Flux and flexibility:
A comparative institutional analysis of evolving university-industry relationships in MIT, Cambridge and Tokyo

by

Sachi Hatakenaka

B.A. Physics
University of Oxford, 1983

M.P.A. Public Administration
Princeton University, 1989

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Signature of
Author:____

Sloan School of Management
April 1, 2002

Certified by:______________

Lotte Bailyn
T Wilson (Class of 1953) Professor of Management
Thesis Supervisor

Certified by:______________________

D. Eleanor Westney
Society of Sloan Fellows Professor of International Management
Thesis Supervisor

Accepted by:________

Birger Wernerfelt
Chairman, Committee for Graduate Students
Professor of Management Science

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Abstract

University-industry relationships are in a state of flux. They represent important strategic issues for universities, for industry, and for governments alike. This confluence of interests has led to experimentation in which universities and industry seek to work together, often with strong government support. And yet partnerships are not easy. Academics and industrialists live in two different worlds, and universities are not known for their organizational flexibility. Some universities appear to change flexibly, while others change more slowly and with difficulty.

The purpose of this dissertation is three-fold: to identify the nature of change taking place in university-industry relationships; to understand the underlying factors that influence that change; and to explore the underlying process of change. Three cases of MIT, Cambridge University, and Tokyo University are examined to compare their experiences in developing new types of university-industry relationships. I argue that internal and external organizational boundaries have influenced the evolution of the new types of relationships, and that the three universities have defined these boundaries differently.

MIT's regulated external boundaries permitted close but bounded relationships with industry, but, on the other hand, its one-way permeable internal boundaries enabled its administration to amplify and institutionalize initiatives. This is contrasted with Cambridge's fuzzy boundaries, which appeared to elicit deeper and more informal and personal relationships in specific local settings. Tokyo's apparently impermeable boundaries, in contrast, led both to formal arm's length relationships as well as to informal but closer and invisible relationships.

The emergence of these relationships has not been a mechanical and deterministic process. Individuals have played an active and important role through "storytelling" to persuade different players to participate in the new relationships. Individuals also developed individual sub-stories that explained the rationale for their own participation. I argue that there are three different types of compatibility between role-stories as told by the players: individual role compatibility, partnership compatibility and organizational compatibility. I then argue that it is these three types of compatibility that have determined the overall strengths of the new behavioral patterns, their ultimate sustainability over time and their replicability across space:

Thesis committee:

Lotte Bailyn (co-chair)
Title: T Wilson (Class of 1953) Professor of Management

D. Eleanor Westney (co-chair)
Title: Society of Sloan Fellows Professor of International Management

Michael Piore
Title: David W. Skinner Professor of Economics and Management

John E. Van Maanen
Title: Erwin H. Shell Professor of Organization Studies

To Q

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Acknowledgement

I never used to think much of acknowledgements in books. I thought that authors were hypocritical in giving credit to everyone, and they said little of importance. As I became more engaged in my dissertation writing, I began to realize how wrong I was. A dissertation is a social product entrusted to the hand of the author, but could not possibly be written by the author alone. Acknowledgement also contains the most significant information about the author whose identity is otherwise hidden.

I was also fearful about writing an acknowledgement because one has to thank people in a given sequence. The "order" would imply a ranking that does not exist in reality, whereas the truth is that everyone has contributed different things and it is impossible to attach an order to the level of thankfulness I feel for them. So, I decided to follow the social conventions: starting with my two committee chairs and two committee members etc- and in an alphabetical order by first name for each category.

Eleanor Westney rescued me from the confusion when I came to MIT. Having come from the practical world, I simply did not know to what theoretical groups I belonged. She has been rescuing me ever since, and indeed almost all of my theoretical constructs come from her quick insights in conversations that I learned to appreciate so much. It is almost comical to remember the early days when I did not "trust" Eleanor's insights. They came so quickly, so naturally, with such ease and with seemingly so little reflection that I simply could not believe that they could be significant. It was only when I discovered that I was reflecting on these quick comments of hers six months later that I began to realize the unique gift that she has in these insights.

Lotte Bailyn was the first person who understood what my thesis was really about. It was when she murmured "nice" with her characteristic reflective tone, that I realized that I was saying something that she understood and that I wanted to say more along that line. Her room was the most productive space I experienced. I would go in with few structured thoughts and some vague ideas about how to structure them – her patient listening skills enabled me to articulate the things in a way that I could not do on my own. She was one of my first real "audiences" who empowered me.

John Van Maanen taught me how to be honest. In the word of Michael Piore, another advisor, "It would be a waste if you don't get to know him while you are here"– and how right he was. He never asked too many questions – but what penetrating questions they were! While I was in the field and during his year out in sabbatical, I often had imaginary conversations with him: "what would John say" became the guiding principle for my data collection and interpretation of data. His influence went far beyond our face to face interactions and I owe him more than he knows.

Michael Piore is a legendary advisor who never seemed to read much of anything I wrote, but remembered exactly where I came from and where I wanted to go like magic. In a business school environment where profit making is the unquestioned goal of most studies, it was his values and concerns that kept me sane and honest in my endeavors in

which policy and public concerns were more important than private ones. He was always three steps ahead of me – and I often had a difficult time understanding him, literally. It took weeks for me to understand even the nature of his comments.

Four was probably the maximum advisable and practical number of advisors in a formal committee. Had that not been the case, I would have brought several other people into the team, each of whom contributed significantly in building the conceptual framework. Richard Lester was one of the few professors who had active research interests in the changing role of research universities. It was in the seminars organized in his center that key concepts of this dissertation were born. Wanda Orlikowski had little to do with me for my dissertation work, except that I shared her passion for thinking about agency which kept me going back to her for small conversations. Paul Carlile was another of the conceptual fathers who influenced my work, probably without himself knowing it. Fiona Murray and Susan Silbey appeared late in my dissertation life, but their support and inputs propelled me considerably in articulating my findings. Ed Roberts and Jim Utterback provided valuable insights into the role of science for industry and the history of MIT. John Carroll taught me the power of interpretation through my work with him as a research assistant for his research on high hazard industry.

I owe my most sincere thanks to all the people I met in the field. Many people from the three universities spent considerable time with me to help me make sense of their complex settings. For the sake of confidentiality, I am unable to list the names, but they know who they are! I only hope that I did justice to the time they gave me.

Fellow doctoral students provided the social and intellectual contexts for the birth of this dissertation. Indeed, their collective influence can easily match those of my advisors. We breathed ideas and lived on thoughts, where emotions and thoughts were intertwined.

Laura Black and I worked like twins – on theses that could not be more different and yet similar. We came to MIT mid-life, looking for change, wanting more from life and all. At the height of production, we talked to each other every couple of hours to keep going. When I submitted my draft, she caught up quickly, and when she got her defense date, I wanted mine. We are submitting our twin theses about a week apart.

Without Sarah Kaplan, I would have never stopped collecting data. She demanded with characteristic clarity that it was ridiculous that I was still collecting data. She also whipped my presentations into shape on many occasions. On rowing machines in the gym we routinely had the most diverse conversations ranging from our epistemological assumptions to our love lives; these conversations kept me sane and healthy through the dissertation years. I hope I can provide similar support when she goes through hers.

Jean Jacques and Henrik provided the European perspective on life – they always seemed well-balanced. Brad, Carsten, Deborah, JoAnn, Julie, Mike and Nils provided a powerful dissertation support group, with each of whom I feel I shared a substantive part of my writing. Carlos, Kate and Sean were not yet writing their dissertations, but they were the

"apricots" who matured with me and with whom I shared the particular brand of institutionalism. They were the key barometers for my work.

Sharon Cayley deserves special thanks. She had the most vivid understanding of the nightmares that we go through in finishing a dissertation, and calmed me down at the most critical and desperate moments.

There are other dear friends who provided support in different ways. Devesh and Sadhana who moved to Boston at the same time as me were unfailingly supportive throughout my student days. Their children, Maya and Kunal provided the needed distractions away from my thesis. Eriko, one of the oldest friends I have, happened to share one year of her life with me here in Cambridge, and how wonderful and reassuring it was to be living a couple of blocks away from her. Chikako's ability to engage provided the most productive input when I needed it the most. Tomoko and Naoshi helped me get adjusted to Cambridge. It was Atsuko who told me that one should remain passionate until the last minute –because it was passion that is the secret of good writing.

Keiko deserves to be a category of her own. She is somewhere between a little sister and a close friend, whose dissertation footsteps I carefully followed until she finished hers. Thereafter, she became an indispensable audience for my dissertation. In a number of phone conversations, she forced me to articulate the least formed of my ideas, what I wanted to do and why, and above all, listened attentively, always with enthusiasm.

My family has been very supportive of my work. Grandma gave me courage to take up studies in mid-life by saying that I still had another half of my life to look forward to! My parents, who had long learned never to be surprised, were also the best sympathizers when I told them the exaggerated accounts of how hard I was working. Noriko, my real sister and her family – Yutaka, Yumiko, Ryosuke, Hiroshi and Toshio - constantly reminded me that a dissertation was not all that life can offer.

I would also like to thank the financiers for this dissertation. The Matsushita Peace Foundation provided the financial assistance I needed to conduct the first year of the field work. The Industrial Performance Center provided a partial fellowship as I was writing the thesis. Lotte Bailyn provided the needed financial assistance in my final year through RA. Without these, I am sure I would not have been able to give my dissertation the concentrated effort that it required.

To Quentin, I owe my life as well as this dissertation. At the beginning of my doctoral studies, he was a professional colleague and a friend. In the course of this journey, he became an indispensable partner for life. He was excited when I came up with new ideas, and he was sympathetic when I got stuck. In his visits, he washed up, cooked and ironed, while always engaging in the intellectual substance of my thesis. Most importantly, he was one of the first to believe that I really could do it.

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Prologue

The origin of this dissertation was Jakarta in 1992. I was working as an economist for the World Bank reviewing public investments in higher education in Indonesia. Indonesia at the time was a successful case of economic development in the eyes of many development specialists, and there was a sense that the time was ripe for various institutions to be ready for the next round of development. Universities were one example of such institutions. There was a strong sense of need for better science and technology capacity, and yet, it was not clear what kind of capacity was appropriate nor how to build it. It was clear that Indonesia could not afford to develop and sustain expensive fundamental sciences, but it was equally clear that the capacity needed should not only focus on solving today's problems. Science and technology capacity had to be future looking.

The experience taught me three things. First, the issue of what kind of science and technology capacity to build, and how, was a universal one. In virtually all the countries I examined, either as a model or as a case for demonstrating what to avoid, there were debates about the role of the government in supporting universities, and the economic rationale for supporting them.

In 1995-7, as I traveled around OECD countries to visit universities on a global recruitment mission for the World Bank, I confirmed that most higher education systems were undergoing some kind of reforms. Similar debates were pushing reform measures in as diverse a group of countries as the UK and Japan, representing respectively the oldest university systems as well as the late developers, characterized by public and private universities. The romantic period when governments simply took for granted the need for universities and better research capacity had ended. The question now was what kind of capacity to build and how.

My second lesson was that, when dealing with policy and institutional issues, the only serious instrument of analysis was comparison against other systems that are by definition very different. While we resorted constantly to comparative analysis, it was not clear how to conduct serious and meaningful comparisons to inform decisions. There was also a curious lack of expertise about universities and higher education policies. Academia believes that there is little relevant expertise outside itself, a belief fuelled by its tradition of self-governance.

And yet, it seemed clear that most "insiders" were so embedded within their own systems, that they brought into their analysis certain romanticism, as well as their personal beliefs, that were often not helpful when dealing with different systems. Thus American professors often saw the American model as the only viable one, and were often incapable of understanding the assumptions on which their own systems were based. Japanese professors recognized the merit of the American university system, as did many others around the globe, and yet, they tended to pick on particular themes they saw as fit – without any systematic analysis.

As I consulted different "world experts" for their wisdom to help Indonesia, I came to realize that, as a lay outsider without even a doctorate to my name, I might actually be able to see more of the things that had become invisible to many of these professors. My audacious plan to undertake research on universities as an outsider emerged. In doing so, a comparative analysis of the world's most different and advanced systems made sense. Comparing the American model, along with two other diverse systems such as the UK and Japan became a reality.

The third lesson was that the role of universities in an economy was complicated by the very fact that universities have often defined themselves as non-economic institutions, in which economic interests are supposed to play the least important part. Particularly important was to understand that universities as organizations are built upon different sets of principles from those of business or government organizations. It seemed essential to understand the full implications of their organizational characteristics before meaningful policy and economic debate could be undertaken. The idea of focusing on those university activities which came closest to outside economic bodies arose out of such a concern. By examining university-industry relationships, I hoped to understand both the nature of universities as organizations and the nature of change taking place.

These are the perceptions that I came with to MIT in August 1997. Four and half years later, the following is what I found.

PART I: INTRODUCTION

Chapter 1:
The Problem

University-industry relationships are in a state of flux. These relationships are an important and current strategic and policy issue for universities, for industry, and for governments alike (OECD, 2000).

Universities are looking for new ways to remain relevant actors in the knowledge economy, which means that they need to secure funding sufficient to cope with the rising costs of research. Industrial firms are exploring ways of keeping abreast of technological progress in this highly uncertain, competitive and rapidly changing environment, and regard universities as important potential partners. Governments, concerned about national competitiveness, are looking for new models of innovation, and they are looking to universities to play major roles in a transition to a knowledge economy.

This confluence of interests has led to unique circumstances of experimentation for universities and industry to work together, and for governments to create supportive environments for such partnerships.

And yet, it is not an easy partnership, because academics and industrialists live in two different worlds. Academics are firmly embedded in the institutions of science, where autonomy of inquiry has been deemed critical for the production of scientific knowledge. Industrialists, on the other hand, are squarely embedded in the institutions of markets, with their interests in science driven by its applications. There is an invisible boundary that separates the two worlds. At the same time, governments are increasingly concerned to establish accountability to the public about the use of public funds and therefore would like to ensure a certain relevance and usefulness in their support of science. University-industry partnerships thus represent a process in which the issues of academic autonomy come head to head with the issues of accountability and relevance.

At first glance, universities do not seem to be organizations known for their flexibility. Scholars have observed that their decision making process could be described by the garbage-can model (Cohen *et al.*, 1972). On the other hand, universities are organizations that survived several centuries and therefore must exhibit some form of flexibility, perhaps through being loosely coupled systems (Glassman, 1973; Weick, 1976). Indeed, universities seem to cover a wide range in terms of their flexibility to change. Some universities appear to be flexible and to evolve types of university-industry relationships effortlessly. Others change somewhat more slowly, along with dramatic changes in overall organizational structures. The question is why some universities are more flexible than others. Are there differences in the kind of university-industry relationships they develop and sustain? What are the organizational underpinnings that are relevant in shaping these changes? How do these changes actually take place? Are organizational structures, such as those of governance, critical elements for introducing flexibility? What is the process of change?

The purpose of this dissertation is to examine and compare this state of flux: to identify the nature of institutional change taking place at the interface of academia and industry; to understand the underlying factors that influence that change, and to explore the processes through which new institutional patterns develop. In order to answer these questions, a historical comparative analysis was undertaken to review and contrast the experience of three universities: MIT, Cambridge University, and Tokyo University.

A few definitions will be helpful. By institutions, I refer to a set of rules, norms and practices, both formal and informal, that pattern human behavior. Institutions usually come as a nested set of related practices and routines that collectively have a certain logic. Institutions of science, for instance, comprise a set of practices and norms, such as scientific publications based on peer reviews and citations, that apply to scientific endeavors and so set the basis for scientific reputations and progress.

As new types of university-industry partnerships emerge, new rules, norms and patterned behaviors arise that had not previously existed. Some of these emergent behaviors will be local both in time and space. They will be ephemeral changes that will eventually disappear as projects or contracts end. Others will become institutions as they become more stable and widespread within the university or even outside. The process by which these patterned behaviors become more stable over time and widespread is referred to as institutionalization.

In the reminder of this chapter, I first describe the global contexts in terms of the rise of the knowledge economy, and demonstrate why university-industry relationships have come to have such prominence in the minds of policy makers, industrialists as well as university academics. Second, I describe what has been written about the phenomenon. Third, I argue that the unanswered question of how these relationships evolve is important and examine issues touched by the question. Fourth, I explain why the US, the UK and Japan on the one hand, and more specifically, MIT, Cambridge, and Tokyo on the other, represent particularly interesting cases for investigation in this regard. Finally, I summarize and describe the structure of the dissertation.

The rise of the knowledge economy

The twentieth century saw a sea change in the way the world views economic resources. Knowledge has come to be regarded as a strategic resource and a source of competitive advantage as distinct from capital, labor or natural resources (OECD, 1996, 2000; Stiglitz, 1999; World Bank, 1998). It is this global interest in the transition to a knowledge economy that places university-industry relationships in a special limelight. What is the nature of the interest?

Academia and industry had long been two independent spheres of knowledge creation. At the time of the industrial revolution, scientific developments contributed very little to industrial activities(Mathias, 1970; Pavitt *et al.*, 1977). It was only in the 19^{th} century that there were increasing instances of basic science supporting technological progress in industry, or technological progress in industry informing the course of scientific agendas

(Freeman, 1974; Pavitt *et al.*, 1977). By the early 20th century, industrial companies, most notably in the US were beginning to conduct their own scientific research in hope that they could systematically capture the benefits of science, particularly in the chemical and electrical industry (Etzkowitz *et al.*, 1998b).

The two World Wars constituted a major turning point in the relationships between the spheres of science and industrial applications, as policymakers as well as scientists learned about the practical value of scientific advances, particularly for military applications. In the US in particular, federal government maintained high levels of funding support for scientific research in universities. The time between discovery and commercialization gradually shortened, with increasing expectations on the part of industrialists to make systematic use of scientific results (Etzkowitz *et al.*, 1998b; Nelson, 1993). The perception grew that knowledge produced by science could lead to economic value and the notions that economies were increasingly dependent on knowledge began to be articulated as early as the 1970s (Bell, 1974), and to be popularized in the 1980s (Toffler, 1980).

The 1980s were a pivotal period during which the institutional framework for the university's ability to assert intellectual property rights was further refined (Katz *et al.*, 1990; Mowery *et al.*, 2001). On one hand, the Bayh-Dole Act in the US set the scene by allowing universities to apply for patents for inventions arising from federally funded research. There were other legal developments where, for instance, molecules became patentable, strengthening considerably intellectual property protection (Mowery *et al.*, 2001).

The 1980s was also the decade when the new models of regional economic development such as Route 128 and the Silicon Valley rose and fell. While the spin-off phenomena had been analyzed since the late 1960s (Cooper, 1971; Roberts, 1968; Roberts, 1991; Roberts *et al.*, 1968; Saxenian, 1994a, 1994b), it was the spin-offs' contribution to regional economies in the otherwise stagnant 1970s that captured the imagination (Dorfman, 1983). However, the region-wide economic downturn in the 1980s dampened the public mood for emulating the experience (Rosegrant *et al.*, 1992).

Another significant development in the 1980s was the first wave of interest among policy makers, in several advanced economies, in promoting university-industry relationships (OECD, 1984), but for different reasons in the different economies. For the US, the 1980s was a period of crisis about national competitiveness, when competition from Japanese manufacturers was seen to be eroding American supremacy. Indeed Japanese industrial successes became the wonder of the world, with other OECD countries speculating whether the strong-handed industrial policy in Japan could be a model for others to emulate (Johnson, 1982). In the US, a series of legal and regulatory changes were introduced to enhance national competitiveness, including the Bayh-Dole Act of 1981 and the relaxation of anti-trust provisions to permit research collaboration (Mowery, 1998; Mowery *et al.*, 1999).

In the UK, it was a decade of wrenching economic reforms under Margaret Thatcher. The lessons from the international experience, particularly from Japan, were examined (Irvine *et al.*, 1984), leading to later policies and mechanisms to develop priority science and technology fields. For Japan, on the other hand, the issue was how to develop its own scientific base to enable its successful manufacturers to move from being imitators to innovators.

In the 1990s, a new kind of political support developed for investing in knowledge, prompted by the rapid globalization (Economist, 1997; OECD, 2000) and by a decade of prosperity in the US. The success stories of Silicon Valley and Boston's high tech cluster were re-told as new industries such as IT and biotechnology blossomed in these regions (BankBoston, 1997; Roberts, 1991; Rosegrant *et al.*, 1992; Saxenian, 1994a, 1994b). America's success was even more impressive against the backdrop of Japan's lost decade and the market crash of East Asia in 1997 that discredited other models of economic development and performance.

More recent analyses also portrayed Japan's industrial policy in a less favorable light (Odagiri *et al.*, 1993, 1996). While the full analysis of the reasons for the US success must await the next generation of research, policy makers, who have to act today, cannot help looking for institutions that may have supported such a spectacular spurt of innovation. American research universities became the main target of emulation, helped by their already global reputation in scientific performance, and with an added interest arising from their impact on their regional economies. The new goal was to create or become an MIT or a Stanford, in the global mood the Economist named "an outbreak of MIT envy" (Economist, 1997).

Today, many OECD countries are scrambling to establish their strategies for the transition into a knowledge economy (OECD, 1996), and developing countries are actively examining the implications for their future (World Bank, 1998). Developing better university-industry relationships appears to have become a standard prescription within such a framework (OECD, 1996, 2000). In some countries, this is being undertaken at a time of relatively robust economic growth, as in the UK. In other countries, most notably Japan, building a strong knowledge economy is seen as a way out of economic stagnation and critical for national survival.

University-industry relationships

What do we know about university-industry relationships? It is clear that university-industry relationships have been changing dramatically in the past two decades. There is a diverse group of authors who documented the increasing incidence of university-industry relationships, particularly in the US. There has clearly been a steady increase in the level and proportion of industry support for academic research, particularly in the 1980s. (Cohen *et al.*, ; National Science Board, 2000). There have been increases in the number of university-industry R&D centers in (Cohen *et al.*, 1994a), university patenting and licensing following the Bayh-Dole Act (Henderson *et al.*, 1995; National Science Board, 2000), large relationships with industry such as strategic alliances or multiple company consortia for pre-competitive research (Etzkowitz *et al.*, 1998a). Comparative studies also highlight the increasing importance of university-industry relationships in other economies such as the UK and Japan (Branscomb *et al.*, 1999; Rahm *et al.*, 2000).

There is a strand of literature, principally by economists, that focuses on the effect of science on industry. The verdict today is not only that academic science contributes to industry, (Blumental *et al.*, 1986; Klevorick *et al.*, 1994; Mansfield, 1991, 1992), but also that the level of contribution may have intensified over time (Cohen *et al.*, 1998a; Cohen *et al.*, 1998b).

The prominence of university-industry relationships has also raised new types of concern about their effect on the integrity of academic science. For instance, some have demonstrated that industry supported research is more likely to be focused on shorter-term research with less emphasis on basic science (Blumental *et al.*, 1996; Cohen *et al.*, 1994b; Cohen *et al.*, 1998b) There is also increasing evidence that secrecy and confidentiality provisions appear to be creeping into academic research (Blumental *et al.*, 1997; Cohen *et al.*, 1994b; Cohen *et al.*, 1998b), where there may be increasing conflicts of interest and commitment (Etzkowitz, 1996). Clearly, norms in academic science are changing (Etzkowitz, 1998) with increasing influence of markets on campus (Slaughter *et al.*, 1998).

There is an emerging literature that looks at how academic science influences industry. The traditional understanding of science-industry relationship had been based on a simple linear model, where academic science was supposed to lead to a wide dissemination and ultimately commercial use. In contrast, the emerging literature emphasizes the interactive nature of the two spheres, academic science on the one hand, and industrial technology on the other (Nelson, 1995; Rosenberg, 1982). Absorptive capacity and a certain "connectedness" to science on the part of a firm have been demonstrated as critical for its ability to utilize scientific discoveries effectively (Cockburn *et al.*, 1998; Cohen *et al.*, 1990; Lim, 2000). It has also been argued that licensing represents only a very small and possibly even an insignificant channel of such connections, with consulting and other direct interaction opportunities increasingly given weight (Agrawal *et al.*, 2002). There is also an increasing interest to document and understand how science and technology might co-evolve (Garud *et al.*, 1994; Murray, 2002).

Unanswered questions: how do university-industry relationships evolve?

There is far less written on the question of how university-industry relationships evolve. This is an interesting neglect, particularly given the current environment where practitioners are moving full speed to foster university-industry relationships and are living through the "how" question. I propose this question can be further unpacked into three specific questions. First, what is the nature of change in university-industry relationships, and more specifically what differences exist in the kinds of relationships developed by different universities? The second question has to do with the factors that might influence the change: is it the external environment that shapes university-industry relationship, or is it a university specific capacity that shapes them? Finally, what do we understand about the process of change?

What is the nature of change? The issue of whether and the extent to which different universities develop different interaction patterns has not received much scrutiny in the past. It is as though all universities are assumed to have equal capacity in developing similar relationships. And yet, clearly, the intuition is that in Silicon Valley or Route 128, some universities played critical roles that are difficult for other universities to imitate (Roberts, 1991; Saxenian, 1994b). The irony is that government after government is establishing its knowledge economy strategies where university-industry relationships serve as a cornerstone, without a firm understanding of the desired nature of change in university-industry relationships and the process. The question is whether universities are equally capable of developing similar types of relationships with industry. Are all partnerships with single companies or pre-competitive multiple company relationships similar, and if not, what are the dimensions of difference? Are they similar in size, depth, or prevalence?

What are the factors that influence change? There are three commonly cited factors that influence the evolution of university-industry relationships: changes in government funding, (Cohen *et al.*, 1998a; Rosenzweig, 2001); government policies and regulatory changes such as the introduction of the Bayh-Dole Act (Mowery *et al.*, 1999), and industrial interest for collaboration with universities. There are several underlying arguments reflected in these factors. One would be an argument that the phenomenon is about changing resource dependency relationships: when universities' most important resource dependency relationships with governments change, universities are forced to respond (Pfeffer *et al.*, 1978). Another is an institutional argument that government regulations and changing legitimacy in the society affect university choices (DiMaggio *et al.*, 1983; Meyer *et al.*, 1977). There is a fourth factor that has to do with founding values of universities. This is an argument that organizations adapt little, where the founding characteristics provide the main explanation for different behaviors, functioning as organizational "imprinting" with a lasting influence (Stinchcombe, 1968). It would be important to examine if and how these factors influence university responses in developing their relationships with industry.

One alternative explanation has to do with internal factors within universities. Clark, having studied university organization for three decades concluded in his study of entrepreneurial universities that the role of the "center" is one key ingredient for university capacity to be entrepreneurial in an changing environment (Clark, 1998). The governance and administrative structures are clearly one obvious factor that differentiates universities.

Another source of variation in university organization may arise along national lines. Organizational histories of universities show that important differences in the way universities are organized across nations, particularly with respect to how education and research activities are linked together (Ben-David, 1977, 1984), have large implications on the way they engage in scientific production. What is more, though universities are rarely "selected out" in the sense of disappearing altogether, there is certainly rise and fall of centers of excellence in an international sense. German universities were clearly the model in the 19th century, taken over by the American research university model in the 20th century. The implication is that universities in a given country may have certain similarities in terms of how they are organized, while across national borders there may be important organizational differences. Examining universities from different countries may provide an important insight in this respect.

What is the process of change? In order to understand what factors matter, it is critically important to examine the process of change. Here, the key process to be examined is the emergence of institutional patterns, or an early stage of institutionalization for new types of university-industry relationships. More specifically, there are three distinct levels of institutionalization. The first has to do with how a new type of relationship might be developed in a given locale within a university and get sustained. The second has to do with how such an initiative grows over time to have stronger and larger spheres of influence in a give locale. The third is how such a new relationship might become an organizational template for future initiatives.

The US, the UK, and Japan: MIT, Cambridge, and Tokyo

There have been two types of "emulation" going on among nations. One centers on economic systems motivated by economic performance. The US had a clear lead as an industrial economy in the 50s and 60s, briefly threatened by the rise of the Japanese model in the 70s and 80s, and again rising as a model for a knowledge economy in the 1990s. The other centers on scientific systems motivated by the effectiveness of scientific production. American research universities have long been a model in this respect. Interestingly, the past two decades have seen the merging of the two types of emulation, as motivation behind scientific production became increasingly economic, where the US represents the model, the UK a partial emulator, and Japan a late emulator.

MIT, Cambridge and Tokyo are the leaders in each national context, and are therefore obvious candidates for organizational level comparison. If their leadership in the field of engineering is reasonably clear, their centrality in shaping the national agenda is unambiguous. There are several contrasting characteristics that make the comparison even more interesting. For one thing, they represent very different governance structures: MIT is centralized; Cambridge is decentralized, and Tokyo is supra-centralized at the ministerial level (that is, Tokyo is a national university and legally an integral part of the Ministry of Education and Science). This is particularly important, as the comparison among the three may provide unique insights into the role of governance in university-industry relationships.

They also come with important historical legacies, particularly during and after WWII, which had a pivotal influence in establishing the role of science in their respective societies. MIT's Radiation Laboratory was a symbol of military success, and its experience helped shape the post WWII national science policy to its advantage. The Radiation Laboratory also served as an important organizational template for interdisciplinary activities within MIT. Tokyo's aeronautical laboratories, along with other war related research groups, on the other hand, were disbanded as a punishment for their contribution during the war. For Cambridge, the effect was less direct and perhaps as a result less dramatic. Individual scientists at Cambridge were drawn into national projects located away from the university. There is an important question about the effect of such historical legacies.

The three universities also provide interesting contrasts in their apparent level of flexibility. MIT is a symbol of such flexibility. Over the past 20 years, it has increased its support base from industry, experimented with several new modes of working with industry - such as consortia, strategic alliances and educational partnerships, and seems to be succeeding. Cambridge is quickly catching up with MIT in the level of industrial support it receives from industry; it is transforming itself from an esteemed ivory tower into a hub of scientific activities, with the concentration of industrial research centers increasing over the last three decades (Marsh, 2001). These changes, however, have taken place along with considerable reforms in the administrative infrastructure, not only in units directly relevant to relationships with industry but also in its governance structures where it began to shed traditions of decentralized structures and to introduce a greater level of managerialism. In Tokyo, there have been less dramatic changes in the overall level of industrial support, which has remained largely static in the past 5 years. However, dramatic changes are now taking place, particularly in the organizational infrastructure to support university-industry initiatives. Parallel with such changes, Tokyo also expects to undergo a thorough governance reform, as it will be legally separated from the Ministry of Education and Science (MOES) in 2004.

One caveat is that the three universities are not necessarily representative of the three national systems, particularly with respect to the governance structures. Both MIT and Cambridge are more extreme than the norm in their centralization and decentralization respectively. Tokyo University shares the same supra-centralized structure with all the other national universities, but differs from the others in its proximity to the Ministry, given both its status and location. While the three universities do exhibit many national characteristics, it would be dangerous to see the comparison as among the three national systems.

Thesis structure

My findings are presented in four parts. In **Part I**, the introduction includes this chapter and Chapter 2, which introduces the problem and explains my analytical approaches as well as my theoretical lens. The subsequent three parts are organized in such a way that each of them addresses one of my three research questions: (a) what is the nature of change in university-industry relationships in the three systems; (b) what factors may have influenced these changes; and (c) what are the processes of change?

In **Part II**, I clarify the nature of change and examine several alternative explanations, in terms of the national contexts in Chapter 3, and the organizational contexts of the three universities, MIT, Cambridge, and Tokyo in Chapter 4. Chapter 3 contrasts the historical national contexts to examine the two macro-level explanations: the changing role of the government as a funding source and a regulator; and the changing interests on the part of industry. I conclude that all of these factors are important, but that they do not exert their influence simply or evenly. For instance, general government funding for universities powerfully influences university responses to seeking industrial funding; however, university responses depend as much on their perceptions and expectations of government funding, as they do on its actual level.

In Chapter 4, the historical organizational contexts of the three universities are reviewed both in order to clarify and contrast the nature of changes in university-industry relationships in the three settings, but also to examine the alternative explanation that the differences arise largely as a result of organizational culture as defined at the time of foundation. Here again, I find that while there are clear differences in values and norms among the three organizations, they did not have permanent and stable cultures over time. Rather, it is clear that historical events, such as organizational foundation, World War II and student unrest, have powerfully influenced the organizational ethos around university-industry relationships.

Part III focuses on the question of the factors that have influenced the changes; this is done by means of the three case chapters on individual universities, and a summary chapter that compares across the three cases and across all initiatives.

In Chapter 5, the experience of MIT in working with industry through consortia, educational partnerships and strategic alliances is presented. While the initiatives at MIT are increasingly larger in monetary scale, they remain relatively constant in the depth of interactions, where academics and industrialists are close but have bounded relationships. I argue that these changes have been shaped by the regulated nature and certain permeability of MIT's external and internal boundaries. Particularly characteristic are the administrators who have played a critical role in managing these boundaries, especially in facilitating inter-departmental activities, which are crucial for large-scale activities.

One observation is the importance of dialectics in the evolution of these initiatives: MIT cases provide often colorful images of academics and industrialists debating – at different locations. Moreover, these debates appear to be critical in sustaining and replicating the initiatives. Individuals make sense of the initiatives in light of their experiences – the initiatives become personal. Academics and industrialists develop their respective roles that are compatible with each other, and organizational players develop supportive roles to accommodate the initiatives.

In chapter 6, Cambridge's experience is presented, namely the evolution of embedded laboratories and other variations in working with single company partners, in which deep, informal relationships have appeared to form, with information flowing back and forth more liberally. In contrast to MIT, there have not been as many inter-departmental initiatives or large-scale ventures. I argue that the fuzzy external boundaries and the relatively impermeable and partially fuzzy internal boundaries have been responsible for such characteristics. Cambridge also provides images of sustained dialectics, particularly between academics and industrialists, that lead to robust and deep relationships.

Chapter 7 describes Tokyo's struggle with single company relationships, and the emergence of multiple company relationships that are often anchored outside the university. I argue that Tokyo's relatively impermeable organizational boundaries have prevented the development of visible relationships based on deep interactions, but that individual academics have formed informal and deeper relationships in less visible ways. It is as though Tokyo has two types of organizational boundaries: formal and informal. Interestingly, some of the informal initiatives have won more visibility or formality over time, gaining greater permanence than the others. What characterizes these breakthrough cases appears to be the roles of individual academics who were personally committed to the success of the initiatives.

Chapter 8 provides a summary of the comparisons at three levels: (a) at the university level, where the three cases are contrasted in terms of the nature of changes and the dynamics of institutionalization; (b) at the level of institutionalized practices, where the degree of institutionalization is reviewed; and (c) at the level of initiatives to highlight the differences in the patterns of their longevity and replicability.

In Part IV, conclusions about how new institutional patterns emerge are laid out in two chapters.

Chapter 9 focuses on the structure that influences university-industry partnerships and further clarifies the nature of two types of organizational boundaries, external and internal. External boundaries are those that separate the worlds of academics and industrialists, although they can be defined and enacted differently, in terms of people, knowledge, or physical space.

Internal boundaries are what separate the disciplines as represented by departments within a single university. I argue that the manner in which these boundaries are defined and enacted depends on the role of the administration - which can provide various mechanisms for boundary crossing. I argue further that the administration can itself form a separate community within a university, and the nature of academic-administrator boundaries over time define the ethos and capacity of the administration.

Chapter 10 introduces storytelling as a metaphor for describing the role of individuals in the the emergence of institutional patterns. I propose that institutional change may be initiated by individuals whose primary function is to develop "powerful stories" about why and how they, the collective, should change. Individuals progressively engage other people in their ideas and plans, using these stories as tools for persuasion. Participants in turn develop their own individual role sub-stories that explain the reason for their participation. I argue that the nested nature of these stories, as well as three types of compatibility between sub-stories, help one understand the strength of emerging institutions.

In Chapter 11, I present a combined framework of structuration, bringing together structure as represented by organizational boundaries, and agency as depicted by story telling. I argue that dialectics are particularly important at the boundaries, because that is where stories are harder to understand because they can have different meanings to different parties. Stories are important as a communicative device at the boundary, and for creating new meanings and persuading people of newly created values and meanings. Stories also have the function of institutionalizing behavior, by providing a stable reason for coordinated behaviors. Tales of MIT, Cambridge, and Tokyo are re-told through this new lens. I end the discussion by summarizing my contributions and the scope for future research on the one hand, and, on the other, by drawing out the implications of my findings, including those for practitioners.

Chapter 2: An analytical approach: Methods and a theoretical lens

The central research theme is the emergence of new institutional patterns during the earliest part of the institutional change. The phenomenon to be examined is the evolving industry-university relationship in the context of the global knowledge economy. More specifically, my dissertation addresses three questions: (a) what are the new patterns of industry-university relationships that have evolved or are evolving in different settings? (b) what organizational factors could explain such patterns? (c) what are the processes through which such changes become or do not become institutionalized?

This chapter first explains the principal methodological stance of my research: qualitative, interpretive and based on grounded-theory. It then describes the specifics of my analytical approach: the comparative framework, the level of analysis and the selection of cases. Third, it explains what data I collected and how, including the issues of validity, reliability, validation processes, possible biases, and limitations. Fourth, the literatures that inform the underlying processes are summarized, to clarify both the context for and the nature of my own contribution. Finally, it introduces the theoretical lens that emerged from the analysis, which will be elaborated further in Chapters 9 and 10, following the presentation of three cases in Chapters 5 to 7.

