to the modern economy: Lessons from Medieval trade*. Cambridge University Press.
Guston, D. (1999). Stabilizing the boundary between U.S. politics and science: The role of the office of technology transfer as a boundary organization. *Social Studies of Science, 29*, 87–111.
Hannan, M., & Carroll, G. (1992). *Dynamics of organizational populations: Density, legitimation, and competition*. New York: Oxford University Press.
Hannan, M., & Freeman, J. (1989). *Organizational ecology*. Cambridge, MA: Harvard University Press.
Haveman, H. (2000). The future of organizational sociology: Forging ties among paradigms. *Contemporary Sociology, 29*, 476–486.
Jepperson, R. L. (1991). Institutions, institutional effects, and institutionalism. In: W. W. Powell & P. J. DiMaggio (Eds), *The new institutionalism in organizational analysis* (pp. 143–163). Chicago: University of Chicago Press.
Kornhauser, W. (1963). *Scientists in industry: Conflict and accommodation*. Berkeley: University of California Press.
Kenney, M. (Ed.) (2000). *Understanding Silicon Valley: The anatomy of an entrepreneurial region*. Stanford: Stanford University Press.
La Porte, T. R. (1965). Conditions of strain and accommodation in industrial research organizations. *Administrative Science Quarterly, 10*(1), 21–38.
Lam, A. (2005). Work roles and careers of R&D scientists in network organizations. *Industrial Relations, 44*(2), 242–275.
Lawrence, T., & Suddaby, R. (2006). Institutions and institutional work. In: *Handbook of Organization Studies*, 2nd edition, Forthcoming.
March, J. G., & Olsen, J. R. (1989). *Rediscovering institutions: The organizational basis of politics*. New York: Free Press.
Marcuson, S. (1960). *The scientist in American industry*. Princeton: Industrial Relations Section, Princeton University.
Merton, R. K. (1973). *The sociology of science*. Chicago: University of Chicago Press.
Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology, 83*(2), 340–363.
Mills, C. W. (1940). Situated actions and vocabularies of motive. *American Sociological Review, 5*, 904–913.

Miner, A. S., & Haunschild, P. R. (1995). Population level learning. In: L. L. Cummings & B. M. Staw (Eds), *Research in Organizational Behavior*, (Vol. 17, pp. 115–166). Greenwich, CT: JAI Press.

Mohr, J. W. (1994). Soldiers, mothers, tramps, and others: Discourse roles in the 1907 New York City charity directory. *Poetics, 22*, 327–357.

Mohr, J. W. (1998). Measuring meaning structures. *Annual Review of Sociology, 24*, 345–370.

Mohr, J., & Guerra-Pearson, F. (2006). The differentiation of institutional space: Organizational forms in the New York social welfare sector, 1888–1917. In: W. W. Powell, & D. L. Jones (Eds), *How institutions change*. University of Chicago Press.

Mowery, D. C., Nelson, R. R., Sampat, B., & Ziedonis, A. (2004). *Ivory tower and industrial innovation*. Stanford, CA: Stanford University Press.

National Science Board. (2000). *Science and engineering indicators – 2000*. Washington, DC: NSB.

Nelson, A. J. (2005). Cacophony or harmony? Multivocal logics and technology licensing by the Stanford University Department of Music. *Industrial and Corporate Change, 14*(1), 93–118.

Nelson, R. R. (2005). Basic scientific research. In: R. Nelson (Ed.), *The Limits of Market Organization* (pp. 233–258). New York: Russell Sage Foundation.

Nelson, R. R., & Rosenberg, N. (1994). American universities and technical advance. *Research Policy, 23*, 323–348.

Nelson, R. R., & Winter, S. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.

Office of Technology Licensing (2004). Celebrating Stanford inventors. Annual report 2003–2004, Stanford University.

Owen-Smith, J. (2003). From separate systems to a hybrid order. *Research Policy, 32*, 1081–1104.

Owen-Smith, J. (2005). Dockets, deals, and sagas: Commensuration and the rationalization of experience in university licensing. *Social Studies of Science, 35*(1), 69–97.

Owen-Smith, J., & Powell, W. W. (2001). Careers and contradictions: Faculty responses to the transformation of knowledge and its uses in the life sciences. In: S. Vallas (Ed.), *The transformation of work* (pp. 109–140). Elsevier Science.

Podolny, J. M. (1993). A status-based model of market competition. *American Journal of Sociology, 98*, 829–872.

Powell, W. W. (1996). Inter-organizational collaboration in the biotechnology industry. *Journal of Institutional and Heoretical Economics, 120*(1), 197–215.