Methodological approach: qualitative and interpretive, and grounded theory

The phenomenon to be investigated is institutional change. Institutions are the patterns of human behavior and include norms, rules, and practices, either formal or informal. When institutions are changing, it therefore means that the norms of operation and the rules of the game are changing over time and can vary across space. This is exactly where an analogy with inanimate objects breaks down. Bouncing ping-pong balls represent a Phenomenon that can be replicated over time and across space with reasonable accuracy and regularity. Human behavior can be subject to changing perceptions and reasoning. White powder can cause a very different reaction today compared with last year, and that may also change over time as we forget the anthrax incident. In other words, institutional change is an intricate process of human action, where observed behavioral change is not a mechanical response to an external stimulus, but human response that can arise from changed reasoning or habit, purposeful or otherwise. This means that the analysis must deal frontally with evolving and multiple causal linkages; it cannot assume that causal linkages are constant across time or space. It is essential that the researcher is placed close enough to the phenomenon to examine the nature of change. As such, arm's length observation without interaction, seemed to be as inadequate as a survey method. Interaction through interviewing seemed optimal – with some supplementary observations.

The other critical characteristic of institutional change is that it unfolds over a long period of time. It therefore required tracing cases over the last 20 years and sometimes more. It was necessary to couple interviews and observations with archival data to complement or correct the realities as retained by human memory. The choice of qualitative approach, based principally on interviews, aided by observation and archival data was also appropriate given that one principal objective of the research was theory generation about the mechanisms of institutional change. (Miles and Huberman 1994).

The analysis also takes an interpretive approach, in which my primary role as a researcher has been to understand events in the light of local meanings and to explain their occurrence in a language of the audience. The main reason for this interpretive approach is that, for social phenomena, what the sociologists call social construction, or creation of shared meanings, is fundamental (Berger and Luckman 1966). People choose their courses of action according to their own interpretations of circumstances – rather than basing them on some 'neutral' facts. People can see totally different meanings and have totally different interpretations of the same circumstances, and may end up acting differently due to their different perceptions. And yet, if new institutional patterns are to emerge, where people assume new roles with respect to each other, they must come to share some basic assumptions about their roles. My role as a researcher has been to understand the meanings they saw, how they interpreted the events around them and then how they translated those into their actions. My role was also to translate all this into a language that is more universally shared by the research community. The idea was to deal directly with people's "perceptions, assumptions and pre-judgments, presuppositions" (Van Maanen 1977).

There is an emerging debate about the importance of the role of narratives in human science. At a minimum, process tracing procedures and narrative accounts, where the sequence of events within individual cases is traced, are considered uniquely important for furthering the causal understanding of phenomena (George and McKeown 1985; Mahoney 1999). Indeed this is arguably the main contribution that qualitative research can make: clarification of the temporal sequence to verify the direction and the "how" of causality. Cognitive psychologist Jerome Bruner goes further and argues that narrative understanding is one of two basic cognitive functions, the other being paradigmatic or logico-scientific (Bruner 1986). Similar sentiments have led other scholars to re-examine more rigorously the interpretative approaches around narratives (Polkinghorne 1988). The proposition here is that narratives somehow capture the ways in which humans make sense of their worlds. While quantitative analyses can provide information about average causal relations and the general directions of change, case studies help to explore the dynamics of change. I used narratives and interpretive approaches based on individual accounts to examine these dynamics.

During institutional change, organizations and/or people rarely act independently. Instead, they are intensely reflective and cognizant of each others' interpretations and actions, and habitually factor those into determining their own actions. I regard such interdependence as central to the phenomenon of institutional change: I certainly could not select a method where data points are assumed to be independent from each other, as in some quantitative methods. Interdependence needed to be explicitly observed and analyzed, for which qualitative and interpretive approaches are well suited.

Finally, I opted to take the grounded-theory approach, which is an inductive approach that emphasizes the emergence of categories and properties from the ground up (Glaser and Strauss 1967). It is suitable for theory generation, particularly if the causal mechanisms are likely to depend on local meanings and perceptions. It emphasizes "theoretical sampling" which can be revised as theories are formed in the field – in contrast to a deductive approach and ex-ante sampling. As many case study researchers propose, the meaning of a case is revised as the researcher's understanding deepens (Ragin & Becker, 1992), and as the necessary data for analysis evolve during the work itself. As argued by Bailyn, research is a cognitive process, where a continuous interplay between the empirical and conceptual planes can enrich the result (Bailyn 1977). Indeed, I tried to adhere to this principle even through the final round of writing.

Comparative framework

Level of analysis: Institutional change is about emergence of new rules, norms, and practices, both formal and informal. As such it requires one to look both at how specific changes are introduced in a given locale, and how these changes are sustained over time and institutionalized. For this purpose, I examined emergence of institutional patterns at three levels of analysis:

(a) groups as represented by 10-15 university-industry relationship sub-cases in each of the three universities or a total of 40 sub-cases. The unit of data collection is sometimes individuals as members of the groups; or sometimes groups, as archival records on the groups were examined;

(b) new institutional patterns that get sustained over time beyond specific individuals and replicated into new locales, as represented by 1-2 sub cases of new practices that were "institutionalized" in each of the three organizations, such as "strategic alliances" and "consortia" in MIT, and embedded laboratories in Cambridge or "endowed chairs" and joint research in Tokyo. The unit of data collection is sometimes individuals, sometimes groups; and

(c) organization as represented by three university cases, where the unit of data collection is sometimes individuals; sometimes groups; and sometimes organizations, as in organizational statements in the archival records; or as in individuals consciously representing organizational plans and actions.

Types of comparison. At all levels, three distinct comparative strategies were adopted: process tracing, structured comparison, and contrasting. The first strategy was to examine the historical evolution and sequence of events, or process tracing and to examine a case as a historical narrative where the main axis of comparison is over time (George and McKeown 1985; Mahoney 1999). For group level sub-cases and institutional pattern cases, the density of available data varied from a single interview with some archival data to 10 interviews with observations as well as archival analysis. This variation in the density of data was the key shortcoming of the research and will be discussed later. However, it is unlikely to have brought a systematic bias into the findings, given the random manner in which the data density varied. The organizational level case write-ups are presented in chapters 4-6 and are more "balanced" in the density of inputs.

Second, two types of comparative approaches were used as a tool for analysis: structured comparison and contrasting. The standard structured comparison is a method that compares two or more cases along the same set of variables using Mill's methods of agreement or difference (Skocpol and Somers 1980; George and McKeown 1985). The selection of the three organizational cases in each setting was based on their position as leading universities in each national context. For the selection of sub-cases, I take a variant approach proposed by Locke and Thelen, the so called "apples and oranges" comparison, where the responses of different institutional systems are treated as different phenomena, and are examined through salient changes (Locke and Thelen 1995). Sub-cases of emerging university-industry relationships were selected explicitly according to this criterion of salience in each organizational context. Comparison across sub-cases was used to highlight the mechanism of institutional change. These sub-cases were taken together for each university to obtain an aggregate picture of the patterns of change, and were in turn compared across universities to highlight the organizational/contextual factors that gave rise to such patterns.

Contrasting was used as a tool for understanding the characteristics of each university case (Skocpol and Somers 1980). For instance, comparison with MIT and Cambridge was used as a dialectic device to highlight the essential features of Tokyo University. This was particularly helpful in developing descriptive materials, as well as in covering tacit and basic assumptions in each of the three universities. Based on the approach of grounded-theory research, before I went to the field, I had merely selected three national contexts on the basis that these were known cases where there had been and/or were on-going changes in university-industry relationships. The selection of organizational cases emerged after the first round of field work and the sub-cases emerged as I developed categories and theories through the rest of field work. It is because of contrasting that I came to observe the absence of certain phenomena, such as multiple company partnerships in Cambridge or single company partnerships in Tokyo.

Selecting countries. There are today global expectations about the new role of research universities in the knowledge economy, where they are to play a key role in knowledge creation and dissemination and be the engine of growth (OECD, 2000). The US was the earliest to set foot on this path. The successes of Route 128 and Silicon Valley led to wider endorsement of the US model and the central role of universities in such regional successes (Roberts, 1991; Saxenian, 1994). In the 1980s, such local successes were overshadowed by the overall sense of economic malaise that dictated the American economic debate. In the 1990s, the decade-long economic success of the US began to be specifically associated with the underlying innovation systems, in which universities played an important role. Just as the image of Japanese successes was destroyed by its decade-long recession in the 1990s, the US model became a model of innovation for the world to emulate.

The three selected nations, the US, the UK and Japan were chosen for their differing positions in the global change in the role of research universities. The US was selected as the original model, where the institutional model was established. The UK was a close follower, but one in which the institutional changes made were not necessarily based on a sense of "emulation", partly because they were so close a follower. Japan in the 1990s is a more direct case of emulation. Just as the US examined and adopted various Japanese systems and practices at the height of Japanese success in the 1980s, the Japanese began to examine and adopt the American practices as they struggled with deepening economic recession in the late 1990s. By looking at such cases, especially the Japanese one as it is very much an on-going process, I hoped to examine more explicitly both the nature of institutional inertia as well as how different perceptions and local meanings feed into the process of change.

Selecting university cases. This dissertation comprises three organizational case studies, namely of MIT, Cambridge University, and Tokyo University. The three universities were selected after preliminary field work, as the institutional leaders that have extraordinarily strong influence on the other universities in the three national contexts. Each of them represents the national best in science and engineering capabilities, with elite standing and clear reputation. They are institutions from which policy advice is sought, as their faculty members habitually sit in government committees, and advisory boards. They are the pace-setters in legitimating new activities, and are the ones that establish new types of relationships with industry.

For example, MIT was the first in the US (and possibly in the world) to establish an Industrial Liaison Program, a corporate program where member companies are given special help in linking to faculty members of relevant research experience, which has been emulated around the globe today. MIT was also one of the first to experience the observable spin-off phenomena through the celebrated Route 128 phenomenon. MIT is home to many other institutional models of working with industry that have been emulated by the other universities, ranging from the Media Lab to an educational innovation such as the Leaders for Manufacturing Program. MIT stands tall above all the other universities in the number and size of strategic alliances established with individual companies.

Similarly, Cambridge was the first university in the UK to create a science park to foster linkages with industry. Their role in start-ups was featured as early as 1985 in a well-known report called "the Cambridge Phenomenon." Cambridge forged close and early ties with key industrial players such as Rolls Royce and British Aerospace. They are a clear leader in establishing their own version of strategic alliances, called embedded laboratories, where large corporations are invited to establish their research units in Cambridge to ensure sustained research collaborations.

Tokyo University was the first university to be established in Japan, and was founded with an explicit mandate to catch up with the West. Ever since, it has been a leader in the Japanese national system, as indicated by its top rank in all measures of activities that involve industries, be they joint or contracted research, or industrial donations. It has also demonstrated leadership in establishing new mechanisms such as "endowed laboratories" to bring in more industrial resources into the university, the Center for Collaborative and International Research, and the Technology Licensing Office.

The three cases introduce an important variation in one critical organizational parameter, namely, governance. Governance is critically important in institutional change, because it provides the mechanisms through which formal rules can be instituted or changed. The configuration and the role of the central administration are likely to be key determinants of how the university perceives the changing external settings. MIT provides a centralized example, and indeed is more centralized than its American peers, with a single faculty structure that bring together all academics from five schools and active central administration that has extensive resource allocation roles. Cambridge is perhaps the most decentralized example even within the UK, where universities have the tradition of less active governing councils than in the US, though there have been significant changes in the 1980s and 1990s. Tokyo University is a national university and legally an integral part of the central ministry, making it an example of supra-centralized governance structures.

Finally, the three universities have specific ties to each other and are cognizant of many aspects of each other's organization. Cambridge and MIT announced a flagship partnership in 1999 with large funding commitments from the UK government, with specific activities just beginning to take place in 2001. Since the bulk of data collection took place before the relationships formed on the ground, the images captured by this research are ones that belong to "before" the partnership, and therefore can provide an interesting basis for future comparison. Tokyo University has a more diffuse relationship with MIT through multiple ties. Since 1997, Tokyo University and MIT have worked together in a tri-partite partnership along with a Swiss university on global environmental issues. The president of Tokyo University brought a team of 20 men and women to MIT in January 2000, in an unusual one day workshop introducing their research agenda as the first step in putting themselves on a global map. The Dean of Engineering in MIT was the only foreigner to serve on the first external evaluation of the faculty of engineering in Tokyo University in 1999. Cambridge was the first foreign university with which one Tokyo University center developed a joint research project in the early 1990s, though there are many informal ties at the level of individuals. The Cambridge-Tokyo link is less developed than the links each has with MIT.

Selecting sub-cases. About twenty sub-cases in each university, or a total of 57 sub-cases were selected through the field work both to establish the nature of change in each setting, and to theorize about a generic mechanism for institutional change that is robust across the three cases. About ten sub-cases in each university, or a total of 32 sub-cases, were examined in greater detail with more than 3 interviews. As argued previously, there is no reason why specific causal links will operate across all settings, and so, theorizing across the settings was expected to take place at a higher level of abstraction, leading to process theories rather than specific causal theories. I selected these sub-cases on the basis of salience as reported by key informants in each setting in accordance with the apples and oranges approach proposed by Locke and Thelen (Locke and Thelen 1995). They argue that salient cases reflect the way in which local institutions interact. While the overall selection criterion of salience was applied to all three settings, different procedures had to be used in their identification because of different availability of information and time periods of change. For instance, the time period used to identify such sub-cases was longer for MIT, covering 1970s through 1990s, while for Cambridge the coverage was focused on the 1980s through the 1990s, and Tokyo the late 1980s to the 1990s. The selection of the sub-cases was very much an emergent and iterative process throughout the field work.

In MIT, key informants included all central academic administrators related to engineering [1] and senior administrators with supportive functions to working with industry,[2] were used to identify two types of new industry-university relationships in the last 20 years: strategic alliances and different types of consortia. All 9 cases of strategic alliances were examined, with three cases covered in more depth. Seven specific sub-cases of consortia were selected based on the Delphi method of soliciting 8 key informants for their views. These were two historical precedents, (the Polymer Processing Program in the 1970s and the Material Processing Center Collegium in the early 1980s), and five more recent initiatives, the Media Lab, the Leadership for Manufacturing, 42 Volts, Oxygen, Microphotonics Center. Access either in terms of interviews or archival data was variable across cases and eventually I ended up with 90% of the total potential interviewees approached. Other milestone events include developments in the administrative infrastructures such as the reform of the Industrial Liaison Office in the 1970s, the reformulation of the Technology Licensing Office in the 1980s and modifications of the Corporate Relations and Intellectual Property Councils in the 1990s.

In Cambridge, key informant interviews and web search led to the category of partnerships called “embedded laboratories, ” and a Cambridge University Brochure that describes industry-university relationships. From these sources, all examples of embedded laboratories in non-medical science, and multiple-company consortia were approached. Though the definition of embedded labs was more variable than the strategic partnerships of MIT, 10 non-medical cases were examined. Five examples of laboratories or centers with strong linkages with industry were examined. Since there were no cases of consortia type arrangements where there were multiple companies working together, examples of these were actively sought through key informants, with two identified as a result. In terms of the administrative changes, the change in the governance, particularly the role of the Vice Chancellor, as well as the on-going reform of the Research Services were examined.

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[1] president, former president, dean of engineering, provost, former dean, chancellor and VP for research
[2] Corporate Relations, Industrial Liaison Program, Office of Sponsored Research, Technology Licensing Office and Intellectual Property Counsellor

For Tokyo, the identification of emergent relationships was difficult. The lack of ready information appeared in fact structural, with each of the four potential sources of information severely constrained in their ability to obtain and process internal information: central academic administrators of the university; central administrative officers; faculty/institute level academic leaders; and faculty-level administrative officers. Although key individuals in each of these categories related to engineering were approached, none of them came up with either a list of exemplary industry-university relationships, or categories of relationships.

The central academic administrators are not knowledgeable about the specifics of relationships since most of the decisions are made at the decentralized faculty/institute level, and there is no ready flow of information upwards. Central administrative officers collect data and statistics about numbers and categories of the contractual forms, but appear to have little sense about what these projects look like. Administrators at the individual faculty level deal with administrative requests coming from faculty members, but their work has little to do with the substance of the projects. They therefore tend to list names of professors that they have dealt with multiple times, rather than for those with special collaborations known for their uniqueness or success. Deans and directors do not have a strong grasp of activities because their tenure in office is too short at 1-2 years. There is also a general lack of shared information on campus, such as campus newsletters or magazines that report on new innovation activities. It is not uncommon for Tokyo professor to find out about each others' work from national newspapers.

It was therefore necessary for me to undertake substantive work to come up with my own list of sub-cases. The main approach was to start with a diverse source of contacts and follow their advice for further contacts until a group of sub-cases were identified. I started with the leads given by a former Tokyo University President, a former Dean of engineering, two MIT related sources (one long-time administrator of the Japan Program and another faculty member who has been working with Tokyo University); two Ministry of Education and Science (MOES) sources; some specific contacts with strong UT ties, and available (and limited) faculty background information on the web.

Through such an iterative search process, five categories of university-industry relationships were identified as emergent and significant in the past 15 years: endowed laboratories (15+), industry-university collaboration center/labs (2), technology licensing offices (2); and special research groups (20+). For the endowed labs and research committees, 3 cases each were selected for inclusion in the study. Although not easy to find initially, the above categories were "institutionalized" in one way or the other. In addition, four cases of consortia activities and 2 cases of relatively large-scale single company projects were identified and examined. It was not possible to get a broader view of the prevalence of these forms of interaction.

Data collection, validity, reliability and other biases

The data sources include interviews, documents and secondary materials, archival data, and some observations. Overall, 297 interviews were conducted with 211 individuals. A majority of the interviews were tape-recorded and transcribed, with durations varying from half an hour to 3 hours at a time. Tape-recording was not used either when interviewees rejected it, or when it seemed to interfere with the interview process by making the interviewees feel uncomfortable. On the whole, I was more careful with industry people, who more often voiced their concern about confidentiality. All interviews were semi-structured, with key questions evolving over time as my own theory evolved.

Table 2-1: Number of interviewees and interviews

	# of interviewees	Repeat interviews	Total
US	79	34	113
UK	68	20	88
Japan	65	32	97
Total	212	86	298

Interviewee selection was guided by two principles: (a) coverage of different types of organizational actors whose differential roles and perspectives seemed important in shaping culture and institutional logic for university-industry relationships (e.g. academic staff, administrators and industry representatives); (b) coverage of sub-cases to represent all salient and new types of relationships with industry in each setting.

Table 2-2: Background of interviewees

	Academic	Administrators	Industry	Government	Other	Total
MIT	35	21	15	0	8	79
Cambridge	34	11	16	2	5	68
Tokyo	34	8	11	7	5	65
	103	40	42	9	18	212

Various documents related to individual initiatives were collected as part of the interview process. These were complemented by archival data obtained from newspaper and campus news articles. The extent to which archival data were available varied across the three institutions. In MIT, the Reports to the President for the last 20 years were screened for major events and developments, and Tech News and Press Releases were searched extensively. Similarly, the Cambridge Reporter was extensively searched for major news and developments. For Tokyo University, the Engineering Faculty newsletter and Tokyo University Newsletters were reviewed.

I was a graduate student at MIT throughout the dissertation, which permitted me to observe faculty-student interaction on a day to day basis. I had a visitor status in both Cambridge and Tokyo University, which allowed me to observe how people interacted on the ground albeit to a much more limited extent. Being a student at MIT, and having faculty advisors, allowed me far more insight as well as direct observation opportunities for university-industry interactions. The latter included seminars/conferences as well as alliance meetings.

Selection bias. Overall, over 90% of people initially contacted were interviewed, with the roughly same distribution across the three universities. Concerted efforts were made to track down the non-respondents, to avoid the possible selection bias against busiest people who pay little attention to email requests. It was noticeably more difficult to set up interviews with MIT professors than any other categories of interviewees. The success rate in interviewing was 63% for the initial contacts at MIT as compared with 77% overall, and 80% based on repeated requests at MIT as compared with 90% as shown in Table 2-3. To avoid the possibility that the busiest people were systematically excluded from my sample of interviews, I had to be extremely active in pursuing no-response cases, particularly at MIT. In more than cases, I contacted the professors on multiple occasions, sometimes asking others to write to them to prompt responses. The fact that I managed to track down as many as of these individuals as I have, probably helped in getting a more balanced view.

Table 2-3: Success rates in interview requests

	Upon multiple requests	Upon single requests
MIT	71%	56%
Cambridge	94%	75%
Tokyo	90%	83%
Other	97%	94%
Total	86%	74%

There may be several reasons for this: as a graduate student at MIT, I may have been less “interesting” for them to meet. On the other hand, I also found that some MIT professors felt special obligations to me as MIT educators. It is most likely that these things cancel out on balance. Another plausible explanation is that MIT professors are too busy to take note of incoming emails for one reason or the other. This was consistent with the general manner in which they allocated time to me, in comparison with Cambridge and Tokyo professors, who appear to be able to be more “interested” in disruptions such as this interview. There are other corroborating pieces of evidence: similar complaints about inability to get responses from MIT faculty coming from a diverse range of people including, ILP officers who are constantly in touch with the academics to set up meetings; one industry representative resident in MIT representing a strategic alliance; and an entrepreneur contacting MIT professors for his start-up activities. If all of these people found it difficult to get responses from MIT professors, clearly it is not just my student status. Interestingly, academic administrators including the President, who would be as pressed for time as faculty, were much more accessible, possibly because of personalized assistance from professional administrators who dealt directly with their scheduling.

Validity and reliability. Particular attention was paid to verification of individual accounts through triangulation and repeated interviews in order to raise validity and reliability. However, to do so, inaccuracies and misrepresentations inherent in individual interview accounts had to be first considered. As Van Maanen pointed out, informants in the field may lie for a specific reason, be ignorant, or have tacit and taken for granted assumptions that they may not bother to articulate (Van Maanen 1979). Where there were specific concerns of lies and ignorance, efforts were made to triangulate both through interviews with different types of players who were engaged and through archival data. Particular attention was paid to interview "bilingual" players who are either new to the organization or otherwise have significant other experience that makes them more sensitive to assumptions that are taken for granted within each setting.

Triangulation through multiple interviews was not a simple matter, since difference in views/accounts could represent either inaccuracy or different perspectives. Since each interviewee has a different role to play in a relationship, each brings in different values and perceptions, and indeed, the identification of such differences was one of the objectives of the research. This situation presents a methodological dilemma in interpretation. How should the researcher interpret the difference in accounts as inaccuracy in data rather than structural differences in perspectives? There seemed to be no simple way of dealing with such an issue other than being mindful of the differences in my analysis, and being conservative in my interpretations.

It is also the case that in a long interview, the interviewee may not always be consistent with him/herself. Particular attention was paid in such cases, to "interpret" their words against what they might have meant, rather than simply following specific words used on the surface. Quotes were particularly carefully selected, to avoid distortion of taking them out of context, and to ensure that they represent accurately the nuances of the speaker, consistent with the rest of the interview.

As important was the validation of findings through repeated interviews. In each university, several individuals were interviewed multiple times in order to verify the findings. The most extended example is a case of one senior academic administrator, who had the 30-year institutional perspective of central administration, with whom 10 one-hour interviews were conducted. The interviews were used to understand how he saw various roles within the university, and how he saw the historical developments. In later interviews, clarifying questions were asked to make sure the nuances in previous discussions were understood correctly. In addition, the final story-line of the three cases were tested by selected individuals in each of the three settings through discussions during final validation interviews.

It is not clear that reliability of data collection in terms of replicability of the process is the valid way in which to evaluate qualitative interpretive research. It is clearly the case that "my perception" with all my experience and background helped me see what I saw. Everyone will agree that to say that someone who spoke no Japanese would not get the same interview data from the Japanese academics is a ridiculous test of replicability. By the same token, someone who spoke English but had no experience of the collegiate system in the UK may simply not be able to ask the same questions about the structure of Cambridge. I therefore argue that the valid issue in interpretive research is to question the verisimilitude as expressed by people who understand these contexts, and not the replicability of data collection in a mechanical sense, which in many ways is a trivial issue. It is the elements of the theory that have to be tested through verisimilitude, precisely the reason why validation was taken seriously as above. The fact that the process of interpretation is not "replicable" leaves me with a problem that this part of my research remains distinctly "personal" and cannot be made "public." I will discuss this issue later as a key limitation.

Reliability of data collection within my own research is another matter altogether. While I tried to maintain certain standards and rough structures of the interviews, the practical realities of evolving theoretical ideas as well as details such as availability of interviewees did introduce variations in my own data collections. Some of these were inevitable progress, others were undoubtedly introducing noise. For instance, there were interviews where I felt that I extracted more honest responses because of the way the interview dynamics worked. By the same token, there were interviews where I felt I did not get as far. Interviewing is a social process, and there is no escaping from the reality that one shrug could make the subsequent responses different. On average, where I got less, I probably managed to recover both from triangulation and repeated interviews.

Researcher background and exposure to the three sites. The choice of the three universities was also guided by my personal background which provided me with preliminary understanding of the settings, which helped enhance validity and reliability of data collection as well as interpretation and analysis. I was an undergraduate of physics in Oxford, UK, another university that has collegiate structures similar to Cambridge. I had worked as a visiting researcher in an engineering laboratory in Tokyo University in 1984 for six months and spoke the language fluently. I was a graduate student at MIT throughout the period of this dissertation.

I had greater exposure to MIT because of my student status. I lived near MIT for four years visiting the campus almost daily when I was not traveling, although my principal work site was my home. My interviews at MIT were therefore evenly spread out over the course of 2 years. I interviewed people at Cambridge through four visits: three one-week visits and a three-month period over one summer spread out in the course of a year and half. I visited Tokyo University four times in all spread over a year: one week, one month, 3 weeks and 2 weeks. For both Cambridge and Tokyo, I also made final 2 day visits in 2002 to discuss and validate my findings.

My relationship with the University of Tokyo became somewhat "clinical" in that several of their professors began to ask for my findings and comments towards the end of my dissertation (Schein 1995). Two professors whom I had previously interviewed visited MIT and asked for my comments on MIT's relationships with industry and what they might do to develop better relationships with industry in the future. There was one occasion where several professors from the University of Tokyo had an informal workshop on the future of higher education, where I was asked to present my findings. These interactions were particularly informative in revealing aspects of the University that had been hidden to me.

All in all, my understanding of MIT as an organization is more complete than those of the other two. For this reason, I selected a couple of people from Tokyo University and Cambridge to whom I went back towards the end of my data collection and presented and discussed my general understanding of how things work in their universities, to test my understanding.

Other sources of error and biases. There were two other methodological concerns: selection bias and sensemaking. The question of selection bias was strongest in the case of sub-case selection for MIT consortia, and simple relationship examples for Tokyo University. For the former, since there were so many cases, and they were so diverse, picking up on those that are novel in some ways, was not easy. Two approaches were taken to mitigate the effect. A careful method for case selection, based on choices made by multiple key informants, helped in identifying a reasonable set. Secondly, for those sub-set of consortia that anybody mentioned as innovative, I looked through their website, at least to understand their profile of activities. Selecting the right sub-cases within Tokyo was methodologically fraught mainly because of the lack of information available. I am comforted by the fact that no one that I met could suggest any other and better list of sub-cases.

Sensemaking was the second methodological problem that could bring in divergence between how interviewees saw things at the time and their current perception of the historical events (Weick 1995). The principal way in which I dealt with this problem was the inclusion of "on-going" sub-cases. Whereas for the historical sub-cases, active sensemaking of the interviewees was inevitable, since they would have thought about what happened, what they did and why they took the actions, in light of the final outcome. In the on-going events, the impact of individual sensemaking is less salient or systematic, since they are not clear about where these events are leading to. To the extent possible, I also tried to follow the sequence of events through repeat interviews, so that I could see how "sensemaking" changed over time. While such longitudinal data collection under the current research was neither sufficient nor systematic enough for separate analysis of sensemaking, there was sufficient evidence that interviewees' own sensemaking evolved over time. For this reason, I explicitly assumed throughout my analysis that all the accounts simply reflected the interviewees' thoughts on the day of the interview, and not necessarily their past thoughts.

It was clear in some interviews that my questions also could induce people to engage in sensemaking. Some interviewees even thanked me for asking good questions that forced them to think more clearly. It was clear that interviewing was too interactive a process to avoid sensemaking on the spot. This methodological "flaw", in fact, provided the key insight for theorizing about institutional change as will be shown in chapter 8. I therefore reserve the full discussion of the implications of sensemaking in data collection until that chapter. Also, given the triangulation within sub-cases from multiple sources, most of the individual sensemaking would be treated as individual-specific perception, which is less problematic. What is much more problematic is if there was collective sensemaking about the history, and it is this collective sensemaking that I will address fully in chapter 10.

Finally, the non-public nature of interpretation remains a problem: I constantly used my judgment in a way that cannot be shown explicitly. In the extreme case, if another person conducted this research with exactly the same interviews, and read all the interview notes, they may arrive at different interpretations because of the different perspectives they come with. Even though I have used verisimilitude as an alternative criterion to validate my findings, even that process of "validation" remains opaque to outsiders, because presumably, I don't just listen and take in all of the comments made by these individuals met during validation interviews. Rather, I observe their reactions, make sense of their reactions and make adjustments to the extent they seem feasible. I will reflect upon this particular limitation, which is pervasive in qualitative research, in chapter 11.

The literature review: institutional change, boundaries and narrative identity

What does the existing literature tell us about the phenomenon of institutional change? I argue that there are five strands of literature that contribute to our understanding of the phenomenon. The first strand is the old institutionalism – or the literature pertaining to organizational analysis in the Weberian tradition, including comparative organizations, which provides a critical insight about the nested nature of institutions, particularly in the context of organizations. The second strand is new institutional theory in organizational sociology, that describes the process of institutional change that is motivated by factors other than technical efficiency, such as legitimacy. The third strand is organizational culture, built on the traditions of anthropologists and sociologists, that adds different lenses to understand the nature of differences between communities such as academics and industrialists. Fourth, practice theories provide an alternative way of looking at boundaries between different communities, with recent works on collaboration across boundaries. Finally, I argue that the literature on narrative identity provides a useful lens for understanding the role of individuals.

Institutional order, logics and comparative organizations

There are many pieces of work that focus attention on the role of institutional order or logics in the Weberian tradition. Weber's argument that the Protestant Ethics supported the evolution of capitalism implies the existence of a coherent set of practices such as religion, that are based upon a set of shared values or assumptions. Crozier's analysis of a match making factory, for instance, illuminated how an organization and its dysfunctions may reflect a wider set of French societal practices (Crozier 1967). Dore's comparison between a Japanese factory and a British one also highlights how organizations reflect a set of nested practices that may belong more broadly to a social setting (Dore 1973). There are other comparative works that highlight the nested nature of the institutions and the impact of local culture upon them (Geertz 1963; Wilson 1968). Institutions often form higher-order societal logics, or institutional logics, such as market, state, democracy, family or religion, which may be contradictory to each other (Friedland and Alford 1991). The past literature on institutional logics has been helpful in demonstrating that there have been historical changes (Fligstein 1987; Fligstein 1990; Barley and Kunda 1992; Thornton and Ocasio 1999; Thornton 2002). However, there has not been as much research on how these changes take place, with some exceptions (Fligstein 1990).

Institutional change in new institutionalism

The new institutional theory in organizational sociology introduced the idea that organizations adopt changes for reasons other than technical efficiency (Meyer and Rowan 1977; DiMaggio and Powell 1983). DiMaggio and Powell proposed a framework for understanding how a group of organizations influence each other through an isomorphic process, with a formation of an "organizational field" (DiMaggio and Powell 1983). Organizational field is a powerful construct comprising not only organizations within a given sector of the economy, but including regulators and other influential bodies; these form a logical set of actors that collectively define what is legitimate. By recognizing that the "environment" is not a separate and inert "thing" that organizations face, but that organizations themselves constitute the environment, institutional theory introduced a recursive mechanism of environmental influence on organizations. The original proposition was simply that organizations would become similar to each other through three distinct mechanisms of isomorphism: coercive, normative, and mimetic. Subsequent theoretical refinements clarified that even straightforward imitation can lead to innovation, given that imitators have their own internal institutions that could distort and influence the process (Westney 1987) or that organizations may belong to multiple organizational fields (Westney 1999), and in the extreme, organizational fields may even form around specific issues (Hoffman 1999). Guillen has argued that competition motivates strategic differentiation, rather than mimicry (Guillen 1999).

In the new institutionalism literature, one central question under active debate is how institutional change takes place. The lack of focus on institutional change has in the past been the main target for criticism in institutional theory (Zucker 1988; Powell 1991; Hirsch and Lounsbury 1997). Recently, there has been a concerted effort made to address this issue (Dacin, Goodstein et al. 2002), both theoretically and empirically (Greenwood, Suddaby et al. 2002). And yet, the process of structuration, the main mechanism for institutional change, remains theoretically under-defined, and empirically unexamined. The question remains, what happens when an organization faces multiple isomorphic pulls?

There are two related issues. First, there remains insufficient emphasis on institutionalization as a process (Tolbert and Zucker 1996; Barley and Tolbert 1997). There is a need for clarification about how a new institutional pattern gets created and sustained in a given locale and be replicated. Second, there remains the issue of how existing fields influence the structuration process. The question is what happens at the boundary of multiple organizational fields and what individuals do at these boundaries. In the past, these questions have been addressed principally through macro-historical analysis based principally on archival data on the one hand (Westney 1987; Brint and Karabel 1989; Holm 1995; Zucker and Darby 1996; Zucker et al. 2002; Greenwood, Suddaby et al. 2002); and examination of micro-level dynamics at a given locale on the other (Barley 1986; Zilber 2002). A middle range analysis that straddles across multiple levels of analysis, and historical and comparative case studies (Scott 1995), may add important insights to our understanding of institutionalization process.

Culture theorists

Culture theories provide an interesting alternative to thinking about the underlying structures. Based on traditions built in anthropology and sociology, this school of thought focuses on the webs of shared meanings in communities (Geertz 1973). Geertz's famous expose about how the meaning of twitching one eye could be perceived differently, either as a wink or an inscrutable physical act, goes a long way towards explaining that action is always interpreted in a context of shared (or not shared) meanings. The strength of the culturists is exactly that: they take seriously the way culture influences the very meanings of every thing we see. The literature on organizational culture provides a useful focus on communities that are more confined than nations or regions and provides some tools for analyzing interactions between local communities. Schein argued that organizations can have their idiosyncratic cultures, as represented by artifacts, values as well as shared assumptions (Schein 1992; Schein 1996). Schein developed a multi-level framework of culture comprising artifacts and behavior that appear at the surface level, supported by espoused values held by organizational members and basic assumptions that are shared, but that are often so taken for granted, that they are rarely articulated. Schein's simple framework helps us understand that the "behavior" as it appears on the surface can have very different meanings depending on the supporting values and basic assumptions.

Schein's culture thesis has been criticized for its taking organization as a simple monolith. An alternative perspective that organizations comprise multiple sub-cultures was proposed (Van Maanen and Barley 1984), with the implication that there can be internal boundaries within organizations between sub-cultures that are difficult to bridge. Yet another alternative was that organizations do not comprise stable cultures or subcultures, but that they are constantly in a state of flux (Martin 1992; Martin 2002). Martin criticizes Schein's integrated and Van Maanen's differentiated culture perspectives as static and simplistic, and argues that what is shared and what is not shared remains highly ambiguous in the real world. Further she argues that boundaries are never clear-cut, and that they are constantly changing, yet contends that the three perspectives on organizational culture can be seen as complementary.

Cultural theories are helpful in clarifying that boundaries do exist between communities: boundaries are what divide communities with different values. Scholars appear to agree that examining cultural boundaries can provide interesting insight on culture and its workings (Swidler 1986; Martin 2002). Like institutional theory, the cultural perspectives have been criticized for their emphasis on stability and the lack of focus on change. Schein argued that organizational leaders can bring in and tweak values and over time may influence basic assumptions. However, the mechanism for doing so, he implies rather than explains. Hatch proposed a dynamic model of cultural change, based on

Schein's constructs, which is conceptually exciting, but remains highly abstract and yet to become empirically grounded (Hatch 1993).

Practice theories and structuration

In the structuration framework of Giddens, he argues that structure and agency have reciprocal influence, and that structure is not an objective reality but an enacted one (Bourdieu 1977; Giddens 1984). When it comes to demonstrating the nature of agency, however, there is still some ways to go. The theory remains abstract even with additional constructs such as "scripts" (Barley and Tolbert 1997) or "interpretative flexibility", and empirical data show little more than the fact that something other than "structural" determinism is at work.

Bourdieu developed a more elaborate framework for understanding the reciprocal nature of influence between structure and agency (Bourdieu 1977). He argues that habitus represents a cognitive structure inside an individual, influencing the way he/she sees the world, but that habitus influences individual action only as a mere disposition, rather than as a deterministic structure. The real world comprises "fields," where various "games" are being played out by people. As individuals engage in fields of play, they are influenced by power structures inherent in them, and these in turn influence the further development of habitus. In other words, habitus is a cognitive structure that is built cumulatively through experience. However, to the extent that habitus reflects multiple fields as experienced by the individual in the course of his/her life, its effect on individual action is different from those of existing field structures. Also, Bourdieu argues that individuals have agency to the extent there is a certain "fuzzy logic" with which these structures relate to individual action. Fields are structures that exist out there, but have fuzzy influence upon habitus, and habitus in turn shapes individual action in a fuzzy way. This margin of error is then individual discretion. Bourdieu's framework is perhaps one of the most comprehensive within social theory, and goes a long way to clarifying the duality of structure and agency. Particularly interesting is his clarification of "fields" which define interests and power. In Bourdieu's world, significant boundaries occur in between fields defined by different games, interests.

Recently, Bourdieu's framework has been used by organizational theorists to add new insight to the collaborative work across functional boundaries (Levina 2001; Black 2002; Carlile 2002; Carlile 2002). Carlile argues that different communities of practice operate as different "thought worlds" and create knowledge boundaries that are not easy to deal with ((Fleck 1978 (originally 1935); Douglas 1986; Dougherty 1992). According to him, it is not only that it is hard to communicate across the boundaries because meanings are different. Different communities of practice have different interests and different things at stake. The fact that players come with different goals and interests, creates complex inter-dependencies between them that are invisible to the players, but powerfully at work in their interactions (Carlile 2002a, Carlile 2002b). Through ethnographic work on product development teams, Carlile argued that joint work among participants can be facilitated by certain types of "boundary objects" (Carlile 1997). With these recent empirical works, Bourdieu's framework has come a long way in illuminating the dynamics of change at the boundaries. While Carlile's boundary objects and Levina's genre systems do much to push the frontier in understanding what boundary processes look like, neither of them provide a focus on how the boundaries are crossed and how new meanings get created. The mechanism for agency remains unclear, leaving the framework looking more deterministic.

Narratives and storytelling.

I turn to the literature on narratives and story telling in search of this image of agency. Narratives have come into limelight in social science in the last two decades, and appear particularly suitable for expressing the "fuzzy" manner in which structures operate. As the literature on the narratives and story telling has been expanding explosively, it is critically important to understand and distinguish between different strands within it. Several authors noted distinctions to be made along the functions of the narratives with respect to research (Ewick and Silbey 1995; Czarniawska 1998): (a) narratives as outputs of research; (b) narratives as inputs or data to be collected and analyzed; or (c) narratives as a theoretical construct to describe a mechanism. Narratives are powerful outcomes of research, ones that reflect underlying epistemological assumptions about the role of researchers and how they relate to the field and data (Van Maanen 1988). Clark was one of the first to introduce the concept of using narratives or stories in the field of organizational theory (Clark 1971). He was followed by other researchers, who created a progressively more rigorous tradition of using narratives as an input to research, for instance, Martin et al in analyzing 7 types of uniqueness claim stories that arise in organizations; or Boje who explored the embedded nature of stories and argued that stories do not often come in tidy complete forms, but that they get developed and performed in social settings through negotiation and enactment (Boje 1991). Others have followed and developed much more detailed mechanisms and procedures for analyzing narratives as created in organizations (Feldman and Skoldberg 2000), leading to a whole field of discourse analysis, where the linguistic use in a given context is examined (Putnam et al 2002). Most of these authors assume a certain social role of narratives. Clark's piece on organizational saga argues that organizational narratives represent a mechanism through which organizational ethos is created and reproduced (Clark 1971). As Boje argued in his field analysis, "stories" often arise in incomplete forms, remain implicit, and not all of them are articulated in a structured manner. In this sense, "organizational narratives" may not be an empirical reality appearing in complete texts, but a theoretical construct that is enacted as well as articulated (Boje 1991).

There have been theoretical developments in several distinct disciplines with respect to social roles of narratives (Czarniawska 1997; Czarniawska 1998). On the one hand, narratives provide a mechanism through which people communicate, understand each other, and create new meanings. On the other, narratives provide a mechanism through which individuals make sense of themselves and their actions. Literary theorist Barthes believed that the role of narratives was pervasive. Narratives help individuals construe what they are and where they are headed. Narratives also contribute to creation and maintenance of shared beliefs and transmission of values (Barthes 1966/77; Polkinghorne 1988; Czarniawska 1997; Czarniawska 1998). In philosophy, MacIntyre argued that social life is a narrative and that human beings are distinct from other beings by the virtue of their ability to account (MacIntyre 1981; Czarniawska 1997; Czarniawska 1998). For psychologists, the essential argument is that narrative understanding constitutes one of the two basic modes of cognitive functioning along with the logico-scientific mode or paradigmatic mode (Bruner 1986; Polkinghorne 1988). Polkinghorne argues that "narrative is a meaning structure that organizes events and human actions into a whole, thereby attributing significance to individual actions and events according to their effect on the whole." The narrative turn also had a special appeal to psychologists and other practitioners whose professional practice relied heavily on the use of individual narratives (Polkinghorne 1988). Ricoeur proposed a conception of self-identity based on his analysis of narrative (Ricoeur 1988; Ricoeur 1992; Ezzy 1998). For him, narratives interact with "action" in two ways. Past actions lead to narratives that make sense of them; and narratives prefigure future actions. In a social world, there is a third step where these actions are observed by others who will in turn create other narratives to interpret them (Ricoeur 1984; Ezzy 1998). Narratives provide a backbone of continuity for individual actions as they live through time, creating coherence over time, but remaining fluid and changeable. This conception of narrative identity has led to further theorizing in the role of narratives in social settings. For instance, Somers argues that there are social narratives that are beyond individuals' power to create, but they are appropriated by individuals to form the basis of social identity (Somers 1994). Narratives or stories are abstract entities rather than empirical realities. They represent both the outputs and the mechanism of the "sensemaking" process that underlies both the formation of individual identities and the sharing of understandings (Weick 1995).

In summary, there is a convergence of view on the dual roles of narratives. On the one hand, narratives or narrating can function within an individual as a mechanism for identity formation and a basis for future action, and on the other as a mechanism for sharing and creating meaning among people. Pentland summarizes that the emergent focus on narratives is about ability to be the "ether" of social existence (Pentland 1999). Narratives are a multiple-level construct in the sense that they are a mechanism that can operate at the individual, group and organizational levels. They can be instrumental in individual identity formation, but can also play an important role in social life, as they create new meanings and communicate them to others. There have been many implicit and explicit theoretical claims on how narratives can play a role in institutional change (Czarniawska 1997). However, past empirical work tended to focus on discourse analysis (Putman et al 2002), treating existing narratives as inputs, which often implicitly assumed certain roles of narratives in organizations, but without explicitly elaborating on them. On the other hand, there have been many theoretical developments that are based on the concept of narratives, as exemplified by Ricoeur's narrative identity, but without the empirical grounding. The confusion is perhaps confounded by the fact that narratives in Ricoeur's or Somers' discussions may not always appear in dialogues, but may indeed be implicit. The terms "narratives" or "stories" are used as theoretical constructs rather than empirical data. It seems possible to push this frontier a little further, to dwell on "narrating" or "storytelling" as a metaphor for the process of institutional change, but in the context of a specific empirical reality.

Proposed theoretical lens

The grounded theory approach led me to a gradual formation of a theoretical lens, that complements the existing literature. Specifically, I propose to draw on two conceptual frameworks to highlight the interdependent nature of structure and agency as in structuration theories (Bourdieu 1977; Giddens 1984; Barley and Tolbert 1997): boundaries that separate individuals; and story telling that helps individuals enact and change the boundaries. By explicitly looking at structure and agency as separate mechanisms, I will highlight the respective functions they serve. Boundaries stabilize behavior and story-telling creates a new variation. And yet, these boundaries are not independent of individuals; they are enacted by them.

I argue that in order to understand the process whereby people begin to share meanings, one must first of all understand not only the nature of the different "thought worlds" (Fleck 1978 (originally 1935); Douglas 1986; Dougherty 1992) but the nature of the boundaries that separate them, and the manner in which boundary-crossing takes place. Examination of boundaries has been highlighted as an important agenda (Abbott 1995; Martin 2002). It makes empirical sense to view university-industry relationships from this perspective, since academics and industrialists do indeed live in different worlds with different values, norms, and interests, and it is precisely this sense of working with the dual worlds, that makes them controversial and difficult. The two worlds can be understood either as two cultures (Van Maanen and Barley 1984)or as different fields of practice (Bourdieu 1977). Boundaries can powerfully influence the subsequent pattern of interaction. I propose that boundaries that separate industrialists and academics can be described in terms of three inter-related dimensions: membership, knowledge, and physical space. These dimensions are not strictly orthogonal, in the sense that knowledge cannot be isolated from people, nor physical space from the sense of membership. And yet, they are categories of "things" that can "belong" to an organizations, and there are distinct and tangible sets of rules and norms along these three dimensions. In other words, they are conceptually separate, if empirically confounded and interdependent categories.

There are also internal boundaries that separate sub-cultures inside each university. Disciplinary communities create boundaries that are not easy to cross. Similarly, administrators and academics can have powerfully different values, norms and interests. Again, how these boundaries are defined and can influence the way they work together, which in turn has a powerful influence on the way new relationships get institutionalized in the university.

At the same time, organizational boundaries are not "fixed" structures. They are sustained and changed through on-going activities of individuals (Giddens 1984). Academics follow the rules and norms, or create their own interpretations, or even violate the norms purposefully, and it is the locus of their and industrialists' or administrators' actions that pave the notion of the boundaries today. Boundaries become boundaries, because people enact them every day. I pay particular attention to the time when people's enacting may diverge from the past in one way or other. I argue that there is then a need to "account" and explain to the others why the new behavior makes sense. People enact the boundaries and create new ones by creating new relationships that in turn give rise to new meanings. I propose to use the metaphor of story telling to highlight the underlying mechanism for this boundary maintenance and change. More specifically, I argue that collective work in such a circumstance begins with a process of meaning making through story-telling and sharing.

In summary, I argue that structures as represented by boundaries among people or across communities, and agency as represented by story-telling can help us understand the nature of processes that underlie the emergence of new institutional patterns.

PART II: WHAT HAS CHANGED?

Chapter 3: National level perspectives

The overall purpose of this chapter is to examine the role of national contexts in shaping university-industry relationships. To this end, this chapter examines the historical developments in the three national settings to address three questions. First, what have been the changes in the role of universities in national research? Second, what have been the changes in university-industry relationships? Third, how have the commonly cited factors, affect or not affect such an evolution? In this respect, there are three usual suspects: (a) the changes in the overall level of government funding may prompt resource-dependent universities to respond; (b) government regulatory policies and funding programs specific to university-industry relationships may influence universities to behave differently; and (c) changing industrial expectations to work with universities may have influenced the pattern of collaboration.

The chapter is structured as follows. For each of the three countries, there are two main sections. The first of these is a discussion of the national historical context, starting with the overall role of universities in the national R&D followed by a description of the historical changes in industrial funding of university research. This is to clarify the nature of university-industry relationships in each setting as well as to describe the changes that have been taking place. The second main section discusses the three commonly cited factors as listed above, that could provide alternative explanations for such changes. In the final section, I conclude that these factors matter, but they do not operate evenly over time or across space, and that in order to understand their influence, it is important to examine specific organizational perspectives.

3-1. US

3-1-1. Historical background in national R&D

In the US, the role of universities in research was shaped heavily by the experience during and following World War II. Prior to the war, in 1940 for instance, national research was dominated by industry, which undertook about 68% of total research, while government and universities trailed behind at 19% and 9% respectively. Though there is little evidence, the wide-spread understanding is that much of the academic research in those days was applied in nature, and yet, specific collaborations across sectors were not common. "Institutional partnerships among the Nation's three research sectors were the exception rather than the rule." (National Science Board 2000)

The way in which the national scientific capacity was mobilized for military technology during World War II was significantly different from the experience of the first World War. As a result of strong recommendations from Vannevar Bush, the then Director of the wartime Office of Scientific Research and Development and former Dean of Engineering at MIT, the US took a decentralized and collegial approach where scientists were funded for various projects at universities and industries. This was strikingly different from the approach taken during World War I, where scientists were recruited and placed into federal laboratories. (National Science Board 2000). The new approach was "superbly effective ", as exemplified by the development of radar in the Radiation Laboratory at MIT, where scientists and engineers were brought together to work on this national project.

In 1944, President Roosevelt asked Vannevar Bush for advice on how the experience of the mobilization of science, including engineering, during World War II could be applied to the peacetime goals of better health, wealth creation and improved living standards. Bush's answer is encapsulated in his seminal report, "Science - the Endless Frontier"(Bush 1945), which recommended strongly continued federal funding for scientific research in universities to support the progress of basic science. Key institutions such as the National Science Foundation were formed directly for that purpose.

What happened subsequently was an unprecedented growth of university science with federal support. Universities became more prominent as performers of research and their overall share of the national research budget grew rapidly from 7.8% in 1953 to 11.8% in 1968 and again from 12.2% in 1985 to 16.0% in 1994, declining a little in the late 1990s to 14.0% in the 1998 as shown in Table 3-1.

Changing university-industry relationships in the US

The picture of industry funding of university research is not surprising given such national developments. As indicated in Table 3-2, during the post-war period, there was a steady decline in the industry funding share of university research, from 7.6% in 1953 to the all time low of 2.5% in 1966-1967, showing how the modest increases in industrial funding were dwarfed by large increases in government funding. In the 1970s, the industrial share increased moderately from 2.7% in 1970 to 4.1% in 1980, accelerated in the 1980s to 6.9% by 1990, and stabilized at just over 7% in the late 1990s, at about 1.9 billion US dollars in 1998 (National Science Board 2000). The examination of the absolute level in constant prices provides a similar picture: a stagnation during the 1960s; a modest increase in the 1970s, a double digit annual growth in the 1980s, stabilizing to a more modest level of annual increase in the 1990s. Albeit small in the overall university R&D, it has been the most rapidly growing source of funds in the last 30 years.

Government funding. The increase in university research income from industry is often said to reflect a decline in federal support. However this pattern of industrial funding of university research, when set alongside the reported trends in government spending, does not support this view. As shown in Fig 3-1, federal R&D spending grew rapidly in the

Table 3-1: US R&D expenditure shares by performing sector: 1953-98

year	Federal	Industry incl.FFRDCs	U&C incl.FFRDCs	U&C FFRDC	FFRDC all	non-profit
1953	19.7%	70.3%	7.8%	2.5%	2.5%	2.2%
1955	15.5%	73.9%	8.4%	3.0%	5.1%	2.1%
1960	13.1%	76.6%	7.9%	2.8%	6.6%	1.9%
1961	13.6%	74.9%	8.7%	3.0%	7.5%	2.1%
1962	14.0%	73.3%	9.5%	3.2%	6.8%	2.3%
1963	14.6%	72.1%	10.0%	3.3%	6.6%	2.3%
1964	15.5%	70.7%	10.5%	3.3%	6.8%	2.2%
1965	15.6%	70.0%	11.0%	3.1%	6.0%	2.3%
1966	15.0%	70.4%	11.2%	3.0%	5.5%	2.4%
1967	14.8%	70.2%	11.7%	3.0%	5.7%	2.4%
1968	14.2%	70.7%	11.8%	2.9%	5.6%	2.4%
1969	14.6%	70.4%	11.6%	2.8%	5.5%	2.5%
1970	15.8%	68.8%	12.0%	2.8%	5.4%	2.6%
1971	16.4%	68.0%	12.2%	2.7%	5.3%	2.6%
1972	16.3%	68.0%	12.3%	2.7%	5.3%	2.7%
1973	15.6%	68.7%	12.3%	2.7%	5.1%	2.8%
1974	15.4%	68.6%	12.4%	2.8%	5.3%	3.0%
1975	15.6%	67.8%	13.0%	3.0%	5.7%	3.0%
1976	14.9%	68.4%	13.1%	3.2%	6.1%	2.9%
1977	14.3%	68.6%	13.6%	3.6%	6.4%	2.9%
1978	14.3%	68.2%	14.0%	3.7%	6.6%	2.9%
1979	13.5%	68.8%	14.1%	3.8%	6.6%	2.9%
1980	12.4%	70.3%	13.9%	3.7%	6.5%	2.7%
1981	11.9%	71.7%	13.2%	3.4%	6.1%	2.5%
1982	11.8%	72.6%	12.6%	3.2%	5.7%	2.4%
1983	12.0%	72.5%	12.4%	3.3%	5.7%	2.4%
1984	11.6%	73.1%	12.2%	3.3%	5.6%	2.4%
1985	11.4%	73.4%	12.2%	3.2%	5.4%	2.4%
1986	11.2%	73.0%	13.0%	3.4%	5.4%	2.4%
1987	10.8%	73.0%	13.6%	3.5%	5.4%	2.2%
1988	10.7%	72.5%	14.1%	3.5%	5.4%	2.4%
1989	10.7%	71.9%	14.4%	3.4%	5.3%	2.6%
1990	10.3%	72.2%	14.4%	3.3%	5.2%	2.7%
1991	9.5%	72.7%	14.5%	3.2%	5.1%	2.9%
1992	9.6%	72.1%	14.9%	3.2%	5.1%	2.9%
1993	10.0%	71.0%	15.6%	3.2%	4.8%	3.0%
1994	9.7%	70.8%	16.0%	3.1%	4.9%	3.0%
1995	9.4%	72.1%	15.3%	2.9%	4.6%	2.8%
1996	8.5%	73.6%	14.8%	2.8%	4.3%	2.7%
1997	8.0%	74.6%	14.4%	2.6%	4.0%	2.7%
1998 prelim.	7.6%	75.4%	14.0%	2.4%	3.8%	2.6%

Source: National Science Board, Science and Engineering Indicators 2000
FFRDCs= Federally Funded Research and Development Centers, U&Cs= universities and colleges

Table 3-2: US R&D expenditures in universities and colleges by funding source: 1953-1998
(Millions of constant 1992 dollars)

Performing sector:	Universities & colleges excluding FFRDCs							
Funding sector:	Total	Federal Govt.	Industry	1970 index	annual increase	5-yr ave increase	Industry as % of university excluding FFRDCs	Industry as % of university incl. FFRDCs
1953	1,350	738	102	47			7.6%	5.1%
1955	1,649	921	130	60	13.0%		7.9%	5.1%
1960	3,028	1,945	172	80	0.0%	5.8%	5.7%	3.7%
1965	6,388	4,675	166	77	0.6%	-0.7%	2.6%	1.9%
1966	7,082	5,201	175	81	5.4%	0.6%	2.5%	1.8%
1967	7,682	5,627	194	90	10.9%	2.7%	2.5%	1.9%
1968	7,912	5,738	208	97	7.2%	4.4%	2.6%	2.0%
1969	7,878	5,610	209	97	0.5%	4.8%	2.7%	2.0%
1970	7,931	5,530	215	100	2.9%	5.3%	2.7%	2.1%
1971	8,001	5,488	225	105	4.7%	5.2%	2.8%	2.2%
1972	8,250	5,655	236	110	4.9%	4.0%	2.9%	2.2%
1973	8,365	5,690	254	118	7.6%	4.1%	3.0%	2.4%
1974	8,358	5,615	270	126	6.3%	5.3%	3.2%	2.5%
1975	8,481	5,702	280	130	3.7%	5.4%	3.3%	2.5%
1976	8,751	5,879	294	137	5.0%	5.5%	3.4%	2.5%
1977	9,163	6,098	326	152	10.9%	6.7%	3.6%	2.6%
1978	9,816	6,541	357	166	9.5%	7.0%	3.6%	2.7%
1979	10,347	6,967	388	180	8.7%	7.5%	3.7%	2.7%
1980	10,699	7,185	437	203	12.6%	9.3%	4.1%	3.0%
1981	10,733	7,074	476	221	8.9%	10.1%	4.4%	3.3%
1982	10,834	6,952	517	240	8.6%	9.7%	4.8%	3.6%
1983	11,278	7,121	590	274	14.1%	10.6%	5.2%	3.9%
1984	12,057	7,570	682	317	15.6%	11.9%	5.7%	4.1%
1985	13,126	8,134	802	373	17.6%	12.9%	6.1%	4.5%
1986	14,321	8,721	925	430	15.3%	14.2%	6.5%	4.8%
1987	15,419	9,352	1,000	465	8.1%	14.1%	6.5%	4.8%
1988	16,516	9,980	1,084	504	8.4%	12.9%	6.6%	5.0%
1989	17,422	10,381	1,183	550	9.1%	11.6%	6.8%	5.2%
1990	18,093	10,614	1,246	580	5.3%	9.2%	6.9%	5.3%
1991	18,702	10,956	1,277	594	2.5%	6.7%	6.8%	5.3%
1992	19,383	11,523	1,321	614	3.4%	5.7%	6.8%	5.4%
1993	19,972	11,994	1,352	629	2.3%	4.5%	6.8%	5.4%
1994	20,579	12,379	1,378	641	1.9%	3.1%	6.7%	5.4%
1995	21,065	12,654	1,431	666	3.8%	2.8%	6.8%	5.5%
1996	21,656	12,946	1,511	703	5.6%	3.4%	7.0%	5.7%
1997	22,408	13,309	1,589	739	5.2%	3.8%	7.1%	5.8%
1998 prelim.	23,374	13,805	1,682	782	5.9%	4.5%	7.2%	5.9%

SOURCE: National Science Board, Science & Engineering Indiators 2000
FFRDCs = Federally Funded Research and Development Centers; U&C = universities and colleges

Fig 3-1: R&D in universities by funding source

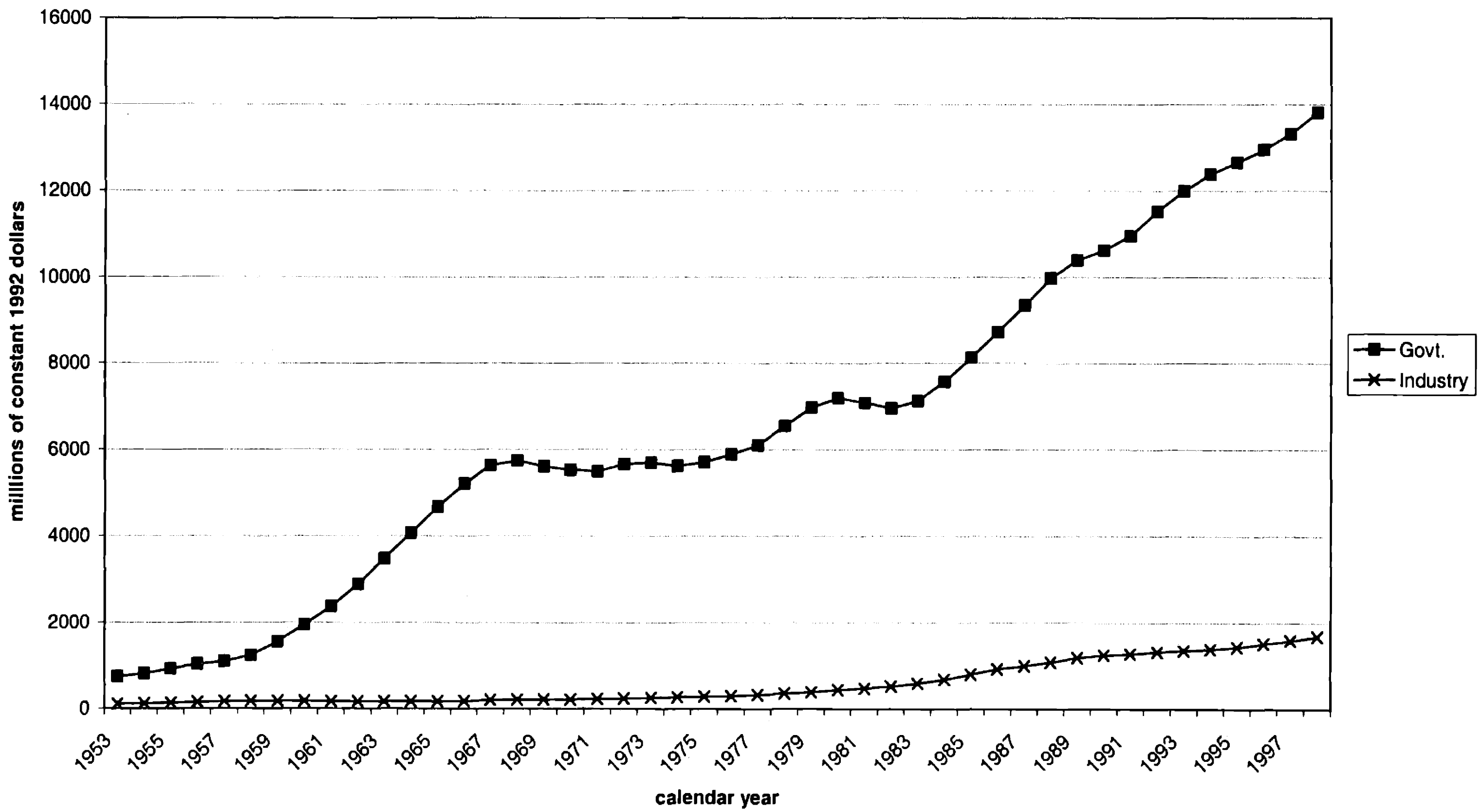

Table 3-3: U.S. basic research expenditures by federal government by performers: 1953-98
(Millions of constant 1992 dollars)

Performer	Total	Index (1970=100)	% increase	5 yr ave increase	U&Cs	% of total	U&C incl FFRDC	% of total
Calendar year[e]								
1953	1,313	16			404	30.8%	582	44.3%
1955	1,577	19	10.8%		562	35.6%	803	50.9%
1960	3,412	42	17.7%	16.7%	1,463	42.9%	1919	56.2%
1965	7,612	93	10.1%	17.4%	3,780	49.7%	4651	61.1%
1966	8,083	98	6.2%	14.4%	4,153	51.4%	5082	62.9%
1967	8,605	105	6.5%	11.0%	4,483	52.1%	5476	63.6%
1968	8,678	106	0.8%	7.7%	4,577	52.7%	5574	64.2%
1969	8,489	103	-2.2%	4.2%	4,449	52.4%	5389	63.5%
1970	8,207	100	-3.3%	1.5%	4,339	52.9%	5207	63.4%
1971	7,981	97	-2.8%	-0.3%	4,318	54.1%	5104	64.0%
1972	7,946	97	-0.4%	-1.6%	4,300	54.1%	5108	64.3%
1973	8,065	98	1.5%	-1.5%	4,217	52.3%	5189	64.3%
1974	8,178	100	1.4%	-0.7%	4,182	51.1%	5259	64.3%
1975	8,114	99	-0.8%	-0.2%	4,201	51.8%	5331	65.7%
1976	8,513	104	4.9%	1.3%	4,319	50.7%	5567	65.4%
1977	9,069	111	6.5%	2.7%	4,457	49.1%	6003	66.2%
1978	9,803	119	8.1%	4.0%	4,714	48.1%	6570	67.0%
1979	10,114	123	3.2%	4.3%	4,923	48.7%	6873	68.0%
1980	10,318	126	2.0%	4.9%	5,073	49.2%	7064	68.5%
1981	10,269	125	-0.5%	3.8%	5,046	49.1%	7013	68.3%
1982	10,452	127	1.8%	2.9%	4,952	47.4%	6955	66.5%
1983	11,049	135	5.7%	2.4%	5,042	45.6%	7211	65.3%
1984	11,621	142	5.2%	2.8%	5,383	46.3%	7658	65.9%
1985	12,152	148	4.6%	3.3%	5,864	48.3%	8182	67.3%
1986	12,847	157	5.7%	4.6%	6,355	49.5%	8781	68.4%
1987	13,436	164	4.6%	5.2%	6,654	49.5%	9229	68.7%
1988	14,082	172	4.8%	5.0%	6,895	49.0%	9565	67.9%
1989	14,946	182	6.1%	5.2%	7,156	47.9%	9820	65.7%
1990	15,060	184	0.8%	4.4%	7,357	48.9%	10040	66.7%
1991	15,766	192	4.7%	4.2%	7,625	48.4%	10419	66.1%
1992	15,732	192	-0.2%	3.2%	8,056	51.2%	10947	69.6%
1993	16,011	195	1.8%	2.6%	8,438	52.7%	11330	70.8%
1994	15,937	194	-0.5%	1.3%	8,741	54.8%	11472	72.0%
1995	15,817	193	-0.8%	1.0%	9,006	56.9%	11481	72.6%
1996	16,624	203	5.1%	1.1%	9,313	56.0%	11716	70.5%
1997	17,236	210	3.7%	1.8%	9,621	55.8%	12037	69.8%
1998 prelim.	17,955	219	4.2%	2.3%	9,980	55.6%	12394	69.0%

Source: National Science Board, Science and Engineering Indicators 2000

FFRDCs = Federally Funded Research and Development Centers; U&C = universities and colleges

1960s in real terms, peaked in 1968 and was stagnant through the 70s, picked up in the 80s and has been growing since. The increase in industrial funding of universities in the 1980s clearly cannot be attributed to the declining federal support. The story of federal funding remains essentially the same even when the analysis is narrowed to basic research funding (Table 3-3). There was a spectacular increase in the university share of federal funds from 31% in 1953 to 54% in 1972, declined to a low level of 46% by 1983 and then gradually grew again to attain 55% by the late 1990s. However, even during the period of stagnation and declines in shares, the total level of funding increased robustly in real terms, in contrast to the period of 1968-1977 when the total volume actually stagnated and even declined somewhat in real terms.

If the pattern of change in industrial funding of university research did not reflect that of federal funding, did it have more to do with the pattern of overall industrial funding of research? Table 3-4 shows that industry funding of university research as a percentage of total industry R&D spending declined from its 1% average in the 50s to 0.6% in the late 60s, rose slightly in the 1970s to 0.8%, more robustly reaching up to 1.4% by the end of the 1980s, and has hovered about that level in the 1990s. The overall volume of industrial R&D spending, on the other hand, scarcely grew in the early 1970s and grew briskly in the late 1970s through the 1990s in real terms. The pattern of industrial funding of universities, therefore, reflects more closely the pattern of industrial funding of research in general, but even here, the phenomenon of the 1980s is unusual in that the overall share of universities increased within the expanding pie.

In other words, the 1980s, which is the period when universities made the most notable increases in industrial research income, do not coincide with a period when the federal support was actually stagnating. One former senior administrator noted that one factor that colored their perceptions was the rising competition for federal funds, as more and more universities started actively seeking them. In other words, the fact that the total pie was increasing was not enough of an assurance.

Charles Vest, current President of MIT, recollects how he and many others from research universities stepped up lobbying in fear that the end of the cold war would lead to a harsh decline in government support. Large-scale decline was actually averted, owing at least in part to active lobbying efforts by the universities themselves. The sense of urgency was sufficient, however, to initiate increasingly active seeking of partnerships with industrial firms (Etzkowitz 1999).

There are two possible ways in which aggregate data may disguise the actual linkages between federal funding and industrial funding at the organizational level. First, individual universities may experience different crunch periods, leading to differential responses to industrial funding, which may be difficult to see in the aggregate data. Second, universities may respond to fears and anticipated changes, rather than the actual declines, which will not be reported until later. In other words, changes in organizational actions may depend on perceptions about what changes are taking place, rather than on the reality.

Table 3-4: Industry funding of R&D
1992 constant prices

performer	Industry[b]	increase	average increase in 5 years	univ	univ share	non-profit
1953	10,902			102	0.9%	129
1955	11,861	4.3%		130	1.1%	169
1960	19,029	9.6%	9.9%	172	0.9%	206
1965	25,821	9.1%	6.3%	166	0.6%	248
1966	28,111	8.9%	7.2%	175	0.6%	273
1967	30,276	7.7%	7.5%	194	0.6%	279
1968	32,088	6.0%	7.6%	208	0.6%	293
1969	34,060	6.1%	7.6%	209	0.6%	321
1970	33,753	-0.9%	5.5%	215	0.6%	312
1971	33,231	-1.5%	3.4%	225	0.7%	306
1972	34,515	3.9%	2.7%	236	0.7%	302
1973	37,122	7.6%	3.0%	254	0.7%	297
1974	38,126	2.7%	2.3%	270	0.7%	299
1975	37,021	-2.9%	1.9%	280	0.8%	297
1976	39,138	5.7%	3.3%	294	0.8%	303
1977	40,776	4.2%	3.4%	326	0.8%	316
1978	43,456	6.6%	3.2%	357	0.8%	324
1979	46,547	7.1%	4.1%	388	0.8%	326
1980	50,515	8.5%	6.4%	437	0.9%	332
1981	53,671	6.2%	6.5%	476	0.9%	341
1982	57,154	6.5%	7.0%	517	0.9%	356
1983	60,946	6.6%	7.0%	590	1.0%	376
1984	67,708	11.1%	7.8%	682	1.0%	426
1985	72,638	7.3%	7.5%	802	1.1%	479
1986	74,376	2.4%	6.7%	925	1.2%	521
1987	73,926	-0.6%	5.3%	1,000	1.4%	541
1988	77,445	4.8%	4.9%	1,084	1.4%	577
1989	81,923	5.8%	3.9%	1,183	1.4%	619
1990	87,182	6.4%	3.7%	1,246	1.4%	656
1991	93,074	6.8%	4.6%	1,277	1.4%	686
1992	94,388	1.4%	5.0%	1,321	1.4%	703
1993	92,158	-2.4%	3.5%	1,352	1.5%	703
1994	92,426	0.3%	2.4%	1,378	1.5%	710
1995	101,062	9.3%	3.0%	1,431	1.4%	757
1996	110,486	9.3%	3.5%	1,511	1.4%	814
1997	119,755	8.4%	4.9%	1,589	1.3%	869
1998	130,174	8.7%	7.2%	1,682	1.3%	932

Source: National Science Board, Science and Engineering Indicators 2000

Government policies on university-industry relationships. Various policy developments are also seen as critical factors responsible for the increasing importance of industrial funding of university research (Mowery and Rosenberg 1993; Bowie 1994; Mowery 1998) (See Table 3-5 for summary). In the US, there had been growing concern about manufacturing competitiveness since the 1970s, especially against rivals from Japan. For instance, an Advisory Committee on Federal Policy on Industrial Innovation noted in 1979 that "an ever-widening gap between the university and industrial communities" posed a significant constraint to the innovative potential of the private sector (Hane 1999). Three streams of government policies were to result from such a national sentiment: funding support for university-industry partnerships; the Bayh-Dole Act of 1980; changes in the tax and other regulatory framework for industry for collaborative work.

For the first of these, the National Science Foundation began to give emphasis to industry-university partnerships as opposed to open-ended science, starting with the pilot support of various collaborative schemes in the early 1970s. One outcome of this pilot exercise was the success of the Polymer Processing Program at MIT, which was founded in 1973 based upon consortium support by industries matched by NSF funding, and which became the model for NSF support in the next two decades (Gray and Walters 1998). Indeed, the founding director of the Polymer Processing Program at MIT served as a director at the NSF between 1984 and 1988, personally contributing to the consolidation of NSF support for collaboration with industry in the form of Engineering Research Centers (ERCs).

The 1980s was a period when policy makers at federal, state and university levels attached increasing importance to university-industry R&D centers(Cohen and Noll 1998; Gray and Walters 1998). The ERCs provided about 50 million dollars annually for the 25 centers (Rossner, Ailes et al. 1998). These federal programs were replicated by state-level support for similar centers, for instance, Utah supported the development of over 20 such centers under their program for Centers of Excellence (Bowie 1994). Cohen et al showed that there were over a thousand university-industry R&D centers by 1990, which collectively spent a total of nearly 3 billion dollars. This was more than double the NSF annual expenditure, and about half of all industrial support to universities was channeled through them (Cohen, Florida et al. 1994; Hane 1999). Sixty percent of them had been established in the 1980s(Cohen and Noll 1998). Some States have also been active in fostering industry-university partnerships through science parks and other facilities dedicated to inviting corporate partnerships, the most notable being South and North Carolina with their Research Triangle and Centennial Campus.

The second government policy was the Bayh-Dole Act of 1980, which simply allowed ownership by universities and small businesses of intellectual properties arising from federally funded research. According to Mowery et al., this was a strong Congressional expression of support for the negotiation of exclusive licenses between universities and industry, a point of policy disputes in the late 1970s. At the same time, it was an enactment of Congressional belief that patent protection would help rather than hinder commercialization. Mowery et al. argue that the effectiveness of the Bayh-Dole Act in

Table 3-5: Chronology of US policies

Year	Policy action	Policy content
1963	Presidential memorandum on federal patent policy	More uniform guidelines to enable universities to retain patent rights
1972	Pilot for the Industry University Cooperative Research Centers Program	To explore models for university-industry collaboration
1978	The Industry University Cooperative Research Centers Program by NSF begins	To promote university-industry collaboration
1980	Bayh-Dole Act	Allowed university ownership and small businesses of intellectual property rights from federally funded research
1980	Economic Recovery Tax Act	Provided tax breaks for university research support by industry
1984	Legislation	Congressional legislation to allow universities to hold patents for DOD labs they run
1984	National Cooperative Research Act	Reduced antitrust penalties for collaboration among companies
1985	Engineering Research Center Program by NSF	To promote engineering research relevant to industrial needs
1986	Federal Technology Transfer Act (and its amendment in 1989)	Allowed federal research labs, scientists paid by the federal government and grantees of public research funds to conduct cooperative research and development agreement (CRADA) with private industry
1987	Executive order	To reduce DOD discretion in patent assigning policies

Source: (Mowery and Rosenberg 1993; Bowie 1994; Mowery 1998) leading to innovation and commercialization is overrated by the public – and that many of the subsequent events might have happened even without the Act. (Mowery, Nelson et al. 1999).

Nonetheless, there is no doubt that the volume of patenting and licensing in the US universities increased rapidly in the 1980s. According to a survey by the Association of University Technology Managers (AUTM), the number of patents issued to universities grew from less than 250 annually before the Bayh-Dole Act to over 5,545 in 1999 (AUTM). New licenses and options executed increased to 3,914 in 1999, an increase of over 100% in a decade. More than 25% or over 4,000 licenses are currently active and associated with product sales which amount to over $35 billion. In the 1990s, university licensing took on a new meaning as technology-based start-ups experienced exponential growth, especially in geographical areas with high support infrastructure such as angels and venture capitalists. AUTM reports that more than 340 new companies were started based on academic discovery in 1999, comprising about 12% of the total new licenses (AUTM). Universities became hotbeds of new ventures as students and professors chose to take entrepreneurial careers. It was only with the NASDAQ dive in March 2000 that the enthusiasm for technology start-ups has abated.