Powell, W. W., & Owen-Smith, J. (1998). Universities and the market for intellectual property in the life sciences. *Journal of Policy Analysis and Management, 17*(2), 253–277.

Powell, W. W., Owen-Smith, J. and Colyvas, J. A. (2007) Innovation and emulation: Lessons from the experiences of U.S. universities in selling private rights to public knowledge. *Minerva*, forthcoming.

Rao, H., Monin, P., & Durand, R. (2003). Institutional change in Toque Ville: Nouvelle cuisine as an identity movement in French gastronomy. *American Journal of Sociology, 108*, 795–843.

Reimers, Niels (1997). *Niels Reimers*. Regional Oral History Office, The Bancroft Library, University of California, Berkeley. Available from the Online Archive of California, http://www.ark.cdlib.org/ark:/13030/kt4b69n6sc.

Rowen, H., Hancock, M. G., Lee, C.-M., & Miller, W. F. (2000). *Silicon Valley edge: A habitat for innovation and entrepreneurship*. Stanford, CA: Stanford University Press.

Sampat, B., & Nelson, R. R. (2002). The evolution of university patenting and licensing procedures: An empirical study of institutional change. *Advances in Strategic Management, 19*, 135–164.

Sarewitz, D. (1996). *Frontiers of illusion: Science, technology, and the politics of progress.* Philadelphia, PA: Temple University.

Schneiberg, M. (1999). Political and institutional conditions for governance by association: Private order and price controls in American fire insurance. *Politics and Society, 27,* 67–103.

Schneiberg, M., & Clemens, E. (2006). The typical tools for the job: Research strategies in institutional analysis. In: W. W. Powell, & D. L. Jones (Eds), *How institutions change.* Chicago: University of Chicago Press.

Scott, W. R. (1987). The adolescence of institutional theory. *Administrative Science Quarterly, 32,* 493–511.

Scott, W. R., & Meyer, J. W. (1983). The organization of societal sectors. In: J. W. Meyer & W. R. Scott (Eds), *Organizational environments: Ritual and rationality* (pp. 129–154). Beverly Hills, CA: Sage.

Scott, W. R., Reuf, M., Mendel, P., & Caronna, C. (2000). *Institutional change and health care organizations.* Chicago: University of Chicago Press.

Selznick, P. (1957). *Leadership in administration: A sociological interpretation.* Evanston, IL: Row, Peterson.

Shane, S. (2004). *Academic entrepreneurship: University spinoffs and wealth creation.* London: Edward Elgar.

Stanford University. (2004). Annual Report of the Office of Technology Licensing 2003–2004. Available at http://www.otl.stanford.edu/about/resources/otlar04.pdf.

Strang, D., & Sine, W. D. (2002). Inter-organizational institutions. In: J. A. C. Baum (Ed.), *Companion to Organizations* (pp. 497–519). Oxford: Blackwell Publishers.

Strang, D., & Soule, S. A. (1998). Diffusion in organizations and social movements: From hybrid corn to poison pills. *Annual Review of Sociology, 24,* 265–290.

Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review, 20,* 571–611.

Suddaby, R., & Greenwood, R. (2005). Rhetorical strategies of legitimacy. *Administrative Science Quarterly, 50*(2005), 35–67.

Tolbert, P. S., & Zucker, L. G. (1996). The institutionalization of institutional theory. In: S. R. Clegg, C. Hardy & W. R. Nord (Eds), *Handbook of organization studies* (pp. 175–190). London: Sage.

Veblen, T. (1899). *The theory of the leisure class: An economic study of institutions.* New York: The Macmillan Company.

Ventresca, M. J., & Mohr, J. (2002). Archival methods in organization analysis. In: J. A. C. Baum (Ed.), *Companion to organizations* (pp. 805–828). New York: Blackwell.

Weick, K. (1995). *Sense-making in organizations.* Thousand Oaks, CA: Sage.

Weisendanger, H. (2000). A History of the OTL. Available at http://www.otl.stanford.edu/about/resources/history.html.

Zelizer, V. (1979). *Morals and markets: The development of life insurance in the United States.* New York: Columbia University Press.

Zucker, L. G. (1977). The role of institutionalization in cultural persistence. *American Sociological Review, 42*(5), 726–743.

Zucker, L., Darby, M., & Brewer, M. (1998). Intellectual human capital and the birth of U.S. biotechnology enterprises. *American Economic Review, 88,* 290–306.

Zuckerman, E. W., Kim, T.-Y., Ukanwa, K., & Ritter, J. V. (2003). Robust identities or nonentities: Type-casting in the feature film labor market. *American Journal of Sociology, 108,* 1018–1075.