Third, there were regulatory changes that changed the incentive framework for industry. In 1980, the Economic Recovery Tax Act of 1980 provided tax breaks for university research support by industry. In addition, the National Cooperative Research Act of 1984 removed concerns about anti-trust prosecutions for collaborative research activities among companies. In effect, collaboration among competing industries for "pre-competitive" research became a permissible norm. Subsequently there has been a rapid increase in R&D alliances since the 1980s. In the 1997 survey, it was found that of the total of $ 5 billion in cooperative corporate R&D expenditures, over 60% went to other companies and commercial labs, with 22% going to universities (Jankowski 1998; Rahm, Kirkland et al. 2000).

Economic and industrial circumstances. Another factor that may have contributed to changes in university-industry relationships is the changing strategies of industrial research. In the 1980s, one major response by US companies to aggressive foreign competition was cost-cutting, which was often accomplished though heavy tolls on R&D budgets (Florida and Kenny 1990; Rahm, Kirkland et al. 2000). Subsequent corporate restructuring, takeovers and mergers led to further downsizing of R&D activities (Fusfeld 1987; Rahm, Kirkland et al. 2000). It is not surprising that universities began to be seen as a cheaper substitute for internal R&D.

These changes led to new ways in which industry cooperated with universities. In the 1980s, new forms of collaboration emerged in which individual firms, mainly pharmaceutical companies, provide several million dollars a year of research support over several years either to a specific department or for a given topic of their research interest to a university (Table 3-6). Early examples included the $23 million 12-year research agreement between the Harvard Medical School and Monsanto in the 1970s, and the $70 million cooperation in the early 1980s between Massachusetts General Hospital, the

Harvard Medical School and Hoechst G.A., a German chemical company (Bowie 1994). In the 1990s, large alliances continued to appear with increased regularity. Nationally, the most well known example was the Novartis deal for Berkeley, which resulted in campus-wide opposition in 1998 (Press and Washburn 2000). However, MIT's experience in strategic alliances is unparalleled, as it now has 9 large-scale multiple-year "strategic partnerships" with major corporate sponsors, ranging from $3 to$7 million per contract per year, with a minimum commitment of 5 years. In contrast to the early strategic alliances which were all connected with the pharmaceutical industry, MIT broke new ground in partnering with other types of industry, including manufacturing and finance.

Table 3-6: Major strategic alliances

Year	Company	University	Size
1974	Monsanto	Harvard	23.5M in 12 years
1981	Hoechst G.A.	Mass General Hospital and Harvard	70M in 12-19 years
1981	Johnson & Johnson	Scripps	120M in 16 years
1982	Monsanto	Washington University	100M in 12 years
1983	Monsanto	Oxford	20M in 5 years
1985	FIDIA	Georgetown University	60M in 20 years
1987	Squibb	Oxford	32M in 7 years
1989	Squibb	ULP	47M in 7 years
1989	Shiseido	Mass Gen Hospital	85M in 10 years
1991	Eisai	University College of London	75M in 15 years
1991	Sandoz	Harvard	
1994	Amgen	MIT	30M in 10 years
1997	Merck	MIT	15M in 5 years
1997	Ford	MIT	20M in 5 years
1997	Sandoz	Scripps	300M in 16 years
1998	NTT	MIT	18M in 5 years
1998	Novartis	Berkeley	25M
1999	Merrill Lynch	MIT	20M in 5 years
1999	DuPont	MIT	35M in 5 years
1999	Trivoli Systems	University of Texas	6.5M in 6 years
1999	Microsoft	MIT	25M in 5 years
1999	IBM	University of Ottawa	7M
2000	Nanovation	MIT	90M in 5 years
2000	HP	MIT	25M in 5 years

Source:(Bowie 1994; Etzkowitz and Webster 1998; Webster 1998; Press and Washburn 2000), MIT press releases, University of Texas News& Publications,

3-2. UK

3-2-1. Historical background in national R&D

Emergence of the dual funding structure. For a country that prides itself in having led the world in the industrial revolution, it was hard for it to understand that its industrial base had decidedly declined relative to other countries by the middle of the 19^{th} Century (Walker 1980). Indeed, it was somewhat of a shock to the British government when World War I forced them to recognize the nation's weaknesses in manufacturing in comparison with Germany. A dual funding structure of science was established in the early 20^{th} century, in recognition of the need for stronger science and technology. (Gummett 1991). The Department of Scientific and Industrial Research (DSIR) was established to operate government laboratories, to administer industrial research association schemes and to award grants to postgraduate students and universities (Gummett 1991) with the objective of serving social and economic needs. In 1918, the Haldane committee was commissioned to review the machinery of the British government, and recommended the need for the government to access "intelligence and research". More specifically, it was proposed that no administrative department should be responsible for research that had implications for multiple departments, to ensure that there will be no administrative biases. As a result, research councils were established: the Medical Research Council (MRC) in 1920, the Agricultural Research Council (ARC) in 1931, and the Nature Conservancy in 1949. Haldane's idea began to be interpreted in an exaggerated form: it became the Haldane principle of research council autonomy. The result was the growth of government funding that gave science autonomy, through four research councils.

In 1919, the University Grants Committee (UGC) was established to provide annual general funding for teaching and research in universities (Rahm, Kirkland et al. 2000). The structure of dual funding for research as exists today was thereby established, comprising some general institutional funding for research to universities from the UGC and specific research grant funding from research councils.

The effect of World War II. World War II further strengthened government-science ties through wartime efforts on radar, jet engines and atomic energy (Gummett 1991). However, the wartime experience was critically different in the UK from the experience in the US for two reasons. First, scientists were assembled outside the universities and summoned into military research groups organized around the country; thus the first thing that scientists had to do during the immediate postwar period was to scramble back to the universities and to initiate activities that had been stopped in the intervening years. Second, some of the key research activities were taken outside the country, most notably to the US, as the war intensified. The most well known example is that of radar technology, where the British had a slight lead (Snow 1961). In August 1940, the famous Tizard mission left the UK for the US with a black suitcase that contained the most up-to-date radar technology in order to expedite the development of this critical technology, which helped win the war. The UK scientists were therefore part of the research efforts in the US rather than in their motherland.

Nevertheless, the postwar period was a "golden era" for science for the UK with strong government support. In 1949, the government created the National Research Development Corporation, the predecessor to the British Technology Group, whose main function was to provide funding for inventions. The British golden era, however, had its own twist: government funding was heavily focussed on defense and a handful of big civilian projects such as nuclear energy and aviation technology. While the total government expenditure on R&D grew from 10 million pounds in 1939 to 76 million pounds in 1945, 60 million of the latter was in defense, with only 9 million in civil R&D and 7 million in universities. While government funding still dominated civil R&D, industrial funding grew from about a quarter of the national total in 1955-56 to more than a third in 1961-62. It should also be noted that while the government was the biggest funder of science, research was actually largely conducted by industry. (Gummett 1991; Williams 1991)

In the 1960s, the need to prioritize became an increasing concern. It was becoming obvious that science was expensive. The research councils were put under the Department of Education and Science (DES), so that the department would have a coordinating function across them – though transferred to the Department of Trade and Industry later. In 1971, the Rothschild report came up with the famous "customer-contractor principle," in which government departments should pay for research for which they were the customers and should decide on the content of research. The report recommended that such a principle should apply not only to department-funded research, but also to 25% of research council funding. This latter recommendation was implemented through transferring research council budgets to departments, and provided a considerable shock to the research community in their perception about availability of funds for open-ended science.

The 1970s were a tough period of economic stagnation for the UK, in spite of repeated attempts by successive governments to set a growth path. The worsening conditions with high inflation and unemployment culminated in the intervention by the International Monetary Fund, a rare occasion when an OECD member has required such assistance. With the change of government in 1979, Margaret Thatcher introduced tough monetarist policies on the nation, with an overriding goal to free the economy and to shrink the role of the government.

For universities, however, it was more than a simple shrinking of the government role. The memory that, in the 1970s, universities had rebuffed policy makers' demands that they should become more accountable was still fresh among government officials[1]. To make it worse, the Thatcher government saw universities as the stronghold of leftist intellectuals, who represented all economic ills. The 1980s were a long decade of shrinking government support for universities, with increasing requirements for reporting and rigorous review. The Research Assessment Exercise was introduced in the mid

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[1] As exemplified by Labor Minister Shirley William's 13 points of demand made to universities which were completely ignored by the universities.

1980s along with new formula-based funding that linked government funding to numbers of students and to research quality (Hatakenaka 1999). In the broader research sector, an annual review was introduced for government-funded research. The British Technology Group was disbanded in 1986 to decentralize the responsibility of commercialization, and some of the government laboratories were privatized (Cunningham and Nicholson 1991; Gummett 1991).

It was also during the 1980s that the issues of selectivity among scientific fields and of exploitability surfaced in policy debate. A study group under ACARD, chaired by Sir Charles Reece, Director of Research and Technology, ICI Chemicals, was established in 1986 to report on major areas of science with large impact. An international comparative study commissioned from John Irvine and Ben R. Martin of SPRU showed how other countries addressed questions about priorities for science. The resulting group report was focused much more on the process of prioritization than on the actual identification of priority scientific fields. In practice, it took almost a decade before the Technology Foresight Program was established through the 1993 government White Paper, entitled "Realizing Our Potential." The Foresight Program was initiated through 16 field-specific panels which were to review areas of relevant science; its results have had an impact on focusing government funding in their programs (Rahm, Kirkland et al. 2000).

3-2-2 Changing University-industry relationships in the UK

In the UK, the overall pattern of change is similar to that in the US, albeit on a smaller scale and appearing with a slight lag as shown in Table 3-7. According to a study by HEFCE and DTI in 1999, which appears to be one of the first reports in which government made a serious effort to produce reliable time series data of industrial funding of research,[2] the share of UK industry's contribution to total research revenues grew steadily from 5.6% in 1985 to 6% in 1995 and 7.1% in 1999. Indeed, there is a continuing strong trend of increases as the level of research support by industry grew by almost 40% between 1995 and 1999, a much larger increase than from government or EU sources. Since industrial support for research is highly concentrated among a small number of institutions(the top seven universities accounted for over a third of total revenues from industry (Howells, Nedeva et al. 1998), much more dramatic changes might be expected in these highly research-oriented universities.

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[2] Consistent data are hard to obtain, partly owing to major historic developments that disturbed the time series, such as the polytechnics becoming universities, and slow evolution of data collected by the government on industrial funding. It was not until the early 1990s that industry funding of research became regularly reported in government statistics in the early 1990s. Even then, the key item has to do with revenues from the UK industry and do not include foreign industry.

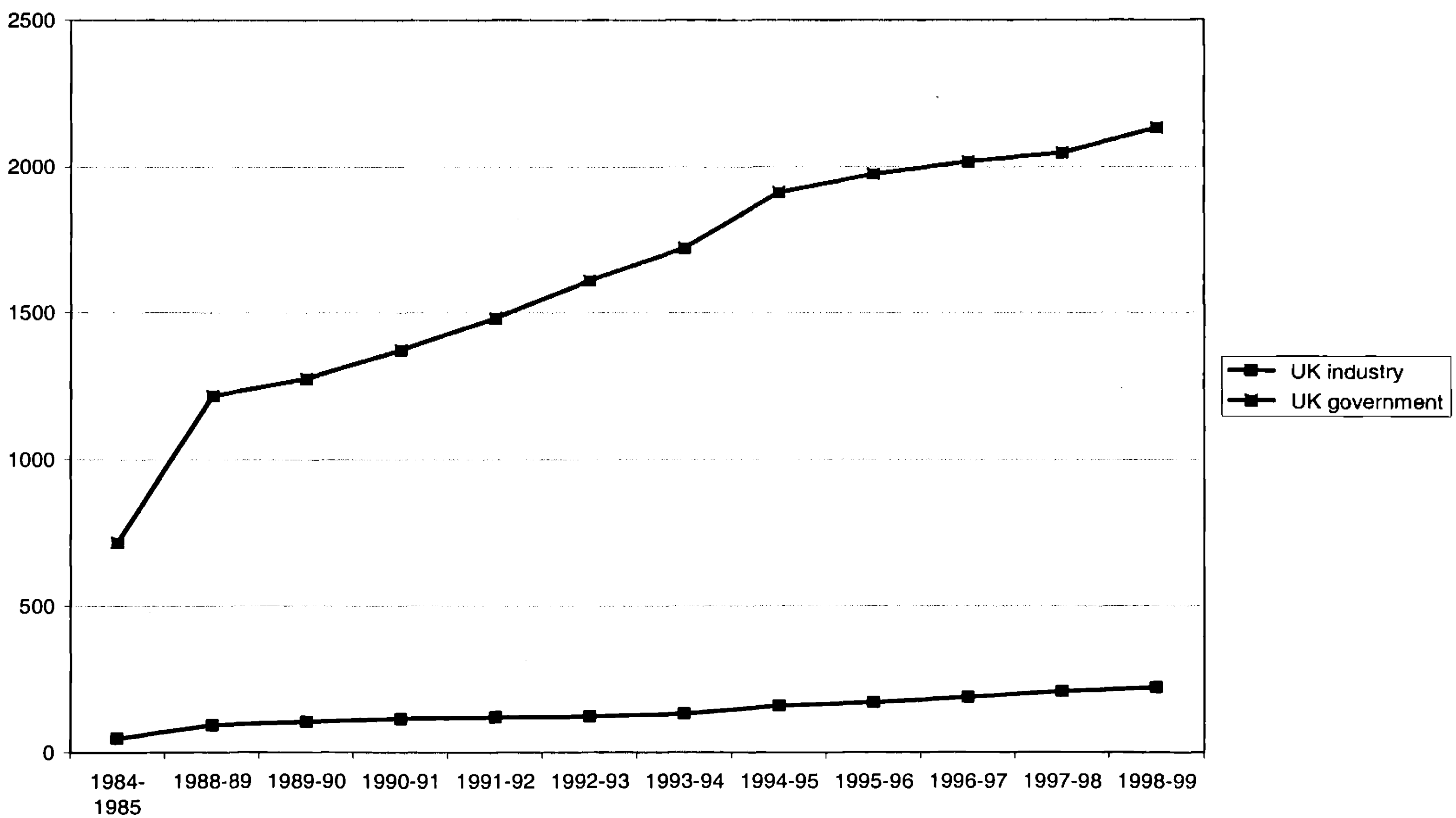
Table 3-7: Research funding for higher education institutions in the UK

£ million	1984-1985	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Research infrastructure												
Research Councils (1)	148	81	91	104	111	133	145	150	156	168	175	173
HEFCs (2)	505	830	830	863	950	963	968	1017	1017	1028	1033	1085
Research grants and contracts												
Research Councils (3)		203	250	284	292	372	460	502	533	525	534	560
Government Depts	64	102	103	121	128	142	149	244	270	297	306	316
UK industry	48	92	104	114	120	121	130	158	170	188	207	221
EU bodies		n/a	38	48	58	76	97	145	148	158	170	184
Other overseas (4)	58	n/a	42	49	52	54	53	56	59	69	79	91
UK based charities (5)		131	154	194	219	246	290	313	338	364	399	429
Other finance (6)	36	30	48	53	59	66	66	40	38	42	39	34
Subtotal	170	558	739	863	928	1077	1245	1458	1556	1643	1734	1835
Grand total	859	1469	1660	1830	1989	2173	2358	2626	2729	2838	2941	3093
UK government	717	1216	1274	1372	1481	1610	1722	1913	1976	2018	2048	2134
UK industry as % of research grants and contracts	28.2%	16.5%	14.1%	13.2%	12.9%	11.2%	10.4%	10.8%	10.9%	11.4%	11.9%	12.0%
UK industry as % of total research support including infrastructure support	5.6%	6.3%	6.3%	6.2%	6.0%	5.6%	5.5%	6.0%	6.2%	6.6%	7.0%	7.1%

Source: DTI, Science and Engineering Statistics, HEFCE Review of Research 2000

HEI data – Before 1994–95 data refer to the 'old universities' (source USR): all other HEI data are from HESA and are for academic years.

Fig 3-2: Research support in the UK (million pounds sterling)



University interest in working closely with industry is also shown in the establishment of science parks. The number of science parks grew from one in 1970 (in Cambridge) to 2 in 1980, to 40 in 1992 and about 50 in 1997(Howells, Nedeva et al. 1998).

Government funding. In the UK, there have been many policy initiatives that directly or indirectly have sought to promote university-industry relationships. The singularly important event that led to the fast growth of such relationships in the 1980s, however, is the budget tightening of universities under the Thatcher government (Cunningham and Nicholson 1991). In 1981, the government announced an average 15% cut in the budget over the following three years, which was implemented unevenly, with the top ranking research universities receiving less heavy cuts. Overall, there is no doubt that the 1980s were a period of severe cutbacks in government funding for higher education (Williams 1992). Even in the 1990s when the overall level of government funding started to increase, the effect was not felt by all universities since the increases were allocated preferentially to those institutions which were expanding, and universities continued to perceive that increases in government support were inadequate given massive enrollment expansion. There was a widespread sense of crisis within the higher education community, which led to serious reflections about the way individual universities were organized and managed and led ultimately to university-level efforts to strengthen their ability to manage finances. Diversifying funding sources became a key activity for most universities (Hatakenaka 1999).

Government special programs. The government has also been encouraging universities to serve the economic needs, through several funding programs such as the Cooperative Awards in Science and Engineering (CASE) and LINK whose objectives were explicitly to strengthen university ties with industry. (See Table 3-8 for the summary). CASE is a program that provides subsidy support for graduate students undertaking projects in industry. Another well established scheme is the Teaching Company Scheme (TCS), that has been in operation since 1975. TCS provides funds for academics to provide technology transfer support to companies through students, and is unusual in providing support for near-market activities. The LINK programme was established in 1986 as a grant scheme to support pre-competitive research partnerships between UK industry, universities and other research institutions. In its 12 years of operation, over 1,300 LINK projects have been supported with over 500 million pounds invested. There have been many other government funding schemes including support for establishing interdisciplinary research centers that have explicitly targeted to foster industry-university linkages.

In May 1993, the previously mentioned government report entitled "Realizing our potential" was submitted to Parliament, and set the scene for further government programs including those for collaboration between industry and universities (Anonymous 1993). The report identified the national need to bridge the gap by "developing stronger partnerships with and between science and engineering communities, industry and the research charities," and proposed a set of reform measures. Included were the re-organization of research councils to reflect greater sensitivity to the

Table 3-8: Chronology in the UK

Year	Events	Policy content
1971	Rothschild report	The customer-client principle emphasizing the role of the departments in becoming active contractor of applied research
1975	Teaching Company Scheme (TCS)	By DTI. Provides for industry-based training, supervised jointly by personnel in the universities and industry
1986	Privatization of the British Technology Group	Ownership of patents arising from government sponsored research was to be decentralized to universities
1986	Research Assessment Exercise by the UGC	The introduction of formula-based funding for research infrastructure as distinct from funding for teaching, to be based on performance
		Government established the principle not to support near-market research with public money
1988	The LINK program	The LINK program started as the government's main mechanism for supporting collaborative research partnerships between UK industry and the research base.
	Cooperative awards in science and engineering (CASE)	Cooperative awards in science and engineering (CASE) started by research councils to support post graduate students in projects of joint interest to industry and higher education
1992	Further and Higher Education Act	Polytechnics were upgraded to become universities, intensifying the sense of competition for higher education funding
1993	Realising our potential	Realising our potential – the white paper from the government published
1994	The ROPA scheme	The ROPA scheme initiated by research councils to reward researchers who have received substantial financial support from the UK private sector for basic and strategic research.
	Foresight awards by Royal Academy of Engineering for R&D projects	Foresight awards by Royal Academy of Engineering for R&D projects
	Biotechnology Exploitation Platform Challenge	By DTI. Aims to encourage the syndicates of universities and intermediaries to work together to build a portfolios of intellectual property.
	Joint Research Equipment Initiative by HEFCE	By HEFCE. To support research infrastructure/equipment in HEIs while promoting partnership with external sponsors of research and industry
1997	Faraday partnerships	Faraday partnerships started
1998	Competitiveness White Paper	Competitiveness White Paper
	Science Enterprise	Science Enterprise
1999	The Higher Education Reach Out to Business and the Community (HEROBAC)	By HEFCE. Competitive funding to support higher education institutions to create the conditions and support structures for more effective links with industry
1999	The University Challenge competition by DTI	By DTI. To set up seed funds to support early stage commercialization
2000	Higher Education Innovation Fund	By DTI and HEFCE jointly, incorporating Higher Education Reach Out to Business and the Community (HEROBAC)

application of science and technology; the establishment of Foresight technology forecasting panels involving both industry and university participants; and the initiation of new government programs, entitled ROPA awards, to reward principal investigators who had good collaboration records with industry. Existing programs such as LINK and TCS, as well as new programs, became focused on technological fields as identified by Foresight.

Partnerships. Although unrelated directly to these policy initiatives, large scale partnerships began to be reported in the late 1990s, starting with universities with strong engineering departments such as Cambridge and Imperial College, though some deep ties may have existed even before without being advertised (Howells, Nedeva et al. 1998). For instance, Microsoft opening a lab in Cambridge was one of the most heavily reported partnerships, but there have been a number of other instances where large companies have formed strategic partnerships with universities, for example through establishment of their R&D laboratories close to the campus. Unilever developed partnerships with both Cambridge and Imperial College, where they developed umbrella agreements within which various projects were funded. Rolls Royce have established a number of University Technology Centers around the country.

Licensing activities by universities became prominent after the break-up of the British Technology Group in 1986, a break up which was in effect the British equivalent of the Bayh-Dole act. One interesting difference from the American case was that the regulatory changes did not include provisions for the tax-status for university licensing activities. Whereas royalty incomes by universities did not conflict with the non-profit status of universities in the US, there was no clear tax provision in the UK for other forms of income. As a result, most universities found it necessary to establish private companies outside the university, wholly owned by the university, specifically to deal with licensing transactions. This was one practical way of avoiding possible problems with university charity status. In 1997, over half of the 123 HE institutions surveyed by PREST had such wholly owned or partially owned companies to exploit Intellectual Property Rights (IPRs) (Howells, Nedeva et al. 1998) [3]. The same survey showed that the number of UK patents granted to HE institutions grew from 45 in 1996 to 56 in 1997, with the number of new licenses rising from 139 to 177(Howells, Nedeva et al. 1998). The total IPR income remained stable at about 11 million pounds (or 18 million US dollars) in both years. These are still modest figures when compared with the 21 million US dollars that MIT raised in 1997 through its technology licensing office.

In 1985, a report entitled "The Cambridge Phenomenon" was published by a private consulting firm, providing documented evidence on the regional network phenomenon around Cambridge, similar to Sillicon Valley and Route 128. The report provided detailed qualitative and quantitative accounts of the university's contribution to the phenomenon of highly concentrated technology start-ups (Segal Quince Wicksteed

[3] The study by PREST covered 78% of 109 UK universities and 59% of 64 higher education colleges. Since collaboration with industry tends to be concentrated within universities, the lower coverage of higher education colleges is unlikely to be a major source of bias.

1985), and concluded that the informal networks around the university were critical to the phenomenon. Overall, there are conflicting reports about the number of spin-offs. The PREST study found that the number of spin-offs reported was relatively low at about 20-30 annually between 1993 and 1997. The survey for the Office of Science and Technology, on the other hand, identified as many as 223 wholly owned businesses spinning out from UK universities in 1997/98 (DTI 2000), with many more that are partially owned or loosely affiliated with university technology.

Economic upturns in the 1990s have not reduced the government focus on innovation issues. The first Foresight report in 1995 recommended further linking of government funding to strategic areas. In the Department of Trade and Industry (DTI), a new unit was established to focus on innovation issues, in which university-industry linkages have been one of the primary interests. In 1998, DTI issued a competitiveness White Paper calling for greater partnership between industry and scientific sectors. Programs to support collaborative research have increased further. In 1999, DTI, DfEE and HEFCE jointly initiated a Higher Education Reach Out to Businesses and the Community (HEROBAC) to encourage universities to develop better internal capacity to promote collaboration with industry and to ensure effective technology transfer. In 2001, this program was further developed into a University Innovation Program – with government commitment to continue funding.

In 1999, the first round competition for University Challenge was organized by the Department of Trade and Industry (DTI) to provide government resources to set up local "seed" funds to support the early stages of commercialization of academic research. A total of 45 million pounds was made available, comprising 25 million from the government, 18 million from the Wellcome Trust and 2 million from the Gatsby Charitable Foundation. The University Enterprise Fund was also established to support universities to establish entrepreneurship training. In November 1999, the UK Chancellor Gordon Brown announced the government special initiative to support the partnership between Cambridge University with MIT, in order to introduce a more entrepreneurial culture into the British university system.

Economic circumstances and industrial research. Sluggish economic performance was one preoccupation for successive governments in the postwar UK and well into the 1980s. In the early years, various policies including nationalization of key industries and massive investments in projects such as nuclear energy and aviation were taken, in the hope of rekindling economic growth. Most performance indicators of dynamism and innovation such as export share or patenting show that British industry was in serious trouble by the mid to late 70s (Pavitt and Soete 1980). The story of the Thatcher government making a complete turn-around in national policies in promotion of the private sector, the privatization of previously nationalized industries and reducing government interventions and subsidies is well known. Her policies led to an inflow of foreign firms, most notably in the automobile industry, and to a steady decline of domestic defense and telecommunications manufacturers as a result of the reduced government support (Patel and Pavitt 2000).

These economic circumstances had important implications for the development of university-industry relationships. There were few vibrant domestic companies looking for scientific ties, but instead, UK universities were to meet an increasing number of foreign firms, most notably from Japan, with interest in locating their R&D facilities in the UK. The number of Japanese R&D facilities in Europe grew from 70 in 1990 to 250 in 1994, with nearly a quarter of them in the UK (Freeman and Soete 1997). The overall consequence was the slow de-coupling "between the national science base in the UK on one hand and both large UK owned firms and the UK production activities of foreign owned firms, on the other. Instead, links have strengthened between the UK science base, and both small UK based firms and foreign firms with R&D activities in the UK." (Patel and Pavitt 2000).

3-3. Japan

3-3-1. Historical backgrounds and national R&D

What characterizes the history of Japanese national universities in general and Tokyo University in particular is the centrality of their role in national development at the time of their birth. Indeed their birth predates the development of any other national research institutes. In the 1870s, various faculties, which later became Tokyo University, were developed with massive infusions of foreign scholars as well as overseas scholarships, with a view to creating organizations to train the critically needed technical expertise for the country, both within government and in industry (Bertholomew 1989). Such drastic measures were important because Japan saw a tremendous national need to catch up quickly with Western science and its applications. The underlying fear was one of colonization that swallowed up many of less developed economies including China. University help for industry was not uncommon (Odagiri 1999). There are many corroborating tales: it was a professor of Tokyo University who founded Toshiba, for example, and the new iron mills also had substantive help from Tokyo University professors (Odagiri 1999). The tradition of collaboration continued through the pre-war period, when there were both significant industrial funding of universities and consulting ties between professors and companies (Bertholomew 1989; Hashimoto 1999).

During World War II, virtually all university and industrial scientific researchers of relevant disciplines were mobilized for military purposes(Rahm, Kirkland et al. 2000). There was a significant expansion of education and research facilities in engineering fields, as exemplified by the establishment of a second engineering faculty at Tokyo University. Many thematic research groups were developed on critical topics, which included members both from universities and from industry (Hashimoto 1999). Though university researchers made important contributions to military technology, towards the end of the war, many younger men were pressed into military combat duty, constraining further developments (Rahm, Kirkland et al. 2000).

In Japan too, the post war experience has had a lasting influence on the role of university research in relation to industry and to government. However, the influence worked in the opposite direction. In striking contrast to the US, where the wartime success was translated into peacetime government support of university research, Japanese academics faced the defeat with a profound loss of face. Their war-time role of supporting the military government was a cause of deep shame. The General Headquarters of Allied Powers in Japan (GHQ) quickly eliminated laboratories that had supported military technology, and required all scientists to report their wartime research role (Rahm, Kirkland et al. 2000). For example, aeronautical research was forbidden (Hashimoto 1999) and an institute attached to Tokyo University had to reconstitute itself immediately as the Science and Engineering Institute. Interestingly, it is not clear if this technological purge actually led to dismissal of people or disbanding of research activities, as witnessed by the fact that the same institute re-constituted itself back into the Aeronautical Research Institute about a decade later (Nano 1991).

The main lessons learned by academia were to be wary of government influence, and to dissociate themselves both from the government and from industry. The main thrust of reform for the university system in the post war period was to create an independent and autonomous academic organization. Interestingly, several rounds of attempted legal reforms to grant separate legal status to national universities since the war were aborted on the grounds that they would jeopardize university autonomy (Kuroha 1993; Hada 1999). The years when universities were dissociating themselves were also the years when new industrial activities were springing up all over Japan. Hashimoto (1999) describes how Japanese industry in the post war period dealt directly with foreign technology suppliers, through the purchase of patents and consulting services, thereby eliminating the need for academics to act as intermediaries as they had done during the pre-war period.

The post-war isolation of universities had a huge cost: industry developed by itself and built internal research capacity rather than relying upon universities. Table 3-9 shows that in Japan, industry began to foot a higher proportion of the R&D bill from the early days. In 1971, industry funded 65% of R&D in Japan as compared with 39% in the US or 44% in the UK, although by 1999, the difference narrows with 74% in Japan, 67% in the US and 47% in the UK. The trend of universities as performers of R&D is less clear, as the OECD data do not provide a consistent time series. However, the university share of R&D performance in Japan appears roughly the same as in the other two countries.

In the 1960s, there was a brief period when the need for collaboration surfaced again, but this was crushed during the student unrest in the late 1960s. Unlike in the US, where the principal target of the student unrest was the university-military connection, the Japanese students rebelled against American influence, capitalism and corporate control over universities. It was perhaps not until the early 1980s that the stigma attached to university-industry relationships disappeared. By the 1980s, Japanese R&D activities were heavily concentrated in companies, with few ties to universities.

3-3-2. Changing university-industry relationships in Japan

According to the Ministry of Education and Science (MOES) statistics, university-industry collaboration has come a long way. As shown in Table 3-10, the data demonstrate rapid increases since the early 1980s through published figures and graphs which show: (a) joint research projects between public universities and industries which are usually based on the placement of researchers on campus; (b) contracted research which includes all research projects in public universities that were supported by non-MOES sponsors; and (c) scholarship donations given by private bodies to public universities. Indeed, these figures provide a rosy picture of robustly rising collaboration, as shown in Fig 3-2.

Particularly impressive is the contrast between rapidly rising contracted research on the one hand and stagnating scholarship donations in the late 90s. There has been a steady and rising trend in the number of the Joint Research projects throughout the period since 1983 when the Joint Research scheme was introduced, whereby the government was to make joint contributions for industrially supported projects.

Such published statistics disguise rather than demonstrate the true state of university-industry collaboration. "Contracted research", which the MOES treats as representing university-industry relationships, actually overstates the level of collaboration with private industry, particularly in the last 5 years when contracts with non-profit semi-governmental agencies have increased significantly. There are two confounding factors that are likely to have led to what appears to be such a simple error. National universities are legally part of MOES, and therefore cannot receive public funds from other governmental ministries directly. As such, all the contracted research funds from other government sources actually come through special non-profit bodies, which are technically not part of the government, and therefore count as "private" and hard to distinguish from, for example, non-governmental industry associations. There is also likely to be a pervasive mentality within MOES that divides the world into "us, the national universities and a governmental ministry" versus "them, anything that is external to us."

MOES is becoming aware of this data problem and has just compiled disaggregated data for the past three years. These figures, as well as the detailed unpublished breakdown, show that (a) the percentage of contracted research with private industry has fluctuated between 15-19%; the largest increase was seen in the amount of contracted research with public bodies and corporations, which rose sharply from 280 in 1994 to 912 in 1996; and (b) the volume of contracted research with private industry in the last three years was quite low, and at a similar level to those in the early 1990s, indicating that there has been little increase. Once the image of huge increases in contracted research is shed, then the picture of university-industry relationship shows becomes one of stagnation, as another important category of industry source income, scholarship donations have also been stagnating in the past 5 years.

Table 3-9: Structural Change in the national R& D system 1971-1998

		Source of R&D finances (%)											
		Industry				Government				Other sources			
		1971	1981	1991	1998	1971	1981	1991	1998	1971	1981	1991	1998
USA		39.3	48.8	57.5	66.7	58.5	49.3	40.5	29.8	2.1	1.9	2	4
JAPAN	A	64.8	62.3	73.1 b	73.4 C	26.5	26.9	18 b	19.7 D	8.5	10.8	8.9	6.8 d
UK		43.5	42	50.4	47.3	48.8	48.1	34.2	31	2.3	3	3.6	21.6

		Share of R&D performance (%)											
		Industry				Government				Higher Education			
		1971	1981	1991	1998	1971	1981	1991	1998	1971	1981	1990	1998
USA		65.9	70.3	72.8	74.6	15.5	12.1	9.9	7.9		14.5	15.4	14.4
JAPAN	A	64.7	66.8	70.9 b	71.9 D	13.8	11.1 d	7.5 d	9.2 D		24.2 c	17.6 c	14 d
UK		62.8	63	65.6	65.8	25.8	20.6	14.2	13.3		13.6	15.6	19.6

Source: Mowery 1998, OECD 2000

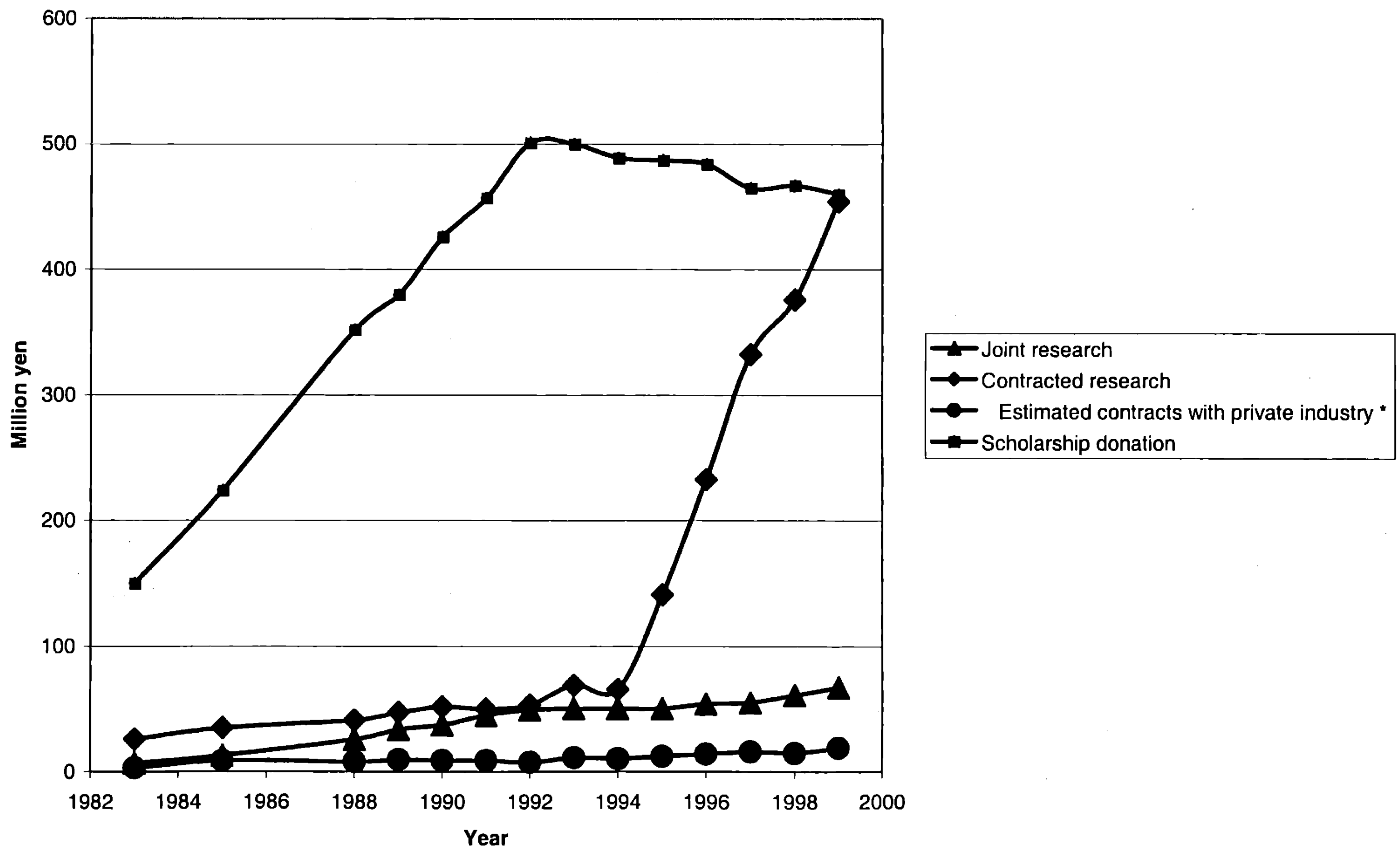
a Discontinuity in time series between 1971 (Mowery) and 1981-1998 (OECD)
b 1990 figure
c Overestimated.
d Underestimated

Table 3-10: Research funding for national universities in Japan

Year	1983	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Joint research	6.8	12.9	37.5	45.1	49.5	50.3	50.3	50.3	54.2	55.4	61.3	67.6
Contracted research	26	34.9	51.7	50.1	53.3	69.1	65.7	141.1	232.6	332.6	376.1	454.17
% private industry in number	12.8%	25.4%	17.5%	18.0%	14.5%	16.4%	16.0%	18.2%	18.4%			
Estimated contracts with private industry *	3	9	9	9	8	11	11	12 *	14 *	16	15	19
Scholarship donation	150	224	426	457	501	500	489	487	484	465	467	460
Industrial donation/contribution	160	246	473	511	558	562	550	550	552	536	543	547
Science research grant (kakenhi)												1314
Research infrastructure grant (sekisan)												1576
Total research funds												3872
% of industrial research funds												14.1%
Total research in universities		17898	22970	24079	25763	27587	27526	29822	30131	30592	32229	33954
% of industrial research funds			2.06%	2.12%	2.17%	2.04%	2.00%	1.84%	1.83%	1.75%	1.69%	1.61%

Source: Monbusho Gakujuchukokusaikyoku, Kiso data shu, May 1998, January 2001
Monbusho Gakujutsukokusaikyoku, Sangakurenkeino suishin, April 2000
* Up to 1994, estimated based on the ratio of the number of industrial contracts to the total number of contracts. For 1995-6 estimated as a straightline fit between 1994 and 1997. For 1997-1999, actual figures.

Fig 3-3: Industry related research funding in universities in Japan



There is another problem with the statistics from MOES: they exclude all activities by private universities and by local government-supported public universities. While national universities are stronger in science and engineering than private universities, there are only 100 national universities as compared with 400 private and 100 other public universities. It is difficult to justify such an omission, especially when there are some private universities that are known to be research active. Waseda and Keio both have significant scientific research and therefore great potential to work with industry. Tokai University and Ritsumeikan are known to have been aggressively pursuing university-industry relationships, with the former starting patenting and licensing activities in the 1960s, and the latter through its innovative approach to working with small and medium industries in the 1990s (College Management 2000). Clearly, the story of national trends cannot be told without a more accurate examination of these large omissions.

Government funding. Unlike the US or UK, Japanese universities never had a golden period of government funding, in spite of their "national" status. Similar to the UK, however, they did face severe budget tightening during the 1980s, when national universities, along with other government departments, were subjected to "zero ceiling" or the policy of no increases in budgets. The tight financial situation of Japanese universities is reflected in the fact that as late as 1997, government spending on higher education was 0.5% of GDP as compared with 0.7% in the UK and 1.1% in the US (OECD 2000). The belt tightening of the 1980s was disproportionately borne by reduced capital investments (Kaneko 1989; Kaneko 1995). While science and research funding has been moderately growing throughout the period, this has not been sufficiently large to counteract the tight conditions in the base budgets. The situation finally began to improve in the 1990s, particularly in 1996 with the adoption of the Basic Science and Technology Promotion Plan, which called for appropriation totaling 17 trillion yen before 2000.

Government policies for promoting university-industry relationships. The public debate about the need to build domestic capacity for developing frontier technology started in the late 1970s. The gradual shift in Japanese government policies is summarized in Table 3-11. In the 1980s, the Japanese government went through the "first wave" of promotion for university-industry relationships (Rahm, Kirkland et al. 2000). In 1980, MITI's report titled "The vision of MITI policies" highlighted the need to move beyond the "catch-up" strategy, one that long characterized Japan's development, towards the development of fundamental science. In the same year, Keidanren called for collaboration between universities and industries (Kobayashi 1998). In 1981, Exploratory Research for Advanced Technology (ERATO) was established by the Science and Technology Agency (STA) as one of the first government programs to support strategic research activities in the scientific sector which were relevant to industry (Irvine and Martin 1984). While the program did not have a specific focus to

Table 3-11: Japan policy chronology

Year	Event	Content	Type
1978	Monbusho regulation on IPR	Clarification of IPR ownership between the government and individual academics	Regulatory change
1981	ERATO Program	By the Science and Technology Agency	Funding
1983	Joint Research Program	By the Ministry of Education and Culture	Funding
1987	Joint Research Center	By the Ministry of Education and Culture	Funding
1995	University Linkages Unit	Established in MITI	Ministerial organization
1995	Basic Science Law	Huge government funding commitment for basic science and technology starting 1996	Funding
1997	Deregulation of external employment of university professors	Enabled civil servant professors to do technical consulting, and to take a leave to work for private R&D initiatives without affecting their retirement benefits	Regulatory change
1997	Report by the Conference for Industry-University Linkages/collaboration in Monbusho	Report by the Conference for Industry-University Linkages/collaboration in Monbusho	Internal report
1997	Greater flexibility in the Joint Research Program requirements	Greater flexibility in the Joint Research Program requirements	Regulatory change
1997	Legal change to permit fixed-term appointments and leaves by Monbusho	Legal change to permit fixed-term appointments and leaves by Monbusho	Legal/regulatory change
1997	Regional consortium for R&D program by MITI	Regional consortium for R&D program by MITI	Funding
1998	University linkages Industrial Science and Technology R&D Program by MITI	University linkages Industrial Science and Technology R&D Program by MITI	Funding
1998	Revision of Research Exchange Promotion Law	Possible land use at a discount by a private enterprise on national university sites	Regulatory change
1998	De-regulation on externally supported research	Consolidation of line item budgets for externally funded contracts and introduction of multi-year contracts	Regulatory change
1998	Law for technology transfer from universities to private entities	So-called Japanese Baye-Dole Law, but enacted to enable special subsidies for TLOs endorsed jointly by MITI and Monbusho	Regulatory change and funding
2000	Industrial Technology Strengthening Law	to simplify procedural requirements for external funding in national universities; legalize TLO use of national facilities, academic discount on patent expenses	Regulatory change and funding
2000	National patent related regulations	Increase in the university share of contracted research or patent income	Regulatory change
2000	Deregulation of external employment of professors	Enabled civil servant professors to work as board directors in TLO, other corporate boards in companies where their inventions are being commercialized, and as an external auditor	Regulatory change

foster university-industry linkages, many university scientists did join ERATO-funded research teams.

One outcome of such activities was to make it public that the system of national university support through the Ministry of Education and Culture (MOEC), the predecessor to MOES, was overly restrictive in terms of the ability to receive funds from outside bodies, including from other government ministries (Rahm, Kirkland et al. 2000). Perhaps spurred on by inter-ministerial competition, MOEC stepped up its activities in promoting science for industrial use. In 1983, MOEC established its first program for joint research between universities and private industries. Starting in 1987, MOEC has also actively supported the establishment of Joint Research Centers with industries.

Interestingly, all of these MOEC programs were targeted at the 100 or so national universities and ignored the 400 plus private universities - which enrolled 80% of the students. This one-sided approach made sense, on the one hand, because scientific and engineering research capacity was concentrated primarily within a handful of national universities. On the other hand, such policies neglected the potential of several strong private universities, as exemplified by Keio which traditionally had a strong medical school, or Waseda which had a traditionally strong engineering school.

MOEC took several other steps to support university-industry relationships in the late 1980s. In 1987, Collaborative Research Centers were established in national universities in order to facilitate collaborative research mainly with local industries in the region. The number of such centers has been steadily rising, and today there are 53 of them. In 1987, the concept of endowed chairs was introduced with the idea of creating new and relevant fields of research, with donations from industry, in order to bring in new faculty members for a fixed period of time. The number of endowed chairs rose from 5 in 1987 to 64 in 1993, though has been stagnating since then.

In order to ensure that national universities can cope with the increased administrative burden of working with industries, MOEC has also been supporting the establishment of new administrative units within national universities since 1988. Today, 5 national universities received additional budgets to establish research collaboration directorates, and 36 national universities have smaller research collaboration sections.

The most critical action on intellectual property rights took place as early as 1978, through a relatively innocuous guideline issued by the Ministry of Education. For inventions made under routine government funding, the intellectual property rights were to be owned by the inventors, while for inventions made under government special programs, the state would own the intellectual property rights (Yoshihara and Tamai 1999). The judgement call as to the appropriateness of ownership assignment was left to university level invention committees. In the absence of tight enforcement mechanisms by the government to pursue licensing or to monitor abuse, these invention committees tended to favor ownership by individual professors. Unless there was critical evidence that inventions were made in government funded facilities, individual professors could claim ownership. This tendency can be seen in the final proportion of patent ownership, about 80% by individual professors and 20% by the government.

University activities in licensing took a new turn with the passage of the Technology Licensing Office (TLO) law in 1999, the so-called Japanese Bayh-Dole, which did not change the legality of university licensing in substance, but endorsed the establishment of university technology licensing offices through government subsidies. There are currently 17 technology licensing offices (TLOs) which have just been established, including 4 in private universities. So far, over 500 patent applications and over 30 licensing agreements have been made by these TLOs.

Economic circumstances. Many of the government programs were set up during the 1980s when there were other factors favoring university-industry collaboration. By 1980, there was awareness among industrialists that further technical innovation necessitated university-industry collaboration, as reflected in a report by Keidanren, an association of employers (Kobayashi 1998). The 1980s also saw a worsening of relations with the US particularly on the imbalance in trade, as well as the so-called "technological friction" which included the alleged free-riding on American science by Japanese manufacturers. This was all happening at a time when Japanese universities were being subjected to severe budget constraints, and the need to diversify sources of funding was being debated. The most natural outcome would have been for Japanese manufacturers to have started to work with Japanese universities.

What actually happened seemingly defies any logic. National universities took hardly any action in the 1980s and Japanese industry went abroad to form stronger ties with foreign universities. One study showed that between 1986 and 1996, Japanese industry increased R&D expenditures abroad six-fold, while domestic R&D expenditures grew by only 50% in nominal terms (Niwa 1999). The same study suggested that there were considerable differences across industrial subsectors in their orientation to R&D, and that communications and electronic equipment were particularly oriented towards foreign sources of R&D. According to Hall, 155 out of 255 foreign R&D facilities in the US in 1992 were Japanese. To give an example, NEC's overseas R&D ventures started with the establishment of a research center in Princeton in 1989, with new sites in Bonn in 1995, and San Jose and Heidelberg in 1998. Many consumer electronics firms took a parallel path or followed suit – with Hitachi, Toshiba and Epson establishing research labs in Cambridge, UK, Sharp in Oxford, UK, Matsushita, Nissan and Mitsubishi in Cambridge, MA, USA. The number of Japanese R&D facilities in Europe grew from 72 in 1990 to 264 by 1994 with 83 of them in the UK (Freeman and Soete 1997).

To say that the national universities did not respond at all would be unduly negative. With the news of Japanese companies donating expensive chairs abroad, NEC at MIT for instance, Japanese national universities did take action. Endowed chairs were established as a new mechanism for companies to donate to national universities. There were modest increases in industrial funding of university research. It was only in the early 1990s that the then President of Tokyo University, Akito Arima, began to appeal to the public about the dire straits of the national universities, as summarized later in his book, "The Story of

Poverty in Universities" (Arima 1996). There was, for instance, a TV program that compared an MIT laboratory and a Tokyo University Laboratory. The political climate gradually eased and led to a fresh focus on basic science and technology in the mid-1990s (Kobayashi 1998).

With the onset of the economic slowdown in the early 1990s, government interest in university-industry collaboration had a new twist. The need to establish a better basis for economic recovery and national competitiveness had an additional meaning in the prolonged recession. The Ministry of International Trade and Industry (MITI) established a unit dedicated to university linkages in 1995, and has been active in promoting new funding schemes and legal and regulatory changes to encourage university-industry collaboration.

3-4. Towards the synthesis

The role of universities in the national R&D systems across the three countries has been converging across the three countries over the last 30 years, with the share of universities in R&D performance in the US and Japan at around 14%, while increasing to a higher level at almost 20% in the UK. The growth in the universities' share of R&D in the UK appears to reflect directly the decreasing share provided by the government. The data on Japan appear too problematic for any conclusive trend analysis. The apparent decline in the role of universities in R&D is puzzling given the renewed emphasis by the government on investing in science and technology since 1996, which should have increased rather than decreased the university share. It is also puzzling that the industry share remains unchanged both as a source of funding and as a performer, given the decade long economic stagnation. It may be prudent to assume that these trends are the artifacts of inconsistent data series, rather than to see them as real.

The level of industrially funded university research shows a steady increase in the UK and US as shown in Fig 3-3, but has been relatively stable for Japan in the past 7 years. Fig 3-4 shows that the share of industry funding in university research appears to be stabilizing at about 7% both for the US and for the UK. In the US, the largest increase was in the 80s and it stabilized in the 90s; for the UK, there was a steady increase throughout the 80s with another spurt in the late 90s. For Japan, there was a steady increase in the 80s but it hovered at a low 2% level in the 90s.

What has been the influence of macro-factors on these trends? In the following section, the overall implications from the analysis of the three countries and the organizational cases are presented in terms of five categories of factors: historical legacy, general levels of government funding, special government programs for collaboration, regulatory interventions and industrial interest.

Historical legacy. World War II was a point of departure for the evolution of science in all three countries in more than one way. In the US, the experience of successful scientific involvement in military technology during the war led to a new paradigm where

Fig 3-4: Industry funded university research index (1985 amount=100)

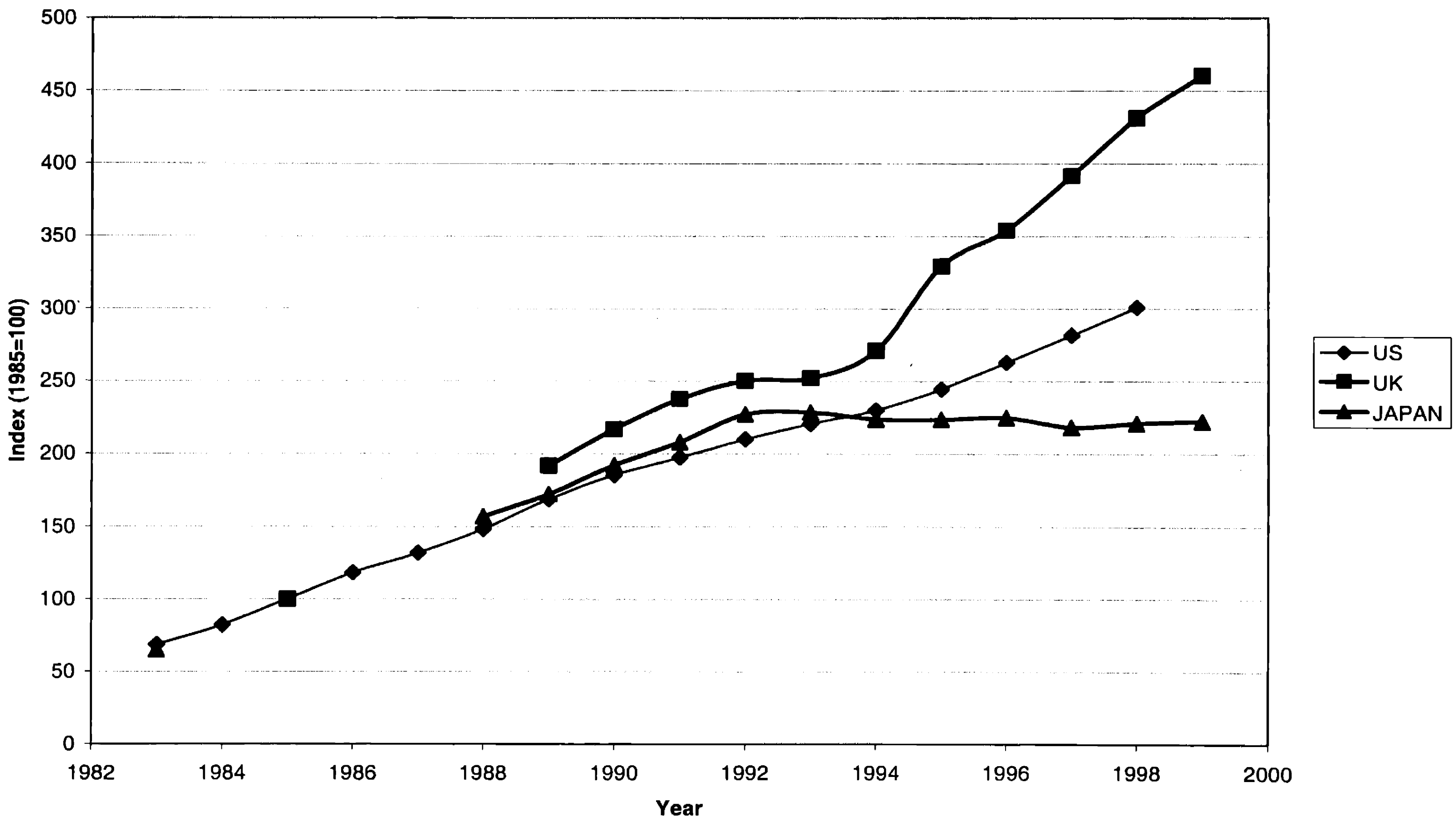


Fig 3-5: Percentage of university research funded by industry

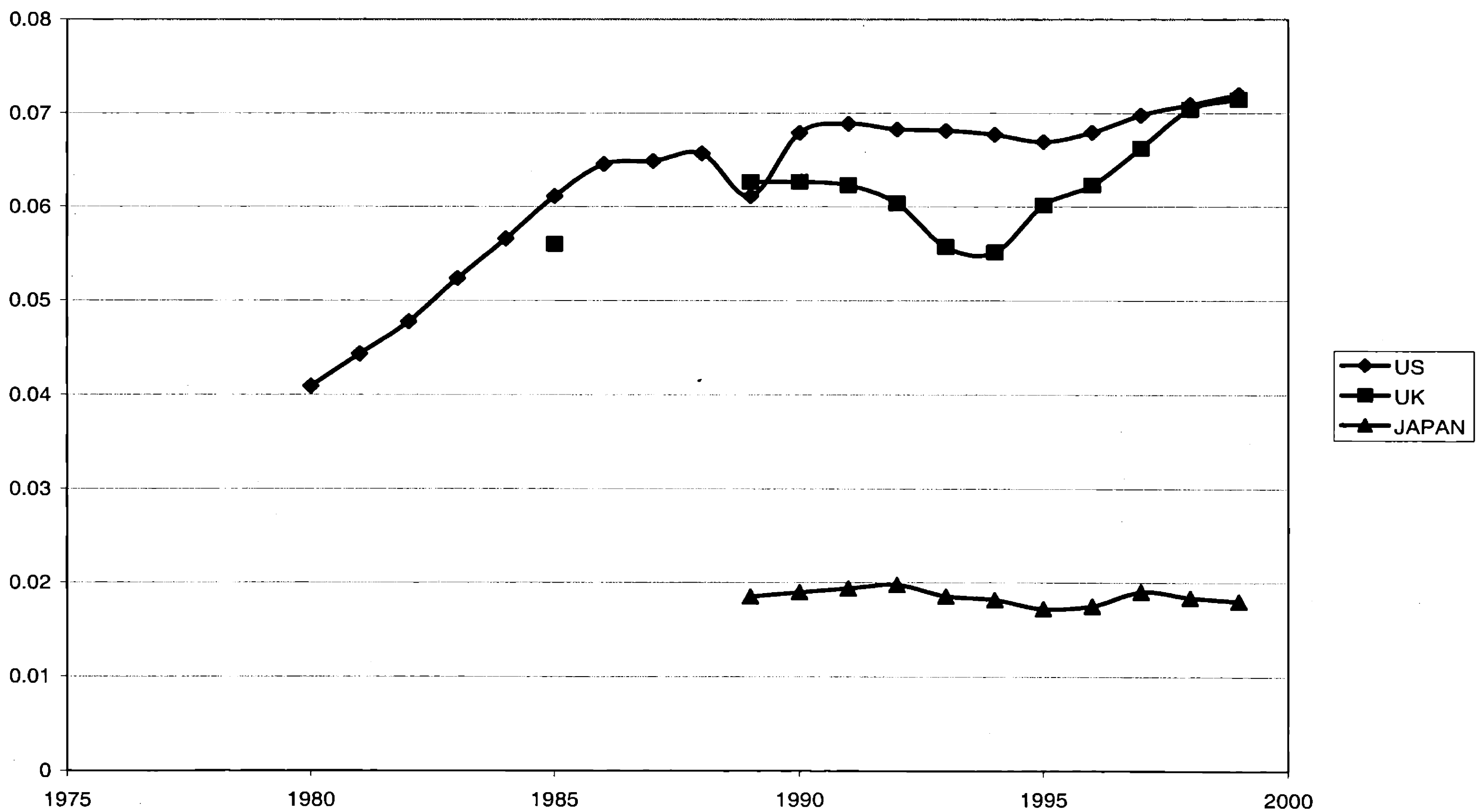
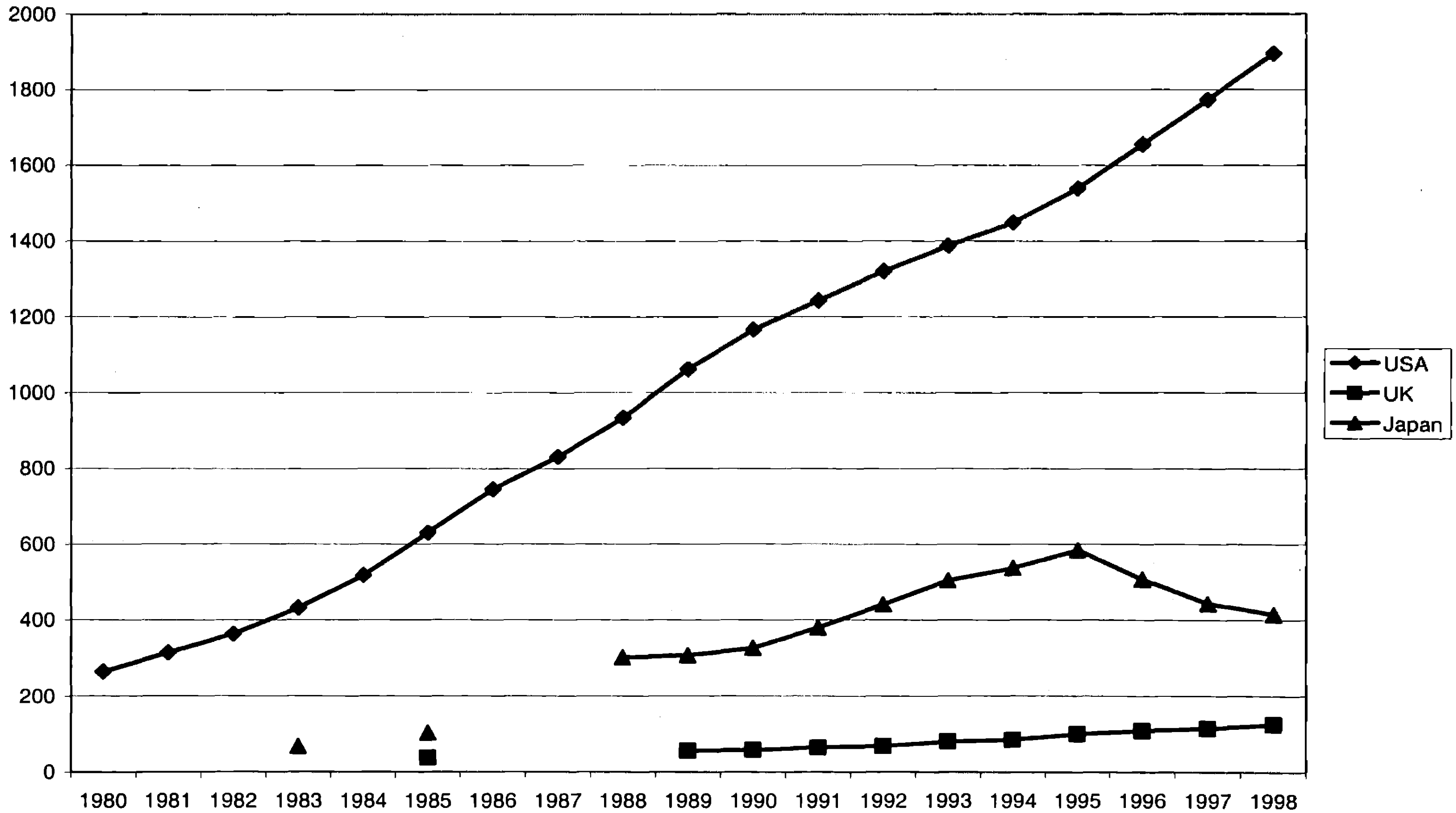


Fig 3-6: Industry support for research (US$ current prices)



science was to be used for peacetime efforts. The trajectory for science in the UK is less obvious – partly as the primary government attention had to be placed upon re-construction of the country and the economy. Nonetheless, the dominant sentiment was that the sciences had proved their worth to society, leading to generous government funding in the subsequent years. For Japan, however, the conclusion reached was quite the opposite. The collaborative effort between the government, industry and universities to develop war technologies was condemned as evil, and universities had to purge their association with such activities. Whereas the radar Lab at MIT was, and is still today, celebrated as a source of national success, the aeronautical research lab in Tokyo University had to be disbanded and re-structured into a new laboratory – to penalize it for its success for air-fighter design during the war.

Both the US and Japan faced new turns in the 1960s as their students became vociferous in criticizing the establishment; large industries and defense were particularly targeted. Many campuses were colored by this new mood. But the effect of these actions was different in each locale. The slow move towards re-establishing university-industry relationships in the 1960s was again shattered and brought back to the starting point in Japan. In the US, the impact of the anti-Vietnamese war movement had the most direct consequence on the military-university connection. Research activities with direct weapons linkages were removed from campus as a result. In the UK, there was less of a student movement, as there were no obvious local causes for political unrest, such as the Vietnam war in the US or the securities treaties with the US as in Japan. Universities in the UK were also less connected to military research in the obvious way that universities were in the US.

World War II and the student unrest are two historical events that appear to have had differential impact on the university-industry relationships in the three countries. These historic events appear to have shaped society-wide values about the role of science and universities. World War II helped create different meanings for the role of science in society. In the US, science was heralded for its wartime success. The belief was that science could lead directly to applications that could improve national welfare. Particularly important was the fact that the role of universities was recognized through projects such as the Radiation Laboratory. There was a massive increase in government funding for university research, including for defense related funding. In Japan, on the other hand, science was to become autonomous from the government as well as industry. The path for the UK was somewhere in the middle: science was regarded as important for application, but subsequent government funding was channeled directly and separately to defense research or specific projects, that were often separate from universities.

Similarly, the student unrest helped consolidate values about what is and what is not acceptable on campus. In the US, secret defense-related research was expelled from campus thereafter, while in Japan, heavy corporate involvement became the target. There was a much gentler backlash in the UK – perhaps because there had been little salient change in the role of universities, either in terms of their relationships with government or with industry.

General funding by the government. What about the role of overall government funding in driving universities to solicit help from industry? The popular view is that if the government provides sufficient funding to universities, they will have little reason to pursue industrial funding. This is certainly corroborated by the evidence coming from Japan in the late 1990s during which time, abundant government research funding co-existed with sluggish growth in industrial funding of university research. However other case examples demonstrate that the way in which government funding affects university behavior has more to do with the way in which universities perceive government funding than the actual funding.

For instance, in the US, we can now see that government funding was sluggish throughout the 1970s but actually grew in the 1980s. However, the perception of universities in the 80s was that they faced a very uncertain federal support with the mounting public debt and Reagan's call for smaller government. It appears that it was the perceived uncertainty that led to greater diversification in funding with large increases in industrial support. Similarly, the perception of heavy-handed budget cuts by the government in the UK in the 1980s led to significant increases in industry funding of research, though the government funding of research was actually increasing throughout the period. To understand the way in which universities responded, then, it is critically important to understand how these policies were perceived at individual universities.

Government programs of support for collaboration with industry. All three countries have had a similar set of special regulatory measures and funding programs to promote university-industry collaborations. The time span and sequence of their introduction, however, are somewhat different. In the US, the federal government interest in application oriented research started in the 1970s, with major regulatory changes and funding programs starting in the 1980s. In the UK, the government specifically developed a policy towards applied research starting with the Rothschild report in 1970, and yet, while there were uproars and protests, it is not clear that these policies led to tangible changes in university behavior. It was not until the 1980s with the clear and tough policy stance taken by the Thatcher government that universities started to look to alternative funding sources and to applied research. In the case of Japan, the first wave of changes was introduced in the early 1980s, though with little impact. It was only in the late 1990s, with the deepening recession, that government began to accelerate a new policy focus on university-industry collaboration.

It is not clear what the contributions are of the regulatory changes such as Bayh-Dole. While its effect on the increasing number of patents is well established, the role it has played in encouraging universities to be better research partners for industry is unclear. Indeed it is interesting the way late comers such as Japan identify Bayh-Dole as a critical factor in American innovation. Their understanding appears at odds with detailed analyses of both Silicon Valley (Saxenian 1994) and the Cambridge Phenomenon (Segal Quince Wicksteed 1985), which indicate that the vitality of both of these regions was founded in the informal networks among professionals and the flexibility with which a university related to the local community. Indeed in the case of Britain, the Bayh-Dole type change was introduced in order to minimize the role of central government through breaking up the British Technology Group; as a result, there was a period of considerable uncertainty and concern on the part of companies who felt that they were facing increasingly demanding university partners who wanted to claim both the money for research and any resulting intellectual property rights. Establishing intellectual property rights can be alienating rather than encouraging for partnerships. And yet the MITI sees establishing the basis of IPR in universities as a critical first step to enabling the commercialization of science and technology in universities. This raises the question about the basis on which countries decide to imitate other countries.

Economic circumstances and industrial interest. It is equally clear that unless there is industrial interest, university-industry relationships are unlikely to change. Hence it might be expected that, during recessions, it would be difficult to develop industrial funding in universities. However, there are other factors that make the link between economic circumstances and industrial funding more complex. For instance, during economic recessions, it is also possible that firms substitute their expensive internal R&D for (cheaper) contracted research. There is also evidence of global mobility among R&D intensive firms such that, even if local national companies are under economic stresses and cut their R&D budgets, there may be other companies that would be interested in investing globally (Patel and Pavitt 2000; Reddy 2000). Indeed the experience of increases in industrial funding in the US and UK in the 1980s shows that economic circumstances do not unambiguously lead to a decline in industrial funding.

3-5. Concluding remarks

I have shown that there has been a generally increasing trend in industrial funding of research in universities in all three countries, particularly in the 1980s. The US and UK appear to be converging to a level of industrial funding of about 7% of total research funding. In Japan, the level is much lower, at about 2%, with no indication of increases in recent years. In the US as well as in the UK, there have also been developments of large partnerships between universities and companies that seem to go well beyond the traditional model of contracted research.

What macro factors influence such a trend and how? Two historical events seem to have shaped the societal values in critical ways that have defined both the role of government and universities in science on one hand, and indirectly or directly the role of university-industry relationships on the other. These are World War II and the student unrest of the 1960s. The three countries emerged from these events in different ways that had a lasting impact on the way university-industry relationships were configured and perceived. Specifically, the US came with the victorious legacy of the military technological success, which in turn helped shape post-world war science policy in favor of government support, and particularly for university science. Japanese universities on the other hand were to learn from the loss of the war and reach the opposite conclusion about the need to maintain a distance both from government and from industry. The UK case stands somewhere in between, where the government was to support science, but not necessarily in universities. These starting points get adjusted again through the student unrest, which led to the expulsion of military research from campuses in the US, and the denouncing of corporate involvement in Japan. The UK was relatively unaffected by the event.

If these historical events shaped the backdrop of societal values about the role of universities in general and university relationships with industry in particular, there have been other macro-level developments that have influenced the specific ways in which the relationships evolved.

The most important factor appears to be the general level of government funding. However, I have found that the manner in which this affects actual university behavior is complicated by the perceptions that universities form. They may respond in anticipation of changes that do not happen in fact, as much as to the actual changes. It is interesting to note that all three countries appear to have arrived at a similar set of policies, ranging from funding programs to encourage university-industry relationships to the establishment of a regulatory framework for intellectual property rights. However, the precise manner in which the regulations are configured depends on historical legacy, and their influence on universities also depends on the general perception that universities have of the policy intentions.

The three countries have shown striking similarities in the range of policies that have been put forward to encourage university-industry relationships, and also in the manner in which these policies have been given even greater strength during economic recessions. The timing and specific configurations of the resulting policies have been different, reflecting differences in how the historical developments have defined the role of the university and the role of government funding for universities.

Economic circumstances, such as recessions, were instrumental in bringing the attention of policy makers into focus. Companies with significant R&D have been increasingly mobile, and there has been sufficient interest on the part of industry to outsource research to result in industrial funding of university research growing, even during a recession.

Clearly, part of the difference has to do with the fact that Japan is lagging behind the other two in the development of university-industry relationships – again a specific legacy of World War II. In the case of the UK, there have been periods such as the 1980s, when the policy makers were perhaps less conscious of the US model, and other periods such as the late 1990s when they have been actively using the US model as a template. However, for the question as to whether the differences are a function solely of the temporal lag, the answer is a resounding no. There are two reasons why.

First, Japan is currently taking a dual track path which is a particular legacy of its past: there is a new emphasis on basic science and technology, and at the same time, there is a policy focus on greater linkages between university and industry. This duality is a result, on the one hand, of the 80s when Japanese manufacturers faced the severe criticisms particularly from the US, about free-riding on American science; and on the other, of the sense of the need to catch up in the development of university capacity for generating relevant science. No other country has had this dual track focus – so the result cannot be predicted on the basis of the experience of any "forerunners".

Second, imitations and learning from other systems do occur, but usually with significant distortions. Imitations and learning depend precariously on the level of knowledge that individuals have of the overall structures of the other systems. Often, the limited time available for reflection, coupled with a general lack of understanding about how the system works as a whole, lead to segmented learning where pieces do not lead to the whole. Whatever practice that seems salient gets adopted with insufficient details about how it is reinforced by the context within which it operates. Even with the best intentions to follow the same path, there will be deviations that will be introduced along the way. The UK and Japan are not simply behind the US catching up along a similar path; they will be generating a very different set of responses, partly because they are responding to a very different set of issues, but also because they will not know how to replicate the experience.

Chapter 4: Organizational level perspectives

In Chapter 3, I showed that changing university-industry relationships could not be simply explained in terms of national level changes. It is then imperative to look at how universities responded at the organizational level and why. The objective of this chapter is two-fold: to further clarify the nature of change at the organizational level, and begin to ask what organizational level factors influenced and shaped such changes. Central to these questions is how we understand the differences among the three universities. It is easy to imagine that MIT, Cambridge University, and Tokyo University would have very different responses, given their "culture" and historically inherited values. One is a technology-oriented university that has a mission to support application. The other is one of the oldest universities in the world with academic traditions that go back centuries. The third is a national university with well-known links with government. It is therefore tempting to simply say that all the differences are to do with the missions with which they were founded. This chapter will begin to unpack what essential legacies arose out of their foundation and function as organizational "imprinting" (Stinchcombe 1968), and what changes have taken place subsequently and how.

To do this, the chapter begins with broad descriptive comparison of the three universities as they exist today, highlighting the differences in terms of size, academic coverage, and physical settings. Second, financial records of industrial sponsorships are compared both in terms of what it is today and historical trends. Third, historical roots of the three universities will be examined separately, with a particular focus on events that shaped norms and values about their relationships with industry. I argue that while the effect of founding missions is important, universities can and do change sufficiently over time that subsequent historical changes are critically important in defining their present. In the fourth section, I argue that two historical legacies play a key role in shaping the future changes: the governance structures that influence the manner in which formal changes are made in the organizational rules and policies; and norms and practices of university-industry relationships. The final section summarizes the key changes in university-industry relationships in the past two decades and begins to argue that "historical legacies" by themselves cannot explain the directions of change today.

4-1. The three universities: size, academic coverage, and physical settings

Table 4-1 provides comparative statistics in terms of the size, coverage, and physical settings. The first difference to note is the size of the universities. In terms of the number of faculty members or permanent academic staff, Cambridge is about 40% larger than MIT, and Tokyo University is almost three times as large as MIT. Interestingly, neither Cambridge nor Tokyo publishes statistics about the breakdown of the number of academic staff by field. Cambridge statistics are particularly complex, given that "Cambridge" comprises the university and the colleges, which are separate legal entities,

Table 4-1 Basic comparative data: MIT, Cambridge, and Tokyo

		MIT	%	Cambridge	%	Tokyo	%
Year		2000		2000		1999	
Academic staff							
Faculty total	1	923	100%	1276	100%	2640	100%
of which science & engineering	2	588	64%	797	62%	2118	80%
of which engineering		333	36%	135	11%	524	20%
Professor		584	63%	304	24%	1387	53%
Associate/assistant professors	3	347	38%	972	76%	1253	47%
Lecturer	4	387		93		140	
Research staff	5	819		1889		1313	
Total academic staff		2129	100%	3258	100%	4093	100%
of which scientific	6	1559	73%	2230	68%	3284	80%
Administrative staff	7	5830				2503	
Student							
Total	8	9972		19877		27746	
Undergrad		4300	43%	13548	68%	16008	58%
of which engineering		2011	47%	1470	11%	2195	14%
Graduate students		5672	57%	6329	32%	11738	42%
of which engineering		2504	44%	535	8%	3036	26%
Campus							
Site (square meters)	9	622,429				1,287,000	
longest distance across campus		1	mile				
number of main campuses		1				3	
longest distance bet campuses						30	km

Source: MIT Report to the President 1999, University of Tokyo Annual Report 2000, Cambridge University Reporter

1 Faculty to include professors, associate and assistant professors in MIT and Tokyo, and lecturers and assistant lecturers in Cambridge.

2 Cambridge and Tokyo figures are estimated using the overall proportion of scientists to the total. The percentage for Tokyo, which was specifically obtained from the university, since it is not part of published information, appears particularly high, but this may depend on the way in which they defined "scientific."

3 Readers, lecturers, and assistant lecturers in Cambridge included.

4 Lecturers and instructors but not including visiting professors in MIT, unestablished academic staff in Cambridge and koshi in Tokyo University.

5 Researchers include post doctoral fellows and research scientists/engineers in MIT (and excludes visiting fellows/professors, affiliates, and non-tenure taching staff such as lecturers), joshu in Tokyo, and unestablished research staf in Cambridge.

6 Those in School of Humanities and Social Science excluded in MIT, science and engineering related estimated by UT staff,

7 MIT figure is estimated using the total number of employees, as reported in MIT facts. Tokyo University figure comes from the annual report and excludes medical non-academic staff who mainly work in their hospital.

8 Student statistics of 1999-2000 for MIT, as of May 2000 in University of Tokyo

9 For Tokyo University, the figure includes Hongo, Komaba, Roppongi, and Chiba - excluding facilities such as agricultural farms and hospitals.

with most academics holding dual appointments in the university and in one of the colleges. Some academic appointments may work exclusively with their college as tutors, though this is rare in scientific subjects where research requires departmental facilities.

In terms of the estimated proportions of engineering as a percentage of the total, MIT is the largest with 36%, or over 300 faculty members in engineering, while Cambridge is the smallest, with 11% or 135 faculty members; Tokyo has 20% or over 500 engineering faculty positions. However, when it comes to faculty members in the scientific subjects including engineering as a whole, the universities are apparently not so different. MIT and Cambridge have similar proportions of scientific faculty at between 60 and 70%, while Tokyo claims to have 80%. The Cambridge numbers are possibly an overestimate owing to college appointments in humanities. The size difference is also visible in student statistics. Cambridge has almost twice as many students as MIT, and Tokyo has nearly 3 times as many. Interesting is the fact that MIT is clearly more oriented towards graduate education where 57% of the total student body are graduate students while at Cambridge they form 32% and at Tokyo, 42%. Among undergraduates, engineering students constitute 47% in MIT, 11% in Cambridge, and 14% in Tokyo. Perhaps, these last figures reflect more accurately the sense of proportions of engineering in the respective universities.

In terms of academic coverage, contrary to its image, MIT has four schools other than engineering, comprising a total of 27 departments. Cambridge has 5 schools that cover 21 faculties and 4 syndicates, which in turn comprise 60 departments. Tokyo University comprises 10 faculties and over 30 research institutes.

Another major difference between the three is their space configuration. MIT has a single campus where the longest distance across the campus is about 1 mile, and with many of the departments physically connected through corridors. Indeed, this connectivity between different departments was put in place by design, to facilitate communication. Cambridge University spreads over the entire city with different departments and colleges occupying different corners. Departments are often separated physically such that one would have to travel (traditionally on a bicycle) to get from one place to another. Tokyo University is the most spread out, with 3 main campuses that are as far as 30km apart, with 40-60 minutes travel time and/or several train rides in between. This physical set up is clearly a legacy of past decisions. Former MIT president Paul Gray reflects that having a single campus, which was enabled by a generous donation by Eastman Kodak, as one of the three defining moments of MIT as it exists today. Having secured the land, MIT leaders at the time went on to design a campus that suited their philosophy. In contrast, it is hard to know if there ever was any conscious design in the way Cambridge University is physically laid out. In the case of Tokyo University, which started as a collection of colleges that had been founded separately brought together by the government for their convenience, it continued to incorporate different campuses mainly as a result of government level decisions.

Table 4-2: Academic structure and coverage

	MIT	Cambridge	Tokyo
Academic structure and coverage	5 schools with 27 departments: engineering; science; architecture and planning; humanities and social science; and management. 2 affiliated research institutes: Lincoln Laboratory and the Whitehead Institutes	University and colleges form a dual structure. Historically (though no longer), colleges were responsible for teaching and the University examined the students. 5 schools: physical sciences; biological sciences; humanities and social sciences; technology; and arts and humanities. 21 faculties and 4 syndicates comprising about 60 departments	10 faculties: law; medicine; engineering; science; literature; agriculture; economics; culture; education; pharmacy There are 13 graduate schools which largely overlap with the faculties and over 30 research institutes/centers with separate staff

4-2. Patterns of industrial funding

As shown in Table 4-3, MIT leads the other two, whether corporate donations are included or not, in terms of absolute volume, as a percentage of its total operating revenue, as a percentage of its total research income, per head of members of faculty, and per contract. More specifically, research support from industry is the highest at MIT at 74 million US dollars, against 30 million in Cambridge, and 9 million in Tokyo in absolute terms. The picture remains the same in terms of per faculty member, for which MIT received $ 81,000 dollars per head from industry as compared against $ 23,000 in Cambridge and $3,000 in Tokyo.

Interestingly, corporate donations are one category of industrial relationship for which Tokyo comes ahead of MIT at $ 56 million[1], and is the only case where MIT's lead is reversed. However, when adjusted for scale either by comparing per capita figures in terms of total faculty, science and engineering faculty, or researchers, MIT regains its lead.

If Tokyo University professors can get so much benefaction without much effort and with minimum obligations, it is not surprising to see them making little further effort to obtain more restrictive contract income. Another interesting contrast is that the donations in

[1] It was not possible to obtain equivalent figures for Cambridge, as its donation figures are not disagregated by type of sponsor. Strictly speaking, this is also true of Tokyo, although in Tokyo, there is a notable lack of traditions of foundations or other individual benefactions.

Table 4-3: Basic comparative data on university-industry relationships: MIT, Cambridge, and Tokyo

	MIT	%	Camb.	%	Tokyo	%
Year	1999		1999		1999	
Academic staff						
All faculty members - 1	923		1276		2640	
Of which in science and engineering -2	588	64%	797	62%	2118	80%
Researchers in science including non faculty – 3	1559		2230		3284	
Finance (million US $)						
Operating Revenues - 4	911	100%	602	100%	1,620	100 %
Research grants and contracts	376	41%	190	32%	287	18%
Industry funded research	74	8%	29	5%	9	1%
Corporate donation	39	4%			56	3%
Finance per faculty (thousand US$)						
Operating revenues per faculty	987		472		614	
Research grants/contracts per faculty	407		149		109	
Industry funded research per faculty	81		23		3	
Income from industry in research grants and contracts						
Total in thousand dollars	74,405		29,004		9,051	
Per faculty (thousand dollars)	81		23		3	
Per scientific faculty (thousand dollars)	127		36		4	
Per scientific researcher	48		13		3	
Income from industry in research grants/contracts and donation						
Total in thousand dollars	113,405				65,071	
Per faculty (thousand dollars0	123				25	
Per science and engineering faculty (thousand dollars)	193				31	
Per science and engineering researcher	73				20	
Industry income for research grants and contract as % of						
total research revenues	19.8%		15.2%		3.2%	
total revenues	8.2%		4.8%		0.6%	
Industrial grants/contracts (thousand US$) 5	74,405		29,004		9,051	
Number of contracts	668		649		287	
Average contract size (thousand US$)	111		45		32	
Industrial donation/grants/contracts (thousand US$)	113,405				65,071	
Number of contracts	1,873				4,837	
Average contract size (thousand US$)	61				13	

1. American concept of faculty to include professors, associate and assistant professors. Lecturers and assistant lecturers included for Cambridge.

2. Cambridge and Tokyo figures are estimated using the overall proportion of scientists to the total. The percentage for Tokyo, which was obtained from the university, appears particularly high, but this may depend on the way in which they defined "scientific."

3. Researchers include post doctoral fellows and research scientists/engineers in MIT (and excludes visiting fellows/professors, affiliates, and non-tenure taching staff such as lecturers), joshu in Tokyo, and unestablished research staf in Cambridge.

4. MIT finance data are from FY1999. Cambridge industry source revenue includes a small amount of revenues from non-EU government organizations. Tokyo finance data are from the annual report 2000.

5. For MIT, 2000 actual expenditure data from the Office of the Sponsored Programs.
For Cambridge from 1999 estimated from "Research wholly or partly supported by funds from outside bodies." For Tokyo, from data in the engineering faculty

Tokyo are usually given in direct support for individual professors, while they are organizationally raised at MIT, and spent in ways that fit the institution's priorities, in negotiation with the donors. MIT's donations therefore include money raised for shared facilities, most notably for expensive pieces of equipment that individual laboratories can ill afford. In Tokyo, benefaction is gracefully consumed by cash-strapped professors for their routine activities. Tokyo professors seem fortunate to be recipients of such voluminous benefaction, although it consists of small amounts which add up to a large total; the individuals would not perceive themselves to be recipients of "large" benefactions.

What is the picture for overall industrial sponsorship including both contracted research and donations? Here, MIT comes back to the leading position, mainly on the strength of its large industrially contracted income, at $ 113 million to be compared with $ 65 million in Tokyo.

The fact that MIT's lead is so robust across so many different indicators, means that the differences are likely to be a reflection of the larger volume of MIT's relationships with industry. It is possible to argue that MIT's lead is a reflection of the fact that it has a smaller humanities component than the other two universities and humanities subjects tend to have smaller industrial support than other disciplines. This would explain the fact that industrial income as a proportion of total university expenditures is lower for Cambridge or Tokyo. However, one would expect less of the humanities effect with the industrial income as proportion of total research income, where humanities contribution would be low both for the numerator as well as the denominator. Indeed, this is exactly what we see, the differences across the three schools get narrower, and yet, MIT maintains its significant lead.

The question is what these differences reflect. Interestingly, Tokyo University professors, as well as many of the Japanese companies interviewed, are painfully aware of the "price differential" between American and Japanese universities. "MIT is expensive" as one Japanese industrialist noted. Another Japanese company pointed out that even Cambridge is "cheaper" than MIT. The real difference appears to be explained by what the "cost of research" includes in the respective universities. At MIT, the salary costs of faculty and graduate students are included as an integral and important part of research sponsorship, for which overhead is also paid at about 60% of the total costs. The inclusion of the full costs of faculty salary is much more prevalent in North America, where the norm is for professors to be paid for only 9 months of the year, and they are expected to engage in outside activities for 3 months of the year. In research universities, they often charge research contracts for their summer time.

In Cambridge, by contrast, salaries of full time academics are presumed to be covered by grant income from the government, although their low levels have become a critical survival issue in attracting and retaining good people for the profession. Interestingly, industrially active academics often supplement their low official pay with consulting incomes, often from sponsoring companies; in other words, industry may be paying more than the formally contracted amounts through consulting salaries but through a route that is less visible or official. In addition, many of the students also come with, or are given, fellowships and there seems to be a less wide-spread expectation for academics to support their students through research grants/contracts. Overhead charges are at about 60% (check) but only of salary costs rather than the total costs, and therefore cheaper in Cambridge than at MIT.

In Tokyo, graduate students, including doctoral students actually pay tuition out of their own pocket (thought the tuition itself is far below the level of that at MIT). Contracted research costs include overhead at 30% of the total costs some of which goes back to the Ministry. Tokyo is "the cheapest" for industry to ask to undertake contracted research. Yet, even though it is cheaper, companies have been choosing to "donate" funds rather than to contract research – evidently opting out of formal contractual relationships; this may be because of the lack of clarity as to what money can buy in terms of the time commitment either of professors or of students.

Past trends in industrial funding at MIT. The overall change in the importance of industry as a source of research funding is shown in table 4-4. Industry was an important source of research funding before and just after World War II at around 14-16%, similar to the level reached in 1990-1995. The proportion of research activities to the total campus revenue rose substantially from 0.8% in 1930 to 6.2% in 1946 indicating the rising volume of research during the war period. In 1970, industrial funding, as a proportion both of research funding and of total campus revenue, declined to all-time lows of 3.4% and 1.9% respectively. Thereafter, industrial share of research funding has been rising steadily with the sharpest rise in between 1980 and 1985 when it rose from 8% to 13.9%, and again between 1995 and 1999 rising from 15.5% to 19.8%.

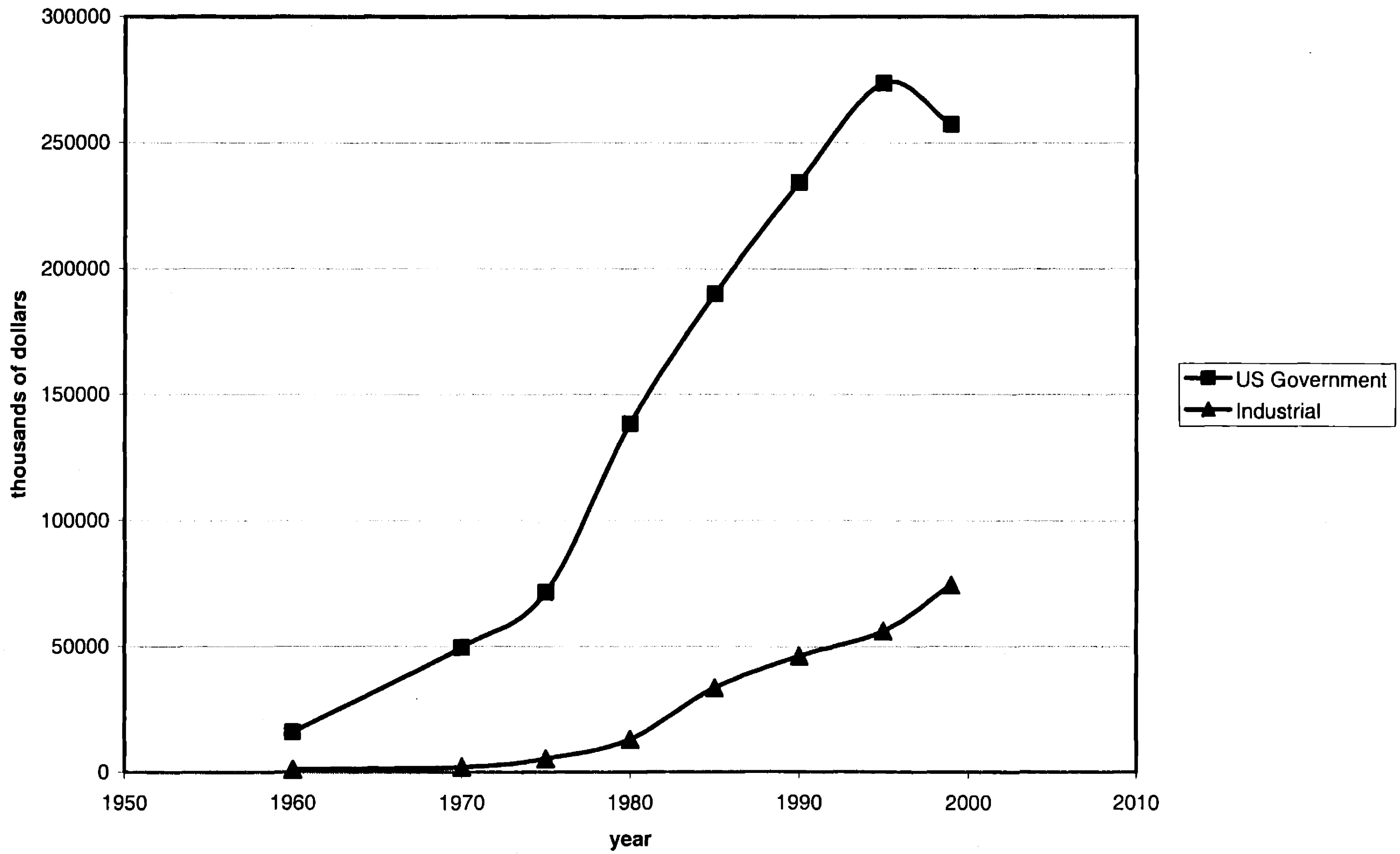
Table 4-4: Research Funding at MIT (1000 dollars)

		1930	1946	1960	1970	1975	1980	1985	1990	1995	1999
US Government	FRSP			15828	49504	71523	138410	189978	234163	273542	257163
DOD	FRSP			2214	16010	12459	19183	38576	51158	55866	65718
DOE	FRSP			3801	8674	11352	50004	56364	61098	67114	63138
NIH	FRSP			1007	8158	14922	24365	39805	57915	61066	58246
NASA	FRSP			321	6511	6940	9294	12315	18469	41292	27301
NSF	FRSP			1403	6485	19623	25054	33628	38093	38564	35352
Other governments local/foreign	FRSP			102	400	757	609	398	369	944	2344
Industrial	FRSP			1064	1994	5319	13058	33487	46223	56120	74405
Foundations/Non-profits	FRSP			773	6172	7473	9653	15282	25220	26430	35137
Other	FRSP			11	56	806	1390	2560	4684	4653	6997
Total Research Grants and contracts	FRSP	199	1547	17778	58126	85878	163120	241705	310659	361689	376046
Of which industry	FRSP	28	253	1064	1994	5319	13058	33487	46223	56120	74405
Total Campus Revenue	TR	3515	4051	60084	103422	139337	283104	456698	643552	890135	911171
Industrial income		**28**	**253**	**1064**	**1994**	**5319**	**13058**	**33487**	**46223**	**56120**	**74405**
Annual increase			**14.7%**	**10.8%**	**6.48%**	**21.68%**	**19.68%**	**20.73%**	**6.66%**	**3.96%**	**7.31%**
as % of research		**14.1%**	**16.4%**	**6.0%**	**3.4%**	**6.2%**	**8.0%**	**13.9%**	**14.9%**	**15.5%**	**19.8%**
as% of campus revenue		**0.8%**	**6.2%**	**1.8%**	**1.9%**	**3.8%**	**4.6%**	**7.3%**	**7.2%**	**6.3%**	**8.2%**
per faculty member											

Source: Financial reports of sponsored programs and Treasurer's reports (various years)

1. 1930 and 1945 data from Treasurer's reports
2. Campus revenues excludes revenues of Lincoln and Draper Laboratories
3. Research grants and contracts do not include gifts for chairs, equipment donation, fellowship support, consortia support?

Fig 4-1: MIT: Research funding



As shown in Table 4-5, the number of industrial sponsors has risen steadily through the 1970s and 1980s, and appears to have stabilized in the 1990s, while the average size of sponsorship per company continues to rise in the 1990s.

Table 4-5: Industrial research sponsorship at MIT

	1970	1980	1990	1999
Total amount (1,000 dollars)	1,994	13,058	46,223	74,405
Number of industrial sponsors	87	244	354	365
Average per sponsor (1,000 dollars)	23	54	131	204

Table 4-6 shows the size of industrial funding from multiple-sponsor projects, which is the closest accounting category to consortia and collegia, although it also includes other projects with multiple sponsors and the research contract portion of strategic alliances. Since some strategic alliances involve donations such as endowed chairs, and since these alliances tend to require a considerable pump priming period, the amount shown is likely to understate the contribution of strategic alliances. Nonetheless, these figures provide the rough magnitude of changes taking place. Before the 1960s, there were no research projects on record where multiple companies participated[2]. By 1970, there were three "multi-sponsor projects" on record, which appear to be research contracts that happen to have had more than one company sponsor. By 1980, there were over 30 multi-sponsor projects, and the number kept on increasing up to about 100 in the 1990s. In terms of their proportion of total industrial funding, it rose from virtually zero to 18% in 1980, 29% in 1990 to 38% in 1999. Collegia and consortia are the two new types of relationships with multiple companies that emerged in MIT during the same period, and these are explained in detail below. Though the records do not give breakdowns, developments of consortia within the multi-sponsor project category is likely to have been significant, given the central role played by consortia in key units such as the Media Lab.

Table 4-6: Rise of multi-sponsor projects at MIT

	1960	1970	1980	1990	1999
Number	None listed	3	34	120	87
Total (thousand dollars)	N/A	2	2,393	13,285	28,192
% of total research supported by industry	N/A	0%	18%	29%	38%

Source: Financial reports of sponsored programs, MIT, multiple years

[2] The only exception was the Industrial Liaison Program (ILP), MIT's campus-wide information service program, where corporate members could get professional assistance in identifying and receiving information about research activities of their interest for a modest annual fee.

Fig. 4-2: Industrial research contracts at MIT

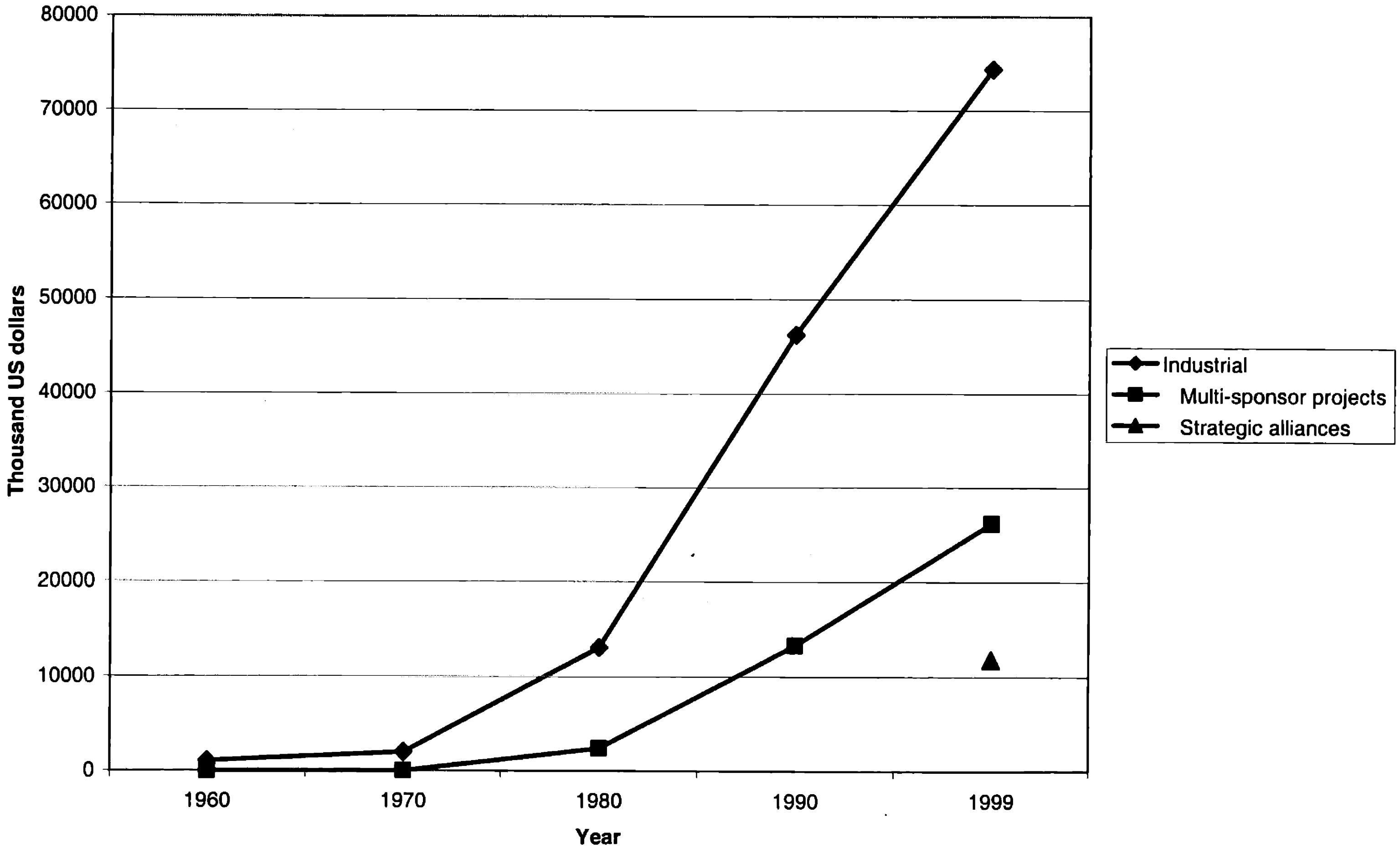


Table 4-7: Research Funding in Cambridge (thousand pounds)

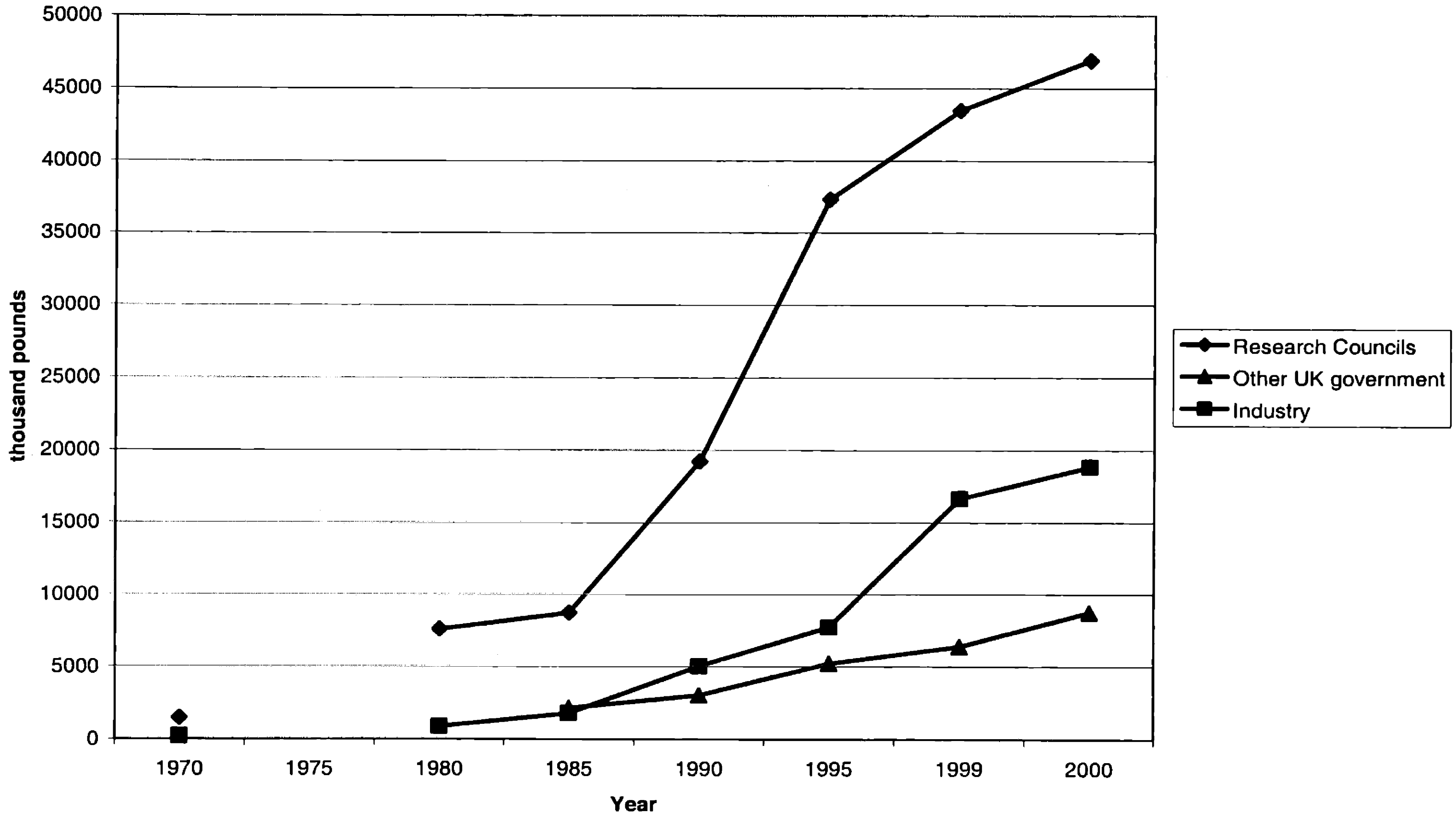
	1970	1975	1980	1985	1990	1995	1999	2000
OST research councils	1459		7587	8707	19226	37328	43481	46902
UK government				2121	3028	5206	6386	8748
UK central government				1856	2468	5187	6177	8286
Local governments				19	21	14	68	79
Public corporations				246	539	5	141	383
UK industry/commerce				1460	3209	6574	12500	12229
UK non profit				3081	8940	22284	31845	36224
UK based charities				3081	8619	21597	30771	35428
UK health and hospital					321	687	1074	796
EU government bodies					1275	8559	8873	6838
EU other					32	216	518	596
Other overseas	525		2692	803	1815	2752	5019	5637
less foreign governments/charitable bodies	322		1831	744	570	1815	1524	
Other sources				240	262	240	348	564
Total Research Grants and contracts	1984	4023	10279	16413	49755	110649	108970	117738
Of which industry b)	203		861	1765	5025	7732	16654	18845
Total	11728	22691	49995	83374	178800	315800	323800	372100
Industry funding								
as % of research	10.23%		8.38%	10.75%	10.10%	6.99%	15.28%	16.01%
as % of total	1.73%		1.72%	2.12%	2.81%	2.45%	5.14%	5.06%

Annual increase	1980-85	1985-90	1990-95	1995-99
industrial revenue	15.4%	23.3%	9.0%	21.1%
Research revenue	9.8%	24.8%	17.3%	-0.4%
total revenue	10.8%	16.5%	12.0%	0.6%

Source: Abstracts of Accounts (various years)

Note: The accounting system changed between 1985-90. Data series may not be comparable

Fig 4-3: Research funding at Cambridge



Industrial funding in Cambridge. The available statistics on the industrial funding of research at Cambridge indicate that there has been a rapid growth (Table 4-7)[3]. The annual growth rates averaged 15% in 1980-85, 23% in 1985-90, 9% in 1990-95 and 21% in 1995-1999. Government funding of research at Cambridge was stagnant in the early 1980s, but thereafter has been increasing robustly, with increases in industrial funding exceeding that of the government funding only in 1995-1999, as shown in Fig 4-3. These figures alonedo not support the simple story that industrial funding had to be increased in order to cope with declining government funding. Rather, it seems to reflect both a delayed reaction on the part of Cambridge to respond to the anxieties generated in the 1980s, and the continued perception of absolute shortages of funds in the higher education sector in the UK.

Industrial funding of research at Tokyo University. As shown in Table 4-8, industrial funding for Tokyo University in general, either in terms of scholarship donations or contracted research, did not increase significantly in the 1970s, particularly relative to increasing government funding. In the 1980s, scholarship donations did increase significantly until the early 1990s. Contracted research has shot up since 1995, but this increase is likely largely to reflect the increase in government funding of research. The level of joint research indicates that industrial collaboration might have been modest and not sharply rising during the whole period.

The 1990s has been a better period for Tokyo University. There have been successive reform measures from the Ministry of Education in terms of relaxed curricular requirements, and progressively reduced budgetary rules and restrictions. This has been matched with real increases in the overall level of funding, particularly for infrastructure and research.

There have also been rapid changes in the infrastructure for university-industry relationships within the university. The Center for Collaboration Research was established in the late 1990s as a joint center between the IIS and RCAST. Though the center's main activity has changed considerably during the tenure of its three center directors, the main objective has been to support industrially active faculty in IIS and RCAST through the provision of needed space. One of the activities initiated was the establishment on the web of a database of expertise available to the public, showing the faculty areas of interest. Tokyo University's first technology licensing unit, CASTI was established in 1998 as a private company owned by two non-scientific faculty members in RCAST. With a new CEO in place, the company is positioned to become a profitable business. In the meantime, a second competing initiative for technology licensing was proposed in 2001 by IIS to provide additional faculty-led licensing activities. Underneath these developments are strong rivalries between the two institutes, IIS with 100 faculty and RCAST with about 30 positions.

[3] Although there are weaknesses in the time series as categories such as industrial sponsorship were refined over the years, as can be seen in Table 4-4.

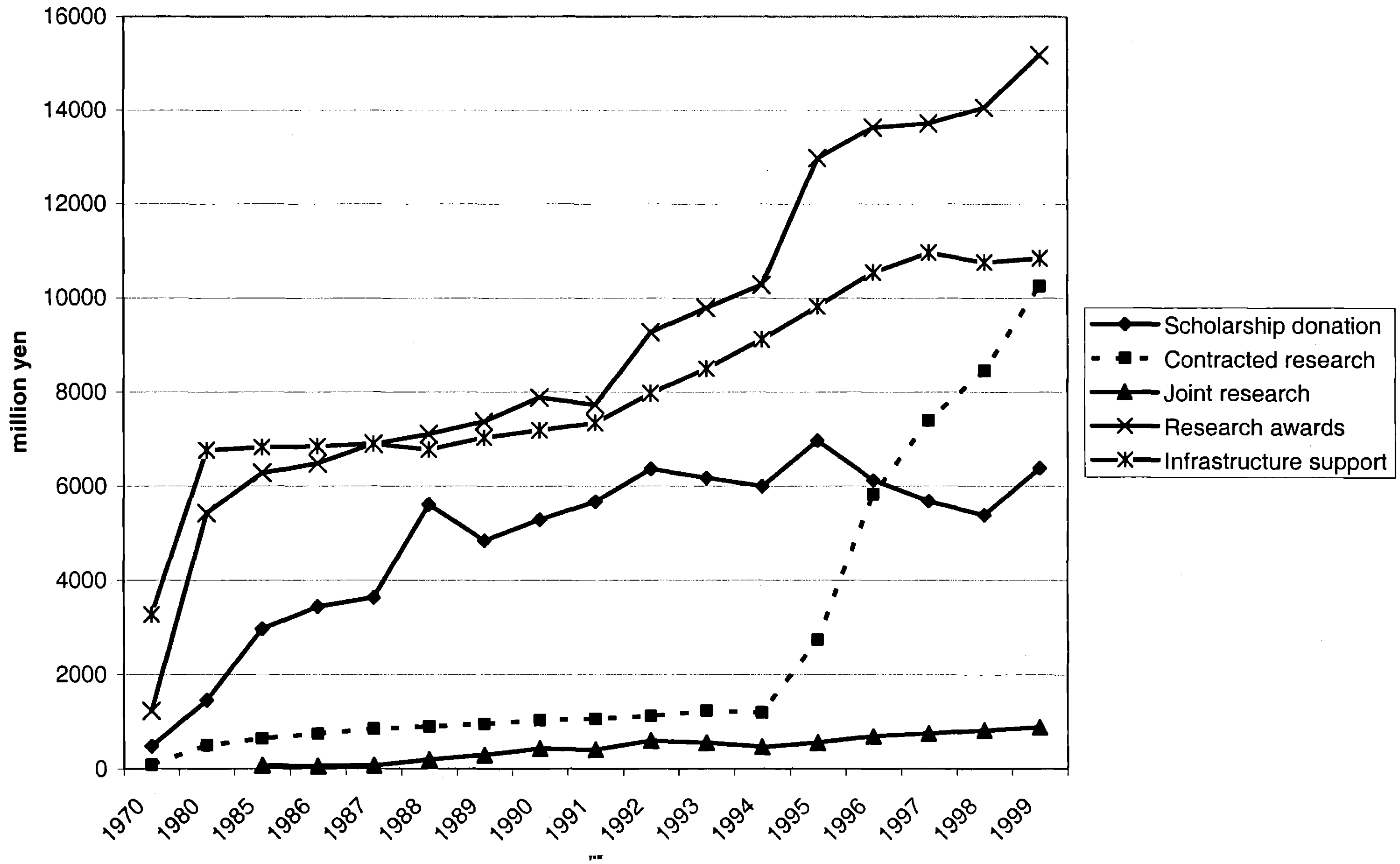
Table 4-8: Research funding at Tokyo University (million yen)

		1970	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Scholarship donation	a	473	1453	2966	5283	5668	6359	6170	5990	6966	6121	5677	5381	6381
Contracted research	b	82	493	642	1030	1059	1117	1228	1193	2734	5827	7392	8455	10249
Joint research	c			70	423	406	589	549	461	554	692	750	814	878
Research awards	d	1225	5426	6275	7880	7725	9270	9783	10277	12977	13632	13718	14057	15178
Infrastructure support	e	3275	6760	6820	7182	7343	7969	8498	9117	9817	10544	10960	10756	10844
Externally funded	f	555	1946	3678	6736	7133	8065	7947	7644	10254	12640	13819	14650	17508
Total research funds	g	5055	14132	16773	21798	22201	25304	26228	27038	33048	36816	38497	39463	43530
Total expenditures		29869	100634	100056	117156	122099	139222	163619	161830	195331	174164	176608	210147	210042
Percentage of total research														
Scholarship grant		9%	10%	18%	24%	26%	25%	24%	22%	21%	17%	15%	14%	15%
Contract research		2%	3%	4%	5%	5%	4%	5%	4%	8%	16%	19%	21%	24%
Joint research		0%	0%	0%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Research awards		24%	38%	37%	36%	35%	37%	37%	38%	39%	37%	36%	36%	35%
Infrastructure		65%	48%	41%	33%	33%	31%	32%	34%	30%	29%	28%	27%	25%
Externally funded		11%	14%	22%	31%	32%	32%	30%	28%	31%	34%	36%	37%	40%
Percentage of total expenditures														
Scholarship grant		2%	1%	3%	5%	5%	5%	4%	4%	4%	4%	3%	3%	3%
Contract Research		0%	0%	1%	1%	1%	1%	1%	1%	1%	3%	4%	4%	5%
Joint Research		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Research Awards		4%	5%	6%	7%	6%	7%	6%	6%	7%	8%	8%	7%	7%
Infrastructure		11%	7%	7%	6%	6%	6%	5%	6%	5%	6%	6%	5%	5%
Externally funded		2%	2%	4%	6%	6%	6%	5%	5%	5%	7%	8%	7%	8%
Total research		17%	14%	17%	19%	18%	18%	16%	17%	17%	21%	22%	19%	21%

Source: Tokyo University

a shogaku kifukin, b=jutaku kenkyuhi, c=kyodo kenkyuhi, d=kakenhi, e=kohi, f=a+b+c; g=a+b+c+d+e

Fig 4-4: Research funding at Tokyo University



Contrasting the three: historical trends. Fig 4-5 shows the trend in research income from industry over the past 30 years as a proportion of total research income. Clearly, there has been a steady increase at MIT, with step changes in the early 1980s and again in the late 1990s, as opposed to the trend in Cambridge for which the level hovered around 10% between 1980 and 1990, dipped once in 1995 and then began to increase again in the late 1990s. The picture of trends in Tokyo depends largely on which time series is looked at. Fig 8-2 shows three time series mainly because there are no disaggregated data available that are comparable with those of MIT and Cambridge. Tokyo 1 is the time series that would be used officially by Ministry and University administrators; it gives a very rosy picture of a steady rise, indeed at a higher level than MIT or Cambridge. The real trend is closer to Tokyo 2, which allows for the fact that the large increase between 1990 and 1995 is mainly explained by government funded contracted research. Tokyo 3 gives time series that are the most comparable with those of MIT and Cambridge, excluding scholarship grants which is an ambiguous category of industrial support more akin to donations in MIT and Cambridge.

Fig 4-6 shows the trend in industrially supported research income relative to the 1970 level. Interestingly, MIT shows a steady growth, while Cambridge shows a steady increase but with a spectacular rise in the late 1990s. For Tokyo, the most distinct characteristic of the trend is the stagnation in the late 1990s. There are two explanations; the first concerns the economic stagnation in Japan, and the inability of Tokyo University to attract many funds from foreign firms. The second concerns the generous levels of government funding since the Basic Science Law, which left university researchers with little need to seek additional funding from industry.

Fig 4-5: Research income from industry as % of total research

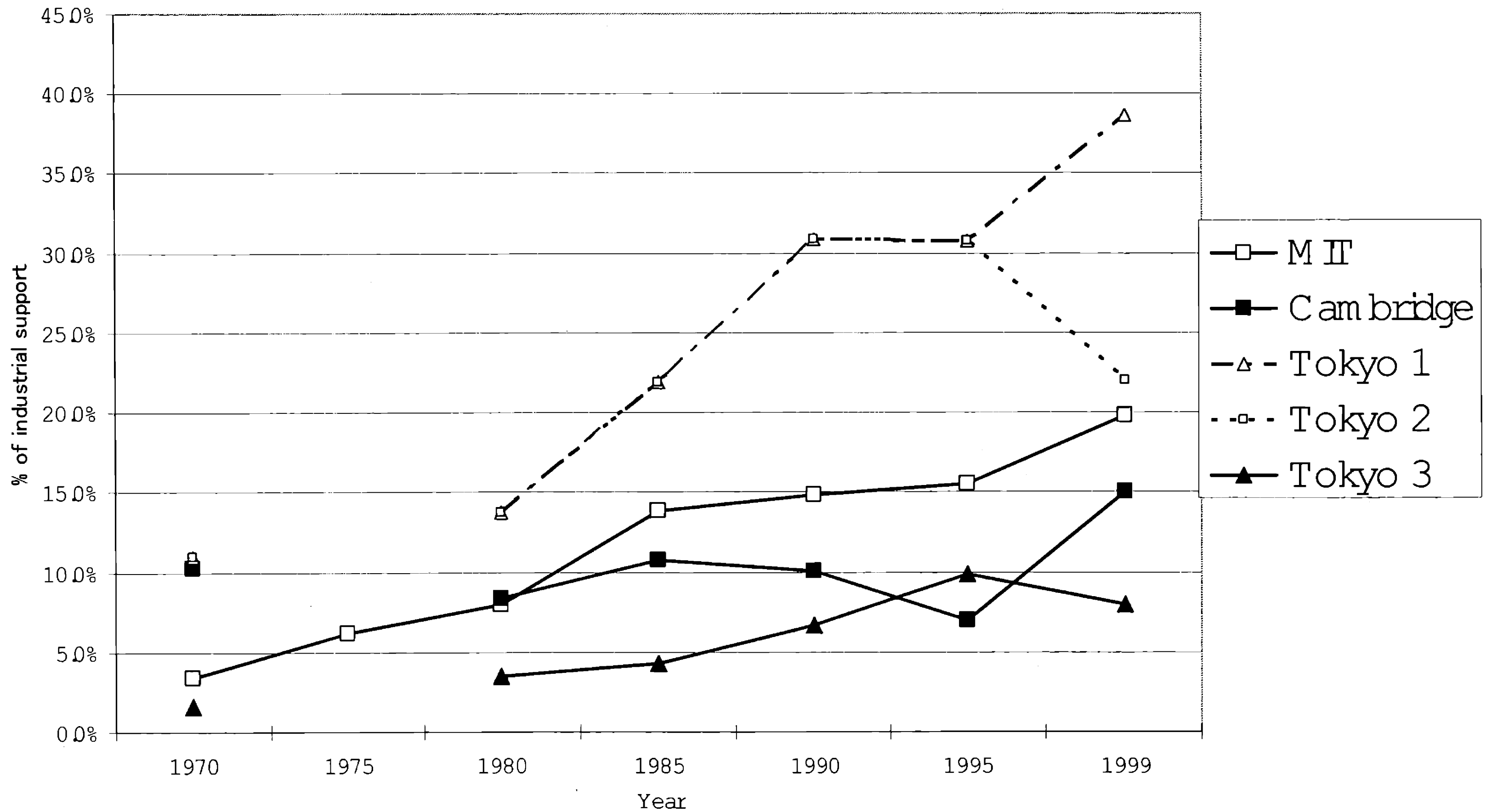
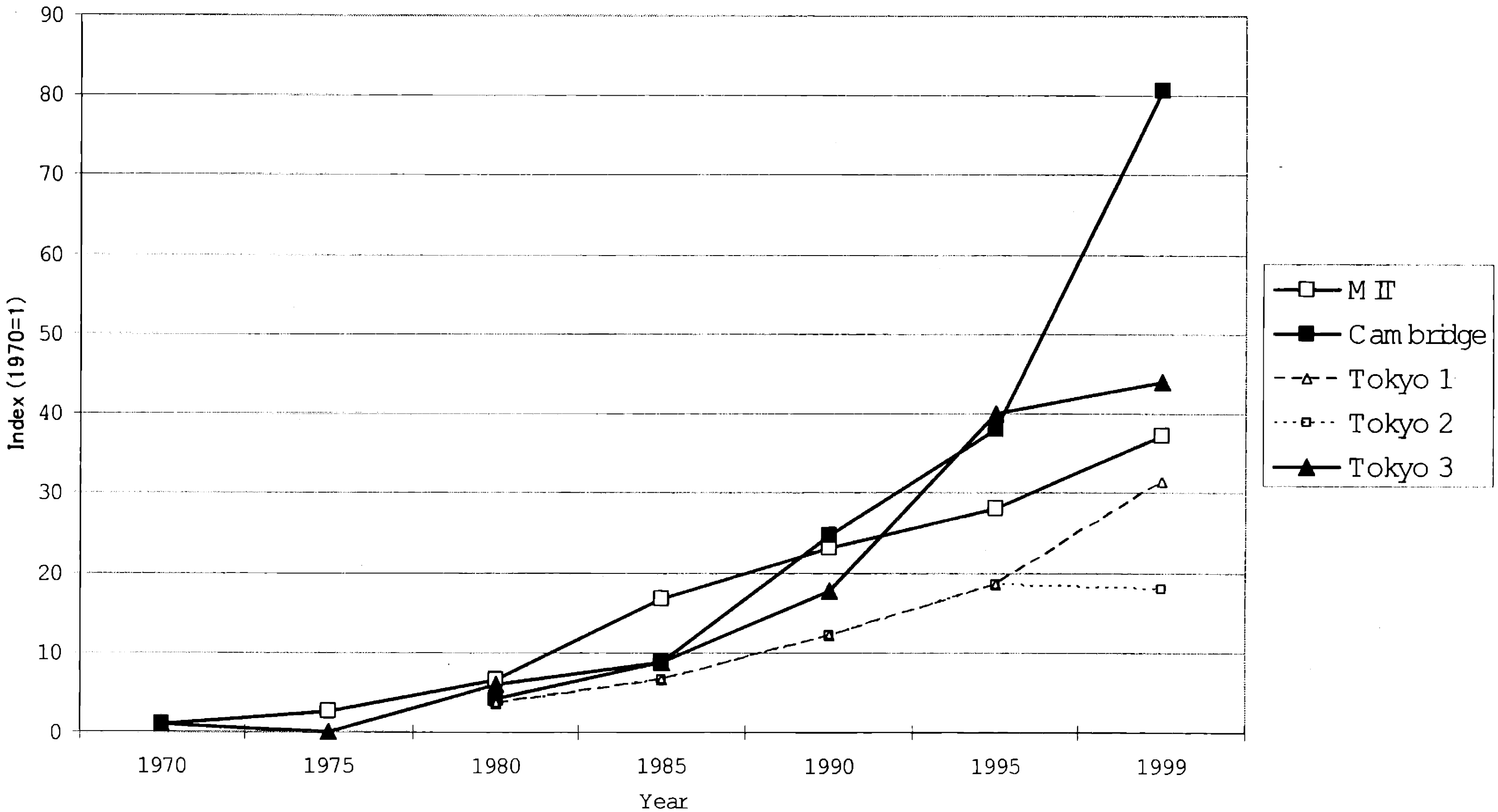


Fig 4-6: Level of research income from industry relative to 1970



4-3. Historical developments

MIT

Founding values. The frequency with which the name of MIT appears in the previous chapter's description of national developments underscores the importance of MIT as a player in national research, and specifically in university-industry relationships. In this section, MIT's historical origin and the developments in its relationships with industry will be examined.

MIT was founded in 1861 by William Rogers, with a founding philosophy to support practical arts in engineering. Indeed, even today, MIT people explain the practical orientation of MIT as arising from its founding spirit, symbolized by its seal comprising the laborer at the anvil and the scholar with a book - representing "mind and hand." In 1891, MIT was authorized to receive one third of the federal funds provided to Massachusetts for land grant colleges under the Morrill Act of 1862. Since the federal government's intention in the Morrill Act was to establish higher education institutions relevant to the practical needs of the country, the award of land grant funds was clearly an indication of commitment to informing practice.

Less emphasized in historical accounts are MIT's scientific aspirations. Rogers was a geologist who believed strongly in the role of science in supporting practical arts – indeed he had little to do with practical arts himself. The charter of MIT was granted by the state of Massachusetts for:

> "instituting and maintaining a society of arts, a museum of arts and a school of industrial science aiding the advancement, development and practical application of science in connection with arts, agriculture, manufacturing and commerce."

Unconventionally at the time, Rogers saw the importance of combining scientific principles with operational manipulations; until then, the two spheres had been isolated from each other. His emphasis on the former distinguished MIT from peer schools which focused merely on the practical side of things (Hapgood 1993)[4].

Early years: heavy emphasis on application. In spite of the initial emphasis on science, by the early 20th century, MIT was decidedly leaning towards practical arts, with little emphasis on science. But in contrast to the rest of the nation, where university research was relatively isolated from industry, many MIT departments were already working very closely with industry. For instance, chemical engineers were extremely active in the formative years of the chemical industry, and prominent scientists successively left MIT in search for environments more supportive of science (Geiger 1986; Servos 1990).

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[4] This is a book written to describe the engineering ethos of MIT, and not necessarily written to be an authoritative historical account. However, its section on historical origins is thorough and captures the essence of the dual goals that are also evident in founding documents.

It was not until 1930, when Karl Compton, a prominent physicist from Princeton, became the president of MIT, that there was a swing back to science. One of the folk tales told in MIT is how Compton met the chairman of Bell Labs when he was still unsure as to whether he should accept the presidency at MIT. Compton decided to do so, taking to his heart the industrial leader's comment that engineering schools were serving the myopic needs of industry today but were failing to create the future of the country (MIT various years). His commitment to bring science into engineering was reflected in key appointments such as that of Vannevar Bush as Dean of Engineering. However, it took much longer to change the nature of the place, which was so strongly oriented to training students to enable them to work well for industrial needs. Indeed, seen from Compton's perspective, one could say that it was his vision of science that led MIT to be involved as critically in wartime science, and people whom he brought on board such as Vannevar Bush who helped him achieve that vision, and shaped national policy on science later. One could argue that it was Compton's vision that shaped the subsequent historical development.

Effect of World War II: towards engineering science. The wartime experience was to change the character of MIT permanently. The most significant experience was the Radiation Lab. It was so successful in bringing together scientists and engineers to develop military applications that it became a symbol of scientific success serving national needs. Within MIT, the experience of the Radiation Laboratory had two major ramifications. First, the recognition that it was physicists rather than engineers who provided the critical inputs to developing military applications, led to serious self-analysis on the part of the Engineering School. Eventually, Gordon Brown, the then head of the Department of Electrical Engineering, strongly pushed for bringing science into engineering disciplines in the 1950s. In 1949, the Committee on Educational Survey, more commonly known as the Lewis Commission, made recommendations to strengthen the scientific base in engineering curricula. The vision of Compton was finally accomplished on campus and the era of engineering science began. It was as though the wartime experience helped people understand the value of Compton's insistence on science.

The second ramification was that laboratories as virtual structures became the organizational norm, in which academics belonging to different departments and schools could work together on a given theme of mutual interest. Laboratories thus provided a mechanism to operate in a matrix structure, providing a flexible and convenient organizational structure for undertaking interdisciplinary work. As with the Radiation Laboratory, most of the large laboratories and centers at MIT were developed in response to sponsors' calls, usually the federal government, to open up new research programs to cope with different fields.

Student unrest in the 1960s. The 1950s through the 1960s were the golden period for federally funded research for MIT, when the ties with industries generally took a back seat. This blissful period of collaboration with the government was to change dramatically in the late 1960s, through the nation-wide student unrest about the US involvement in Vietnam and about university contributions to military technology

(Johnson 1999). This also marked the time when the federal support for research began to decline, as other government expenditures escalated because of the war on the one hand, and the extended social programs of Johnson's "Great Society."

At MIT, student criticisms were focused on its relationship with the military. On November 5, 1969, about 350 students picketed in front of the Instrumentation Laboratory, known today as the Draper Laboratory, a symbol of military research. Indeed, until that time, it was not uncommon for students to be engaged in secret research. Libraries had special sections for dissertations that were written under confidential conditions, so that they could control access. All this was to change. Draper Laboratory was spun off to become an independent non-profit research agency. The new credo at MIT was that all campus activities should be open and public, with definitely no secret research where the results could not be made public (Leslie 1993).

The 1970s and gradual re-emphasis on working with industrial sponsors. The beginning of the 1970s marked a financial crunch for MIT. Lyndon Johnson's Great Society could not co-exist with large military expenditures and there were cutbacks in government military expenditures. The spin-off of Draper Laboratory, which constituted roughly a quarter of MIT in size, also created a serious blow to cost structures within MIT. The result was a new focus on industry as an alternative source of funds, mainly led by the administration with an intensive campaign during 1975-80 under President Jerome Wiesner (Johnson 1999).

The Industrial Liaison Program (ILP), a program that had been started in the late 1940s, to provide facilitated access to MIT research, was re-invigorated with a faculty member appointed to head it. The mission and content of ILP has not changed since its inception. It comprises a group of dedicated administrative staff who serve corporate members of the program, who obtain facilitated access to MIT technology through information bulletins; symposia and conferences; and exchange of visits (faculty members visiting companies and company representatives visiting MIT faculty on campus). ILP officers were to provide personalized services to client companies, for instance, by setting up meetings for their visits and accompanying them. The decision to re-vamp the ILP arose out of a confluence of factors. There was a desire to increase revenues from the program, but in addition, working with Japanese companies also provided a unique potential for MIT to diversify its contacts internationally. Several people in relevant positions had good ties with Japanese companies already and were in a position to undertake such a task. As a result of intensive efforts to work with the international corporate community, especially in Japan, MIT opened its first overseas office in Tokyo in the late 1970s.

Emergence of consortia in the 1970s and 1980s. Initiatives to work with multiple companies through establishing consortia began sometime in early 1970s. The Polymer Processing Program (PPP), which started in 1973 was one of the earliest that people remember as a consortium. Working with industry was clearly gaining legitimacy. The Laboratory for Manufacturing Productivity was established as a departmental laboratory in 1977, taking over PPP, and was upgraded to represent all engineering departments three years later. Another center with a strong focus on industrial application, the

Materials Processing Center (MPC), was also established around the same time as an engineering-wide laboratory. The consortium model of research funding was adopted by the MPC, learning from the Laboratory for Manufacturing Productivity. The founding faculty of the MPC, who had previously worked in the Industrial Liaison Program (ILP), added an important new feature to the MPC consortia membership: MPC consortia members could become ILP members at a discount or vice versa.

This marked the beginning of a period when new centers were created with industrial funding rather than with funds from the government. The most visible example was the Media Laboratory. The Media Lab today matches the size of the other two laboratories with similar emphasis on information technology, the Laboratory of Computer Science and the Artificial Intelligence Laboratory, which had origins in government funding, and yet its development was strikingly different from the other two. The Media Lab relied heavily on industrial sponsors while the other two initially grew out of government sponsorship.

The Media Lab in the 1980s. The early ideas for the Media Lab were developed by Nicholas Negroponte in partnership with Jerry Wiesner, the former MIT President. As Wiesner stepped down from office in 1980, he began to work directly with Negroponte, traveling with him to solicit donations and support from a broad industrial community. While the Media Lab activities date back to the late 1970s, the actual opening of the lab took place when the new Wiesner Building was opened in 1985. The level of support they commanded made the Media Lab famous in places as far away as Japan. The subsequent development has been legendary. Its annual resource level grew to $18 million in 2000, reaching the size of the largest laboratories in MIT, and based almost entirely on industrial funding.

An important innovation by the Media Lab that supported such growth was its own consortia arrangements; these have three key characteristics. First, each consortium is relatively large, with up to 50 member companies and a laboratory-wide total of about 150 industrial sponsors. Each member pays a large annual due – in the order of 200,000 dollars annually. Second, members collectively get exclusive rights to commercialize patents arising from the Lab free of charge. Third, consortia are like windows through which to look into the Media Lab and separate consortia do not necessarily have separate research activities.

Partnership with industry for education. By the early 1980s, there was a national competitiveness crisis prompted by strong competition from Japanese industry. MIT became involved in this crisis through at least two separate avenues. Engineering departments were pounded by industrialists in their visiting committees to do something for the manufacturing sector, for instance, to establish a new manufacturing department. As the Dean of engineering considered options, there were parallel activities on campus. Several industrial trustees of the MIT corporation were also urging MIT to take steps. In 1986, MIT convened its "first commission on a major national issue since World War II," the MIT Commission of Industrial Productivity, comprising 16 faculty members from around the campus. The rare interdisciplinary collaborative work resulted in the book entitled "Made in America." When the recommendations of "Made in America" also included one to provide different types of education, MIT could not longer sit still. The two parallel developments led to strong institutional support for a new educational program at the graduate level: the Leaders for Manufacturing Program (LFM).

LFM was an unprecedented initiative in three distinct ways. First, it was based on partnership with, rather than sponsorship from, industry. The stakes were high: 8 founding members were asked to put in up to 8 million dollars per company over 5 years. They were also asked to sit on the governing board and the operating committee, where they were expected to put in substantive "sweat equity." In striking contrast to their usual advisory roles with respect to university activities, these industrial representatives were asked to participate actively in the development of program vision and curriculum and in the operation of the program through internships. Second, it was the first interdisciplinary graduate program at MIT. Students had to satisfy admission criteria both for engineering and for management; they were to work with faculty advisors from each, and were to end up with two masters degrees. The LFM paved the way for later programs such as the Systems Design Management Program, which was started in 199-, a distance-education graduate degree based on engineering and management courses. Third, it was supported by a widely held sentiment of national crisis.

Administrative Reforms: Technology Licensing Office and Corporate Relations. From the 1980s to the early 1990s was also the period when various administrative functions were streamlined in support of activities to work with industry. The sleepy patent office was reformed into a vibrant Technology Licensing Office in 1986 with technical assistance from the former TLO director at Stanford. The Intellectual Property Counsel became a separate and professional function in 1990, and was given a separate mandate, providing support to research sponsorship contracting. It provided a bridge between the Office of Sponsored Research and the TLO on legal issues and worked on legal issues related to computers and networks. In 1989, all activities related to corporate sponsors were brought together in the Office of Corporate Relations, where corporate development activities to solicit gifts and other special support from companies were for the first time, brought together with the ILP in order to make a consolidated corporate focus. The idea was to create a one-stop shop for corporate clients, and to ensure that liaison activities are conducted not only to solicit ILP membership, but to bring broader benefits to the MIT community through multiple avenues.

Emergence of Strategic Partnerships. In the 1990s, the concern that federal funding was going to wane led to a brand new type of relationship with industry: strategic alliances with individual companies. Starting with the announcement of a strategic alliance with a pharmaceutical company (Amgen in 1994 for $30 million over 10 years), there have been 9 such alliance announcements. Closer examination reveals that these alliances have significant variations between them. However, they are similar in the scale and duration of industrial commitment, as well as the management structure in which higher level administrators are represented to help ensure their success.

In the 1990s, more variations to consortia were formed, with some of them truly breaking the mold in the size and nature of their activities. "42 volts" was based on modest contributions, but provided an unprecedented technical forum for the establishment of industry-wide standards among competing firms. More specifically, it was a global consortium of about 40 automobile related companies, where competing companies such as Ford, Toyota, and Mercedez-Benz came together to develop a technological consensus about the move to a higher voltage system in cars. "Oxygen" combined the concepts of partnership and consortia, developing a 6 member industrial sponsor group that supported its programs. Currently, the Microphotonic Center is establishing a new mode of industrial relationship that combines consortia with strategic alliances.

Institutional policies with respect to "outside professional activities." There are two key legacies of the past that underlie MIT's policies about outside work by faculty: the role of consulting and the concept of externally supported salaries. The MIT community believes that academics have consulted for industry and earned external income throughout the history of MIT, although there are no specific historical records to prove this. As early as 1939, MIT's Policies and Procedures specifically described service to industry through consulting as important, provided that it did not interfere with the direct MIT responsibilities. One senior faculty recalls how it was normal for engineering faculty to consult when he joined in the early 1950s. Former MIT President, Howard Johnson recollects in his memoirs how he started to consult both "to supplement my income and build my experience in the field of organization."(Johnson 1999) In addition to his initial MIT salary of $10,000 in 1955, his consulting income was significant at $6,000.

The loosely defined rule that faculty can allocate one day a week to outside activities such as consulting is first mentioned in MIT's Policies and Procedures of 1945. However there have been subtle changes in the application of these rules over the years. One faculty member recalls that in the 1960s, intensification of faculty members engaged in start-up activities led to serious concerns about conflicts of interest. There was one case where one professor in mechanical engineering was specifically asked to choose between working for MIT and working for his firm, and this led to the formation of a special faculty Committee on Outside Professional Activities in 1963. In 1966, the policy that faculty members should disclose their outside activities to their department heads is first mentioned in Policies and Procedures.

Today, the norm is for faculty to submit annually to department heads, a signed form describing all their outside activities and the amount of time spent, and stating that they see no conflict of interest. In the 1970s, there were further clarifications made with respect to the meaning of "one day a week" to specify the fact that it was one day per calendar week, and not one day out of the 5 working days. This detailed clarification may seem unnecessarily fastidious, but it followed a national scandal where some academics at another university were found to be charging more days than were possible in a year when consulting and campus days were added together. These rules are not necessarily enforced, largely left up to the discretion of the individual faculty, and so, some faculty members suspect that there may be some divergence between the reality and what is on the books.

Another practice that powerfully shaped faculty behavior was the traditional expectation for engineering faculty to develop sufficient external research support to cover 50% of their compensation. This was a practice that became adopted in the 50s and 60s, when there was a massive expansion of MIT, particularly of its Engineering School. The number of faculty members grew from just over 250 after World War II to 1,000 in 1970, fueled by the massive support of federal government. The practice to charge some of the salary costs to federally funded research became a norm among universities not only at MIT. It was only in the 1980s that the requirement to have faculty salaries supported by "soft money", or by external research contracts, began to be phased out, partly spurred by the price competition among universities. As of May 2000, 95% of the engineering faculty salaries were supported by "hard money," non-restricted money arising from tuition and other institutional revenues. It is only for the summer 3 months that faculty would charge externally funded research.

The most recent change in policies about potential conflicts of interest occurred 2 years ago. Students are now not allowed to take part in work in which their faculty supervisors have financial interests. This appears to have arisen with various scandals that came to fore, including the aforementioned one where a student claimed that he could not do the homework, because he was bound by the non-disclosure agreement to a company started by another faculty (Marcus 1999).

Today, MIT's policies are quite clear. Faculty may engage in external work up to one day a week. Faculty may not assume line management positions for outside organizations. They can take a leave of absence, which is given quite liberally, should they wish to concentrate on external activities such as start-ups. Faculty may not receive sponsorship money from companies of which they are a part owner. Faculty members are not expected to receive research sponsorship from companies for which they consult, but this policy is somewhat more loosely applied: they can do so provided that there is no conflict of interest.

Cambridge University

Foundations. Cambridge University is nearly 800 years old. Among many of its boasts, one that is relevant to university-industry relationships is its historical tradition in mathematics, accentuated by Sir Isaac Newton in the 17th Century. Indeed, Cambridge was so strongly dominated by mathematics that even classics students were expected to first prove themselves through examination in mathematics. It was not until the establishment of the Cavendish Laboratory and the Engineering Department towards the end of the 19th century that experimental science and engineering became established in Cambridge.

The Cavendish Laboratory was established in 1871 as Cambridge's physics department, with support from a benefactor. In spite of its reputation in pure sciences, it also has a legacy of early spin-offs such as Cambridge Instruments (1881), established by two graduates including the son of Charles Darwin, and Pye (1896), established by a laboratory technician, as documented in "the Cambridge Phenomenon" (Segal Quince Wicksteed 1998). This tradition lives to this day, as symbolized by the fact that the current Cavendish Professor, the most prestigious chair in the Cavendish, is known for two spin-off companies.

Although close in time, it was not as easy to establish the Engineering Department, which was started in 1875 with an appointment of a professor of mechanism and applied mechanics. The word "engineering" was rejected in the title with a disdain about applied subjects. The founder of the Engineering Department had a difficult time with the university, "particularly with regard to the value of the workshop in the teaching of engineering" (Engineering 2000), and this eventually led to his resignation. His successor, Sir James Alfred Ewing, was more adept at working with the university and persuaded them to establish a complete School of Mechanism and Applied Mechanics.

World War II. World War II represented a less dramatic transition for Cambridge than it did for MIT. Perhaps the only common factor across all departments was that there was an inevitable gap in activities as scientists had to return from their military research work and re-engage in their civilian research (Wilkes 1985). Indeed the impact of the war was felt differently by different departments. For the Cavendish, the war represented a period of reduced research activities as many scientists were taken away into wartime research activities, most notably for the development of radar. The celebrated legacy of atomic physics, from J. J. Thompson's discovery of electrons to Cockcroft and Walton splitting the atom, was to come to an end as the war had transformed atomic physics into "big science" that was unsuitable for Cambridge structures (Cambridge website http://www.phy.cam.ac.uk/cavendish/history/). Recognizing the difficulty in regaining its supremacy in atomic physics, the Cavendish leadership looked into new applications of physics including molecular biology. DNA deciphering by Crick and Watson in 1953 shows the success of such new approaches that opened Cambridge's new era in biological sciences, though they soon moved from the Cavendish to join other biological research groups in Cambridge.

The Engineering Department was relatively successful in recovering from the war. The department head appointed in 1943 had extensive work experience with the government in wartime research as a scientific advisor, which had strengthened his belief about the role of scientific methods in addressing practical problems. Based on his carefully developed plan, the Department launched into an era of unusual expansion, particularly in research (Engineering 2000).

Early work in computing had been undertaken in the Mathematics Laboratory established in 1937, which was soon taken over by the government during the war. After the war, Maurice Wilkes returned to head the laboratory and turned it into the Computer Laboratory. His success in developing one of the first computers led to subsequent efforts in software and applications. The Computer Laboratory became another hub for technology start-ups, including Acorn Computers.

Early developments in relationships with industry. It was not until the 1960s that the University engaged in serious reflection on relationships with industry. The increasing awareness that isolation from industrial laboratories was not good for the university led to a report from a university sub-committee under Sir Nevill Mott, the head of the Cavendish Laboratory in 1969. The report addressed the need to link teaching and research to applications in industry and pushed the local planning authority to remove its tight restrictions on industrial growth in the region. Following the Mott recommendations, Trinity College established Cambridge Science Park in 1970 (Segal Quince Wicksteed 1998).

Another notable development was the establishment of the Computer Aided Design Center, supported by the Department of Industry. The Wolfson Cambridge Industrial Unit was established in 1971 to demonstrate the technique to industry. The first notable industrial liaison was probably the Whittle Laboratory, opened in 1973, which focused on turbo-machinery with 10 year support from Rolls Royce.

Uncertain years in the 1980s. The 1980s marked an unprecedented change in government policies for higher education with real budget cuts and increasing demands for accountability. Cambridge was perhaps one of the fortunate universities with successive leadership that led it through two decades of tight finances. As early as 1981, the then Vice Chancellor (who later became the head of the University Grants Committee where he introduced vigorous reforms in university funding as well as the Research Assessment Exercise), Sir Peter Swinnerton-Dyer, announced that "universities cannot hope to pass through the next few years unchanged, and we shall all have to learn to live with less resources than we have become accustomed to." He set forth an ambitious early retirement plan, whose success saved the university from dire consequences in the first few years. He noted that these funding changes reflected not just the economic circumstances, but the government's belief that universities needed to reform and that the only way to induce them to reform was through financing (Cambridge Reporter 1981). Indeed, starting from that time till 1995, there was scarcely a year when the vice chancellor did not lament the tough financial conditions, with funding increasingly used by the government to reflect policy concerns (Cambridge Reporter, various issues).

Emerging focus on industry as a source of funding. Attention was gradually turned to developing alternative funding sources, most notably through better linkages with industry. In 1982, the organization of the Wolfson Cambridge Industrial Unit was reviewed to explore possibilities for introducing an MIT type membership-based industrial liaison program (Jennings 1991). Although the conclusion was that there was insufficient demand to command fees from industrial partners, the unit was remodeled to take overall responsibility for establishing better linkages between industry and the University, and was moved out of the Department of Engineering to the University. By 1984, the University was hopeful of its assuming new roles in technology transfer. With the break-up of the British Technology Group in 1986, the Wolfson Cambridge Industrial Unit formally assumed all responsibilities for technology transfer, through a university-owned company. In 1990, it was instrumental in establishing the Cambridge Quantum Fund, a venture capital fund in support of early start-ups.

Changes in governance. Another change was a direct response to the Jarrat Report of 1985, commissioned by the Committee of Vice Chancellors and Principals. It provided a set of recommendations both to the government and to universities on measures to improve efficiency. The initial Cambridge reaction to the report was favorable, as they agreed on its recommendations to the government (Reporter 1987). It was only in 1987 that they realized that the real implications of the report: the government intention to link increases in funding to efficiency gains as recommended by the Jarrat report. This meant that Cambridge had to improve management and accountability of line departments, and clearer leadership by vice chancellors.

For the first time, Cambridge recognized that any new activities of the university required external support, which in turn required the University to have the ability to respond quickly and with a single voice – in short the office of Vice Chancellor had to be strengthened (reporter 1988). A syndicate to review university governance was commissioned in 1988 and its recommendations were formally approved in 1990. Their recommendations included strengthening the Vice Chancellorship from the current rotated 2 year terms among college masters, to a full-time appointment of 5-7 years. Although not all of the recommendations were adopted, in 1992, the incumbent Vice Chancellor became full time, and various other organizational changes were made in support of stronger central management.

There were also developments in organizing fund-raising. There was an early recognition for the need for increased benefaction. In 1989, Cambridge Foundation was established effectively to manage Cambridge's endowment funds. In 1990, the first professional Development Office was established to conduct fund-raising and planning effectively. In 1991, a strategic plan for developing real estate in West Cambridge to house Cambridge's scientific and technological activities was approved by Cambridge's governing body, the Regent House.

Evolution of embedded laboratories and its variations. Another change was the evolution of "embedded laboratories" where industry supports university research activities while locating its own laboratory on university premises. Because of the Whittle Laboratory in the 1970s, the idea of having close relationships with support from industry was not new. In the 1980s, as the need for external support for funding expensive research became more acute, individual faculty members began to make isolated efforts. For instance, in the mid 1980s, one lecturer who was also the research director of a start-up company, was asked by another company which was about to buy the start-up company, to establish an industrial laboratory. With support from the Head of Department to assume such a responsibility as a faculty member, he became the first faculty formally to hold dual positions overseeing both an academic laboratory within the university and an industrial lab. Another entrepreneurial faculty member negotiated the building of his laboratories with the support of Hitachi, Toshiba, and Schlumberger. Since Schlumberger already had its premises in West Cambridge, it was no surprise when Hitachi expressed interest in building its own laboratory there. What was distinct in this plan was that the MRL was to be built in a building shared by Hitachi. In other words, Hitachi's Cambridge Laboratory was to sit next door to the MRL.

These early examples of industrial laboratories with close ties with the university occurred without much central attention. It was only when a bigger venture such as Microsoft materialized later that the notion of "embedded laboratory" came to the fore. The idea to work with large corporate partners was further experimented through BP and Unilever, though resulting partnerships have very different organizational parameters. Seiko- Epson was another company which opened its own laboratories in Cambridge based on close collaborations with several laboratories of the university. Marconi is the latest to be added to the series that have pledged to open their laboratories in Cambridge.

Getting the administrative infrastructure in place. There was another round of administrative changes in support of better linkages with industry. The Research Services Division was established in March 2000, merging the Wolfson Industrial Liaison Unit and the contracting office, and considerably expanding its capacity. Around the same time, Cambridge won its bid for the University Challenge Program, , from where it obtained seed capital for venture capital financing. It also won government funding under the Higher Education Reach Out to Businesses and the Community (HEROBAC) program to establish their own Reach Out Office – a new kind of corporate liaison office. It also won funds from various government programs to support the development of entrepreneurship.

Tokyo University

Foundation. Tokyo University was established in the late 19th century by the Meiji government as a critical instrument for modernization. Initially established as separate schools that were combined to become the first Imperial University in 1886, Tokyo Imperial University had a focus on professional practice such as engineering and agriculture. As Meiji reformers were selective in their choice of model countries depending on the field, different colleges and disciplines had slightly different historical legacies as to how they came to be established.

In industry, the UK had been advising the Meiji government about the need to establish a Ministry of Industry together with a College of Engineering, with a view to establishing critically needed expertise for government and the private sector alike. The 25-year old Henry Dyer from Glasgow was nominated to become the first Principal of such an establishment (Miyoshi 1983; Tokyo daigaku hyaku nenshi iinkai 1984; Odagiri and Goto 1996). Though young, Dyer had had ambitions to reform engineering education in the UK and had made some preliminary investigations as to how engineering education had been done in other countries. According to him, engineering education at the time followed either the continental European model with a focus on theory and sciences or the British model based on crafts and practice. To him, neither was adequate and the ideal was to be found in combining the two. It was this ideal school of engineering that he established with his youthful energy in Tokyo in 1873. Its innovative approach won instant fame and was reported as early as 1877 in Nature (Miyoshi 1983). Dyer himself was so jubilant with the success of the school that he actively promoted the same approach in some colleges in Scotland upon his return (Odagiri and Goto 1996).

Early years. Graduates and professors from the Engineering Department of the University of Tokyo were critical to the modernization and industrial development of Japan (Tokyo daigaku hyaku nenshi iinkai 1984; Odagiri and Goto 1996). The Japanese government invested directly in key production facilities such as steel and textiles in order to prime industry with modern technology. While most of these facilities were later sold off to private manufacturers, this period of government-led experimentation made the role of the Engineering Department simpler – even the government employees needed to have hands-on technological knowledge. From nameless small factories to those that survived to become leading manufacturers such as Toshiba, Hitachi, and Toyota, engineers from Tokyo University were the key executive and engineering resources in the adaptation of foreign technology (Odagiri and Goto 1996). For example, Toyota Motors was started by an engineering graduate from Tokyo University who effectively used his ties to his professors and classmates to assemble the required technical expertise. Clearly, the Engineering Department was built upon the ethos of science informing practice.

There was an early interest in developing the aircraft industry. In 1909, six years after the Wright brothers made the world's first flight, a study group called the Temporary Research Committee on Military Balloons was formed, comprising the Army, the Navy and the University of Tokyo, to conduct aircraft research (Odagiri and Goto 1996). In 1918, the Aviation Laboratory, along with a specialization on aviation, was established in the Engineering Department. Tokyo University produced many engineers thereafter, including graduates such as to Jiro Horikoshi, the chief engineer who designed the Zero fighters which caught the world by such surprise during World War II.

Within the Engineering Department, a General Experimental Station was established in 1939 with a view to working closely with industry. There were many deep collaborative engagements with industrial engineers coming to work in the center. During World War II, the government mobilized all scientific and engineering resources from universities and private industries alike (Tokyo daigaku hyaku nenshi iinkai 1984). Tokyo University was forced to work with the military government, with an ever increasing need for engineers. Tokyo University selected a former Dean of Engineering, who was then working for the military, as their president, in hope of improving the tightening government relations. He and his successor who was also an engineer, served as wartime presidents and under their leadership, the engineering faculty expanded rapidly. Indeed, Tokyo University was given enough resources to establish a second engineering faculty.

After World War II. The end of the war marked a striking contrast in the path for universities between those in a winner country and those in a loser country. Whereas MIT with its Radiation Laboratory was enjoying a new national reputation for success, significant engineering facilities such in Tokyo University were meeting serious internal scrutiny prompted by fear that the Occupation government may dismantle them as a punishment for their involvement in war-time science (Tokyo daigaku hyaku nenshi iinkai 1984). Academics went through a period of collective reflection with a new awareness about the need to maintain academic autonomy from the adverse influence of government or industry.

Engineers moved quickly to rename all of their war-related divisions within a month of the defeat. By the time the General Headquarters of Allied Powers in Japan (GHQ) announced their policy to ban all aviation related research, most Tokyo University aviation groups had been reconstituted into other groups. The first faculty of engineering had renamed three of its divisions with strong military ties. The second Engineering Faculty had also done the same, and proceeded to reconstitute itself as the Institute of Industrial Science (Tokyo daigaku hyaku nenshi iinkai 1984) with a well-articulated civilian mandate to serve the production needs of companies. The Aviation Laboratory was reformulated into a Science Institute.

The post war period marked a period of relative isolation for Tokyo University from industrial and governmental contacts. There were strong emotions of regret among the intellectuals with respect to the military role played by universities during the war. The general mood was to re-establish academic autonomy, rather than to serve societal needs. This must have been a complex period for engineering related groups. On the one hand, isolation from industry did not make sense given their engineering mandate. On the other hand, their immediate legacy of working closely with the military government was nothing to be proud of. The distance between industry and academia appears to have grown slowly. The inability of faculty members to work for industry under civil service law, and the lack of mechanisms for the university to receive external funds to conduct research, all fed each other to further the isolation. In the development of university-industry relationships, "we got behind (the other countries) by about 20 years" as several senior academics pointed out.

Student Unrest. Twenty years after the end of the war, the engineering faculty members were to meet another round of criticisms, this time from the students. The 1960s represent a decade of leftist attacks and student unrest, culminating in the upheavals in Tokyo University in 1968. It was so out of control that the central administration brought in defense forces and police to calm things down, only to fuel anger among students. Interestingly, the final reconciliation statement proposed by students and agreed to by the university included a line that condemned academic collaboration with industry that served their capitalist interests (Tokyo daigaku hyaku nenshi iinkai 1984). One Engineering Dean who resigned in the aftermath, published his final reflections about the whole affair: while clearly stating that engineering cannot survive without collaboration with industry, he agreed to remain critical of engineering as a discipline contributing to the creation of environmental hazards, or to capitalist interests (Moriguchi 1969). Another engineering professor with active industrial involvement criticized the student statement and proposed that only certain types of collaboration with industry were to be avoided (Moriguchi 1969). The then director of the IIS also gave a cautious interpretation of the joint statement that it is the loss of academic autonomy rather than collaborations with industry that should be criticized (Isshiki 1969). The Engineering Department had to renew its resolve to maintain its distance from industry. Interestingly enough, because student protests were concentrated in the main Hongo campus, their effect did not seem as strongly felt in the other campuses. The IIS, in its remote campus, where there were hardly any undergraduates, appeared to come out of the period relatively unscathed.

Industry still valued graduate recruitment from Tokyo University, but was using it for its selectivity process, rather than for its education. Indeed, there was a period until the early 1980s when industry actively spurned education by the University, indicating that they had more faith in their in-house training than in university education.

During such a period of isolation, key collaborations took place through national projects with multiple industries, typically sponsored by MITI, to which academics were invited to contribute. Tokyo University professors actively participated in such projects. However, since there was no mechanism for national universities to be able to receive funds from other Ministries, their involvement did not lead to substantive research collaboration. One exceptional example of collaboration took place with Hitachi, which supplied a supercomputer for the University. The academics using the computer actively engaged in discussions with engineers and managers from Hitachi, providing substantive and technical feedback on the way the computer worked.

Developments in the 1980s. In the early 1980s, a Joint Research Scheme was introduced by MOEC to enable private industry to work with national universities. Joint research activities finally began to grow, slowly but steadily. Until then, there were two other financial channels through which industry could work with Tokyo University: scholarship grants and contracted research. The difference with the Joint Research Scheme was that there could be explicit support from the government in a way that matched industrial contributions to support collaborative research. Even then, there was little budgetary support for activities such as patenting. Professors who wanted to get their inventions patented were implicitly encouraged to go their own way or to do it through corporate partners.

The most significant development in the 1980s was the perception that significant investments were being made by Japanese industries overseas, particularly in American universities. NEC's agreement to endow a chair in its name at MIT in the early 1980s created an outcry in Japanese universities, which felt deprived and neglected as they went through zero-budget increases throughout the 1980s. Tokyo University approached NEC to obtain similar support.

In the late 1980s, the former Aeronautical Research Institute, which had been reformed several times, was to be finally reformed into the Research Center for Advanced Science and Technology. One key feature of the lab was to have endowed chairs, which were introduced as new mechanisms to introduce mobility and to bring in fresh blood from the outside. Based on corporate donations, a typical endowed chair was to provide several fixed, typically 3 year term positions for visiting professors. There was significant internal opposition to the proposed scheme, where the expressed fear was of contamination by corporate interests. In the end, whereas NEC's chair at MIT meant a full professor in the field of their interest who would give NEC special attention through visits, Tokyo University did not agree to provide any such services.

Several Tokyo University professors described how badly they were handicapped by the internal opposition to establishing endowed chairs. Interestingly, to demonstrate the extreme nature of the opposition, they refer to the fact that they were not allowed to recruit people from the donating company into the positions. The fact is that such a practice was not at all common, and would certainly be considered strange, even in the Western systems. If positions were to be given to their own employees, why would a company need to establish a chair in the first place? For Tokyo professors, however, the idea of endowed chairs was naturally linked to the idea of placing people from the same company – almost as though it were an extension of the company employment policies.

Developments in the 1990s. There has been a rapid change in the organizational structures for collaboration with industry in the late 1990s. The Center for Collaborative Research (CCR) was established in 1995, providing space for industrially active academics for their collaborative research, and developing a database of the industrially relevant research projects that were being proposed by the academics. Another laboratory was established in 1999 to explore different ways to work with industry. Technology Licensing Offices (TLOs) were also established in the late 1990s to support academic patenting and the licensing of inventions.

There has also been a sea change in the regulatory framework for academics working with industry, though through incremental changes over the decade. The most important change in the rules concerning university-industry relationships is the permission for faculty members to consult for industry. Although up front approvals are still needed, an academic can now work as a consultant for any industry to provide technical advice or as a board member in a company commercializing his/her inventions. There has also been considerable deregulation in the financial controls, with a gradual relaxation of line-item requirements and permission to use multiple year contracts. In the short term, however, these incremental changes are hard to keep abreast of, as every year, there are slightly fewer requirements, but they are introduced and implemented unevenly across different categories of contractual relationships. For instance, most academics were not updated in their understanding of the current rules about what categories of money can be used for what. There has been an unevenness in understanding even among university administrators, for instance, in terms of which category of money can be used for post docs, and what are the applicable overhead rates. In the medium term, these measures are consistent with the move to greater financial autonomy under the proposed legal separation of national universities in 2004.

Contrasting the three organizational histories

There are three historical events, in particular, which exerted considerable influence in shaping the norms and values as well as the governance structures of the three universities: organizational founding; World War II, and the student unrest of the 1960s.

Foundation. Interestingly, the foundational values or mission statements exhibit the least different legacy in the departments and groups that are relevant to university-industry relationships in the three universities. That the original organizational goal of MIT was to contribute to the application of science is well-known and well-remembered. It is interesting to note that the Faculty of Engineering of Tokyo University was built with a similar emphasis on the applications of science. Henry Dyer realized his dream curriculum by marrying theory and applications, believing it to be the first "modern" program in engineering in the world. There is a much less direct emphasis on applications in the founding of the Cavendish Laboratory. However, both the founding father of the Department of Engineering and his successor, Ewing, explicitly attempted a similar dual focus on applications and science.

One striking difference related to the foundations is the difference in governance structures. MIT was founded as a private institution with its own board of trustees, called the Corporation. By the time MIT was born, the norm of having lay boards accountable to the public had long been established in the US (Bailyn 1991). Cambridge developed as composite bodies of private colleges and a university that was responsible for examining the students. The university had a legal status separate from the colleges, but was a relatively weak body; it was governed principally by its own members. Tokyo University was an amalgamation of various government bodies established in the late 19th century. Various schools and faculties had been founded independently, but were brought together later to form an imperial university as integral part of the Ministry of Education and Culture. Built as an instrument of the government to help Japan attain economic growth, the imperial universities had no separate governance structures, but were integral part of the government. This is the origin of the independence of the schools and faculties on the one hand, and the nominal governance responsibility by the Minister of Education and Culture on the other.

World War II. World War II was the next historical event that had a systematic influence on the three schools. Dubbed the Physicists' war, this war was different from World War I in the way science was systematically mobilized by all nations. The way in which scientists were mobilized during the war, as well as the actual results of the war, both provided a lasting influence on the three universities. MIT was central in the war science effort, as the radar project, one of the large national projects, was housed in the Radiation Laboratory on campus. Being a site for a major national war effort meant that there was a large inflow of exceptional scientists throughout the period. The success of radar became a firm source of pride for MIT, and its legacy, both in terms of the importance of interdisciplinary work as well as the relevance of basic science to application, was to shape MIT's subsequent actions.

The path taken by Tokyo University could not have been more different. The ultimate loss of the war meant that all the technological glories that the university scientists could have claimed were to go to oblivion as quickly as possible. Instead, the academics were to face a new life of remorse and loss of confidence, from which stemmed a new weariness of external influence and a resolve to remain autonomous both from government and from the military. Many of the militarily successful laboratories and groups were disbanded by the Occupation, and military research was turned out of the campus.

The experience of Cambridge was somewhere in between. There was far less sense of glory or success for the scientists, and far more a sense of the need to re-assemble scientific ventures back at the universities, but there was no loss of face on the part of the scientists. The scientific enterprise at universities continued as it had been prior to the war. 1945 marked the moment when the three universities began pushing science in completely different ways.

Student unrest. The student unrest in the 1960s constitutes another historical event that shaped the orientations of the three universities. In the US, student protests centered on the role of the US in Vietnam, and at MIT their main target was military research. While pickets and demonstrations on campus were mild in comparison with other campuses, their focus on the military involvement of MIT eventually led to the spin off of the Instrumentation Laboratory and a new principle of having no secret research on campus. While the Lincoln Laboratory remained affiliated to MIT, students' involvement in secret research there also became regarded as unacceptable.

In Japan, student unrest followed decade long criticisms about the American role in Japanese national security. The national universities had already shed their responsibilities in military research, which had been scaled down drastically since 1945. The main target for students' criticisms therefore became focused on university involvement with corporate sponsors. University-industry relationships as a direct target for attack was followed by the subsequent administrative disputes in the 1970s. As a result, working closely with industry became taboo for the academics. The student unrest had a differential impact across the three campuses. Hongo, the main site for historical clashes, was hit the hardest, while Roppongi and Komaba were relatively quiet. Interestingly, Cambridge and the rest of UK universities suffered relatively little from student unrest, aided by the fact that there was no specific socio-political debate that pushed students to fight.

Clearly, organizational foundation is important but not all encompassing. As we saw in the case of MIT or Tokyo, it is possible for a university to be built with one mission and drift to another. Tokyo University is perhaps an extreme case, where they were almost forced to change owing to external reasons. The point is however, that imprinting does work, but it is not all pervasive.

4-4: Two historical legacies

Clearly organizational history matters, but how can we be more specific than that? It seems that history influences the way things are done at any given time through two distinct mechanisms: through governance structures, which influence the way new decisions are made formally; and through existing norms and routines that are themselves historical legacies.

Governance structures

Governance structures are largely the legacy of the foundation and they tend to be changed only under specific and subsequent reforms. They are very different in the three institutions. As shown in Table 4-9: MIT has a clearly centralized structure with a single board of trustees, while the Regent House, the governing board of Cambridge has a considerably more dilute authority. For Tokyo University, the nominal authority rests with the Minister of education, but in real terms, this level of decision making rarely takes place.

MIT is a centralized structure, unusual even among American universities, in which the Board provides active support and guidance to the central administration. Important in this configuration is the fact that there are many individuals with industrial connections who sit on the Board and who bring an industrial perspective into the operation of MIT at the highest level. Another mechanism, related closely to governance, is the system of visiting committees, each of which is a group of 20-30 individuals again including many from industry, with a mandate to review the overall activities including education and research in a department and report to the Board. This is another mechanism through which industry perspectives are brought into the strategies at departmental level. The budgetary and personnel processes are also centralized, whereby departments play a significant role in proposing, but the final decisions remain in the hands of the central administration. On personnel matters, it would be unusual for the central administration to overturn departmental or school proposals. On budgetary matters, the central administration plays a more significant role, particularly on expansion, with advice from specialized committees.

The governance structure in Cambridge is communal, with Regent House as the supreme university body essentially comprising most of the academics who have permanent positions in the University. The Council consists of elected representatives of Regent House. Traditionally, there was a "troika" system of the Treasurer responsible for financial matters, the General Board and its Secretary with a mandate to oversee academic matters, and the Registrar responsible for student affairs. The Vice Chancellor post was little more than a nominal position held by one of the college heads, on a part-time basis and only for 2-year terms. Since the 1980s, there has been a reform of the governance, whereby the Vice Chancellor became a full-time position, to work with appointed pro-vice chancellors. The administration is becoming streamlined with the Registrar as the single administrative head, and the Council becoming an executive body focused on policy issues.

Another characteristic of Cambridge is the traditional power of department heads, who have considerable authority over resource allocation within their departments The managerial responsibility of department heads also appears to have become more pronounced through the tight budget years in the 1980s and 1990s.

Table 4-9: Governance structures in MIT, Cambridge and Tokyo

	MIT	Cambridge	Tokyo
Highest authority	The Board of Trustees, known as the Corporation comprises about 75 individuals, including many with industry experience. The executive committee of the Board meets monthly	The Regent House comprising about 3,000 teaching and other members of the university and colleges	The Minister of Education, nominally, though this authority has not been exercised in practice
Executive body	MIT Academic Council serves as the President's cabinet, and includes about 20 senior administrators, including provost, deans, vice presidents.	The Council is the principal executive body comprising 20 elected members of the Regent House chaired by the Vice Chancellor	Senate, comprising all heads of faculties and institutes, and 2 elected members from each faculty or institute..
Central administration	President (academic) Provost (academic) Chancellor (academic) 6 Vice Presidents (academic and admin) 8 deans (academic and admin) Director of library (admin)	Until recently, part-time Vice Chancellor who was also a college master, with a 2-yr term Registrar (admin) Secretary general of the General Board (academic) Treasurer (admin)	President Vice Presidents Secretary general
Budgetary	Central administration for the main resource allocation based on proposals from Deans and department heads	Little discretion in the central administration as it allocates resources to facs/depts, following the central government formula. Department heads have devolved discretion within the system.	Ministry for the overall allocation and special projects Faculty senate for within-envelope allocation – tends to equitable distribution
Personnel	Proposed by departments, approved by schools and the university	Faculty boards have the responsibility for final decisions within their allocated budgets, but the colleges have to find some joint postings	Proposed by faculty, traditionally based on unanimous support of the senate. Increasingly, the unanimity requirement is being dropped
Main changes in the recent past	Increase in the number of participants in the Academic Council , the principal executive body	Vice chancellor position became full-time with a longer term, and with appointed pro-vice chancellors. Clearer roles of the Council	Increased number of Vice Presidents The governance structure to be revamped in 2004 when the university becomes legally autonomous

Tokyo University is paradoxically both the most centralized and the most decentralized of the three. Many of the budgetary decisions are negotiated with the Ministry which has the final decision (with support of the Ministry of Finance). The detailed rules of accounting and line-item budgets have been cast upon the university by the Ministry, though there have been constant and incremental efforts to de-regulate in recent years. However, there is also a tradition of allocating resources equitably to all professors, which leaves no room for any discretion or strategizing between them. There is also a tradition of the senate making all decisions based on consensus. This practice, by default, means that every professor has power of a veto.

Norms in relationships with industry

Norms about how to relate to industry are another legacy of the past. In Table 4-10, I summarize the norms as they existed circa the 1970s, before many of the "new wave" of changes began to take place. At MIT, the main modalities of the relationships with industry for faculty were through research contracts and consulting activities. As an organization, MIT also had other distinct features: (a) an Industrial Liaison Program to provide better access to MIT technology from member companies, (b) individuals from industry represented on the Board of Trustees and departmental visiting committees, (c) and student internships. These multiple avenues provided the possibility for some companies to be particularly close to MIT.

In Cambridge, individual faculty members could have relationships with industry both through research contracts and through CASE awards (in which research students worked on a project in a sponsoring company), and through some advisory work and consulting. Unlike regular internship, CASE awards appear to have provided another link between faculty and their industrialist peers, as they are in a position to work jointly with the student(s). Consulting was not a prevalent norm, though working with industry in an advisory position was more prevalent, but not universally so.

In Tokyo, the normal route was for faculty members to have contracted research but some academics also engaged in informal research or advisory work with companies - for which they often received scholarship grants in which the money had least red tape associated with it. It is not clear how prevalent the latter practices were, but it would not be too far fetched to imagine that this is the kind of activity whose volume would be affected significantly in times when there were open criticisms about working with industry.

Graduate recruitment is another important route of relating to industry for all three universities. However, it is also a route whose function does not appear to have changed significantly over the years.

Particularly interesting is the differences in the role of consulting across the three universities. At MIT, it is something that almost all engineering faculty members are expected to undertake, partly to supplement their own income, but more importantly, to keep up with practice. In Cambridge, there are no such expectations, and external

Table 4-10: Norms related to relationships with industry in the 1970s

	MIT	Cambridge	Tokyo
Main modalities	Regular research contracts Prevalent consulting Industrial Liaison Program Industrialists on the Board and on visiting committees Student internships Graduate recruitment	Regular research contracts Case awards: student sponsorship Some advisory work/consulting Graduate recruitment	Contracted research Informal research support through scholarship grants Informal advisory work Graduate recruitment
Role of faculty consulting	Important to keep up with industrial progress and to supplement salary An annual list of external activities including consulting is submitted ex post to department heads with a signed statement that there is no conflict of interest All engineering faculty are expected to be consulting	An individual affair left up to individual academics	Not permitted All external activities are subject to prior and annual approval including detailed time tables to show how they will not affect main responsibilities
Key administrative units	Industrial liaison and fund raising from corporate sources Office of Sponsored Research for contracting Patent office for administrating patents and licensing technology.	Wolfson Industrial Liaison Office, a small unit for promoting contact with industry for Dept of Engineering	Central administrative finance unit for contracting and monetary issues Faculty-level finance units for actual contracts
New modalities and changes	Consortia/collegia Strategic alliances Educational partnerships ILP reform, TLO reform, Corporate Relations	Embedded laboratories Institute/laboratories with collaboration with industry Strengthened WILO Establishment of the Research Services Division	Consortia New laboratories for collaboration with industry Establishment of research support division at faculty and university levels

activities are regarded largely as individual affairs. Nobody is willing to even guess the proportion of academics who consult – but one senior academic hazarded a guess at about 50%. In Tokyo, civil servant professors were not permitted to undertake paid work outside the universities other than committee type tasks for which they may receive small honoraria. Three years later, the number of faculty undertaking consulting is still low. Several academics who were strong proponents of industrial linkages estimated that they would expect to get no more than 20% of academics to engage actively with industry.

Administratively, MIT had an Industrial Liaison Program Office staffed by liaison officers, the Patent Office comprising several lawyers and the Office of Sponsored Research responsible for research contracting - including those with the government. In contrast, Cambridge only had a contracts office and the Wolfson Industrial Liaison Office that served only the Engineering Department. In Tokyo University, contracts were undertaken as part of the finance function by non-specialist units at the faculty and central university levels.

It is against these norms, practices, and structures that changes have taken place. These include, at MIT, the rise of consortia and collegia as well as strategic alliances, and educational partnerships. At Cambridge, they are the embedded laboratories and new institutes, and laboratories. In Tokyo, they are emergent consortia with external secretariats, as well as new laboratories specially developed for collaboration with industry. In each case, these new modalities of working with industry have been accompanied by changes in the administrative infrastructures. It is these changes on which the next three chapters will focus.

4-5. Concluding remarks

At MIT, the effect of World War II was to emphasize the importance of basic science for technological applications. The assumption that it was good to work closely with industry to help solve today's problems was replaced by desires to undertake science to cope with future problems. Interestingly, adopting a more "basic" orientation at MIT did not mean going against the notion of being application-oriented. The assumption was precisely that one needed to be both. And yet, as MIT became accustomed to generous government funding in the 1950s and 1960s, and as industrial connections became less and less, a new framing that working too closely with industry could be counter-productive to scientific accomplishment crept in. The new developments in the 1980s and 1990s appear to represent the swinging back of the pendulum into the other direction, the key change being the reassurance that working with industry can be structured so that one does not have to sell one's soul.

For Cambridge, there have been fewer value swings after World War II. Government funding had already been based on autonomy of science from the early 20th century, and there was no discernible change in the government position, especially as the increases in resources in the 1960s were complemented by increases in the number of universities. If there was any tangible effect of WWII, perhaps it took place at individual levels. Because most of the country's top scientists were systematically drawn into military application, it perhaps led to a generation of scientists who were imprinted in this direction. Nonetheless, on the surface level, the strong preferences for mathematics and purer sciences continued to dominate in Cambridge. Starting from the 1970s where the customer-client principle was established for government contracted research, and as the government increased emphasis on university relevance for the society during the 1980s and 1990s, there has been a gradual increase in overall focus on application-orientated fields. The business school was established as late as in 1990. However, there is no universal comfort level about working with industry.

Value swings in Tokyo University provide an interesting contrast to the above two. Clearly, WWII was a watershed in shaping a new set of values that dictated a move away from the military-industrial collaboration prevalent during the war. Subsequently, two apparently opposing values appear to have developed: that science should be independent of monetary matters, and the other that Tokyo University must contribute to national development. Such values, however, are not uniformly and evenly held across the university. Diversity of values held by individuals as well as different organizational units will be revisited in Chapter 7.

PART III: HOW DID THESE CHANGES TAKE PLACE?

Chapter 5: The MIT Way

The purpose of this chapter is to characterize the nature of institutional change in university-industry relationships at MIT and to understand the organizational factors that have shaped these changes.

As described in Chapter 4, THE main changes in university-industry relationships at MIT are the institutionalization of three types of relationships: (a) the emergence OF industrial collegia and consortia in the 1970s and their proliferation in the 1980s; (b) the emergence of educational partnerships in the 1980s followed by subsequent attempts in the 1990s; and (c) the emergence and proliferation of strategic alliances in the 1990s. In this chapter, I will explore what lies behind these processes of change. I conclude that institutionalization at MIT begins through a specific relationship in a given locale, which is sustained over time, scaled up, and/or replicated into new locales. In the second section, I argue that the way in which MIT defines the organizational boundaries, particularly with respect to memberships, knowledge and physical location, shapes powerfully the nature of initial agreements and the nature of subsequent interactions. Third, I argue that "administrators" play a critical role in sustaining and replicating the new patterns of interactions. Administrators constitute a category that is in fact not well defined or established in universities in general, and have somewhat different meanings in the three universities that I examined. For the purpose of this dissertation, I will use the term administrators to include all the people who engage in administrative tasks, including academic and professional administrators. By academic administrators I mean all those who are academics who have administrative responsibilities such as the heads of departments, deans, provost, or president/vice chancellor. Professional administrators include all the administrators who join the universities without having had an academic career. In the final section, I demonstrate that individuals do not simply play "expected roles" as defined by the organizational boundaries, but provide real inputs in defining and developing the initiatives through active dialectics, which in turn appear to influence the way they are sustained, scaled up or replicated.

5-1. Multiple company relationships: emergence of Collegia and Consortia

Collegia are membership mechanisms for research groups or centers to collect small amounts of money that will be used to provide members with better access to new research results arising from the group. Consortia are also membership-based, but tend to command larger fees that are then used to support a specific set of research activities. Whereas collegia may only give rise to regular annual conferences or newsletters, consortia typically involve the establishment of advisory committees/boards where industry representatives meet academics to discuss research priorities.

The case of a reported consortium is the Polymer Processing Program (PPP), which was established in 1973, supported partly by the NSF as a pilot for university-industry collaboration (Lampe and Utterback 1983; Gray and Walters 1998). This earliest consortium was initiated as a research program by a faculty member who came to MIT with some work experience in industry. Realizing that there were no courses on polymer processing, an industrial technology of increasing importance, he decided to start one, only to find that there was not enough research material to support his teaching. All the knowledge resided inside industry. He eventually persuaded his previous employer to support his consortium by giving up his consulting fee, and persuaded 13 other companies to come together to start a 1-2 million dollar research program. Members paid membership fees calculated on the basis of the size of their polymer operations, and came together once a year to discuss research priorities. The program was managed largely by the single faculty member who brought in other engineering professors to work on specific projects. The model for small consortia with significantly higher level of membership contributions as well as participation was thus established.

A completely different model of a consortium was developed in the Media Lab, and became a lynch-pin for mustering industrial support for this world renowned lab. Following several multiple-company projects in the early 1980s, the Movies of the Future and the Television of Tomorrow (TVOT) were established as membership-based research programs with 8-12 companies. However, these early consortia were little more than a collection of disparate research agendas that were too narrow to provide the basis for bringing together a significant number of Media Lab researchers. It was not until the News of the Future was established with 20 members in the late 1980s that the norm was established for consortia to support a larger theme bringing multiple research groups together. From then on, the Media Lab developed multiple consortia with an increasingly greater level of membership and membership fees.

Consortia became a mechanism through which sponsors and researchers could be bound to a given theme of research. However, in contrast to other centers such as the Material Processing Center, where each consortium supported different activities, the Media Lab consortia were more like different windows to look at the same set of research. All the intellectual property rights arising from the Media Lab were owned by MIT with royalty-free exclusive rights to commercialize shared among all consortia members. All the money raised through the consortia were pooled together by the Lab and shared among all research groups – which enabled the Media Lab to maintain a balance between the high and low risk research projects. One senior researcher/administrator at the Lab explains the role of consortia as follows.

> "One purpose was as a way of telling a story that made sense…we used to describe them as a lens surface to look at in the lab."

The Media Lab today has four large consortia each with 40-50 members at 200-250,000 dollars a year – "very expensive" in comparison with many other similar schemes. One administrator familiar with the intellectual property arrangement of the Media Lab consortia describes it as "one of a kind."

> "It only works because it is a self-contained lab that can live… sponsorship funding is robust enough so that the lab doesn't need anything else. And that is

> why it's able to basically operate as an island under a totally different type of agreement."

Their consortia operate on the basic assumption that the Media Lab only produces basic technology which could be shared by all. It is up to the industrial sponsors to develop specific applications in which they could protect their own intellectual property. The model also assumes that faculty and students working in the Media Lab cannot gain financially from their inventions there.

If the Media Lab developed a model for attracting and coping with a large number of corporate members, Oxygen represents the other extreme model characterized by a small number of members who pay more and work closely together. Oxygen is a 50 million-dollar research program, launched in 1999 with an objective to develop a human-friendly computer environment, so friendly that it would be "like air." Only six companies were invited to be the founding members, paying $1 million each annually. Organizers in the two Computer Science related laboratories that are older and more established than the Media Lab are careful to point out that they are partners, with expectations for intensive and regular interactions. They would be loathe to admit any influence in the design of Oxygen by the Media Lab. This is because the two older computer science laboratories have long looked down at the Media Lab with a complex mix of disdain and envy. And yet, the way in which Oxygen was announced at the Laboratory's 35th anniversary, with its futuristic vision, is strangely reminiscent of Media Lab's THINGS THAT THINK, a large and successful consortium announced at Media Lab's 10th anniversary four years before. Interestingly, the idea of tight partnerships appears to come from the experience that the two laboratories had in a successful strategic alliance with NTT. Clearly, existing relationships matter in the selection of partners, as two other founding member companies also had existing ties with the laboratories.

The final example is a pair of consortia that are currently in the making at the Microphotonic Center. The prospectus for new partners is available on the Web, describing how the center hopes to establish separate strategic partnerships with a limited number of companies, each focussing on a specific technological application. Parallel to that, there will be a consortium for companies to share the development of the technology roadmap. What is not clear on the Web is the evolution of the second consortium, as the negotiation with potential members and partners clarified the need for a more focused membership group. The on-going negotiation is trying to determine simultaneously the scope of the joint work, the nature of the intellectual property rights arrangements, and the size of membership. The preparatory activity is orchestrated by the founding faculty, assisted by a professional administrator specific to the Center, another administrator from the contracts office and a lawyer from the Intellectual Counsel Office to advise on the detailed arrangements, particularly on intellectual property rights.

The founding faculty brings managerial experience from working in an industrial research laboratory. The center's professional administrator brings knowledge from 20 years of running other consortia, and also an intimate knowledge about the nature of technology and science, as he himself obtained his doctorate through work supported by the center. In fact, he represents a category of "administrator" that appears to be quite unique to MIT – fully qualified scientists/engineers who turned to "administrative" jobs and opted to stay at MIT. The people at the contracts office bring in the initial template contract for consortia at the stage of discussing the details. The lawyer from the intellectual property office brings intricate knowledge on negotiating intellectual property rights for all the strategic partnerships as well as for consortia, including those at the Media Lab among others.

The birth of collegia is more recent. One collegium that several interviewees referred to as being the earliest was started at the Material Processing Center in 1980, to provide research information on on-going research activities of the center, for a small annual fee of 10-15,000 dollars. The founding faculty for that collegium could not recall where the idea came from – but he thought that it was nothing new and that similar activities were located in other places within MIT.

What was new? So what is new in these collegia or consortia that did not exist before? By and large, the term collegia applies to cases where multiple companies pay membership fees in exchange for information about a given research group. Since the concept of membership was already well established through the ILP, the new element in Collegia is only that they pertain to a confined group of faculty and researchers. Consortia are also membership-based, but support research programs whose agenda industrial members can collectively and loosely influence, and whose results they share. They also provided opportunities for companies to get to know students and their work, which was useful to companies with recruitment goals.

What is new in consortia is the notion of "loose influence" and "sharing the results," though the level at which these take place can vary from low to medium. The new practices would include annual advisory board/committee meetings where research agenda would be discussed, and increasingly well-defined contractual arrangements where the intellectual property rights would be owned by MIT but shared equally among the members. Another key element that distinguishes consortia from any other practices of the past is the fact that multiple faculty members might work on projects that were related to each other.

And yet, the categories of "consortia" or "collegia" are not defined clearly and unequivocally. There is still considerable confusion, especially among faculty members who only come across a few examples indirectly through having their research funded by them. For them, there is no reason to distinguish carefully among consortia, collegia and centers – from their point of view, they have the same meaning: some group of external sponsors who collectively fund their research and to whom they have to present once a while.

For the faculty members who actively organize them, there are more distinct categories. But again, their clarity is often limited by their own experience. For those who have only organized a center, they know that a center is somewhat different from collegia and consortia, but are not sure why and certainly not capable of distinguishing between the latter two. Only a small number of faculty who have organized all three categories – as well as professional administrators who tend to come across many examples are capable of distinguishing them. The ILP officers are clear about them, because they see them emerge and disappear and are in the position to explain them to external constituents. The contract officers live with multiple negotiations every day. The local administrators may only live through a small number, but they are far more likely to go through multiple cases during their career than faculty because of the nature of their work.

5-2. Multiple company relationships: educational partnerships

The preceding discussions of consortia and collegia have been largely focused on research activities. There have in fact been several cases where multiple companies were brought together for educational initiatives. These initiatives are described in this section.

The 1980s were a period of anxiety for the US economy. There was serious concern about national competitiveness, particularly that of manufacturing industry. One former academic administrator recalls:

> "Around 1980 – Japan is leading in terms of manufacturing. It's very clear that we are behind and we had people who were in industry on visiting committees here, railing and pounding the table that we should be teaching manufacturing. This is what led to LFM."

He was not convinced of the need to start a department of manufacturing as requested by the industrialists, and while he refused such a request.

> "(I) began thinking about that with other faculty – many of us thinking about what to do. I began and went out and started visiting a lot of companies – I think I must have visited 70 over a year and half."

Their early proposal to study the situation was rejected both by IBM and NSF in the mid-1980s. It became clear to the organizers that they needed not only to solicit sponsorship but also to work with industry to address this problem. The Leaders for Manufacturing Program was born out of this historical background and represented a multi-faceted partnership with 6 large manufacturing companies. One senior industry representative at the time recalls how he received the MIT proposal. He was unimpressed by the initial proposal and made suggestions and comments, and it was when they came back 3-4 weeks later that he was struck by the real potential for partnership.

> "And the thing that was so striking to us was this was the first time that we really felt...that they listened to us... Not that they took all our points but it was constructive...(and) at least provided this sense there was going to be real dialogue."

The commitment to partnership with industry was reflected not only in the large amount of funding that was requested from them, but in the real participation expected of them. Industry representatives were to sit not on the "advisory board" which was a conventional mechanism for industrial participation in universities, but on the "governing board" for the program. Industrial representatives also had to put in "sweat capital" and be actively engaged in the development of the curriculum.

Another novel element of the proposal was the fact that two schools, engineering and management, were trying to work together. Indeed, LFM is often referred to as a tri-partite partnership between industry, the School of Engineering and the School of Management. That MIT itself could not be an integral partner, but needed to be represented by two partners is an interesting recognition of the kind of internal divide that existed between the schools, especially when the third partner, "industry," was representing 6 large companies.

While the companies agreed that there was a need for action, none wanted to come forward, particularly to be the first to pledge the $40 million endowment. It was companies with "deep ties" with MIT that were the first to jump. It required active solicitation on the part of MIT – and having solid support from the President, as well as two deans was very important for such an endeavor. Paul Gray, then President of MIT recalls how there was another parallel development in which industrial representatives on the Board of Trustees (called the Corporation at MIT) urged MIT to take action. One immediate result was a multi-disciplinary committee of faculty to think about the issues around national productivity – activities that culminated in the book entitled "Made in America". He recollects that when the book's key recommendations included changing education, he felt obliged to take action. LFM was not born in isolation – there were other activities that implicitly or explicitly created the mood for various parties to come together.

One industry representative had a strong sense that there was a kind of forged understanding about the importance of LFM within MIT.

> "It was clear to all of us that this was not a couple of faculty members off by themselves without institutional support or institutional importance. I mean, they (president, deans and other institutional leaders) knew about it when they would occasionally meet with us or be at a dinner. Yes, they gave the speeches like everybody else but you had a sense that they did not just read this thing before they came in. They had some understanding that this was an important innovation."

The program has been successful in attracting excellent students and has in fact been replicated in other universities. There was a real need for combined education linking engineering and business administration. One striking result of the partnership is the changing careers of the three key champions representing the three partners at MIT. One of the founding co-directors who represented the School of Engineering now teaches at a business school. The other founding co-director, who represented the School of Management is now Dean of Engineering. The former Vice President of manufacturing in one of the active member companies is now the only remaining director of LFM at MIT. "It had a huge impact" for all of them.

Another program, System Design and Management (SDM) was developed in the mid-1990s, following in the steps of LFM and again bringing together the two schools, engineering and management. The champion of the new program was one of the founding directors of LFM, who admits how heavily influenced he had been by the experience of LFM. He had to do something new again. It followed similar footsteps in its preparation – a multi-disciplinary committee, intensive company visits to develop the key concepts behind the curriculum. While the program was successfully launched, it did not do nearly as well in commanding the same kind of commitment from industrial partners. While their views were reflected in the curriculum, their participation became more like "sponsors" of individual candidates. The faculty champion reflects that this time there was no sense of "national crisis" to pull people together. Another difference was the lack of truly committed central academic administrators, who were willing to campaign on the behalf of the program.

What was new? The question is how new were these initiatives? In terms of bringing a small number of industrial partners together to sponsor a new program targeted at working engineers or engineering managers, there are previous examples. One executive management program, the Sloan Fellows Program, was established in the 1930s by the Sloan School to provide education to senior engineering managers; it was strongly supported by General Motors, DuPont and Goodyear. Another program, the Management of Technology (MOT), was established in the 1980s, championed by a faculty for a younger cohort of engineers with aspirations to become future chief technology officers.

These two sets of program development provide an interesting comparison along two dimensions. But before delving into the detailed comparison, one qualification should be made: today, all four programs look to an outsider as equally successful, bringing in excellent students and providing an interesting variation of the main theme of the MBA. So, any comparison has to be with the internal perspective that is largely invisible to the outsiders.

What was the nature of the "novelty" in LFM and SDM, as compared with their predecessors, the Sloan Fellows Program and MOT? One striking difference is in the level of collaboration among the three partners: industry, the Sloan School of Management, and the School of Engineering. Companies were much more than sponsors and actively influenced the nature of the curriculum in LFM and its successor program. LFM perhaps benefited from the special local condition of other activities where school boundaries were being crossed, through Made-in-America and other initiatives. The detailed understanding of its need by the President, as well as the two key deans, paved the way to massive boundary crossing between industry and university on the one hand, and across the two schools on the other. It is for this reason that the birth of LFM is considered by the MIT community as a significantly novel phenomenon. The crossing of the two boundaries – allowing companies to influence curriculum (the legitimate autonomy territory of the academics) on the one hand, and collaboration across the two disciplinary spheres of social science and engineering on the other, were too visible and meaningful a development for other local players to ignore.

The second axis of comparison was the level of organizational support for the initiative. The two programs that have organizational support, LFM and the Sloan Fellows Program, managed to obtain far higher levels of external support than those championed by individual faculty. The main claim to legitimacy was made by virtue of individual persuasion and credibility – because while the organization may have provided the stamp of approval, none other than these individuals were going to campaign actively for them. Again the critical difference is the role of the administrators and the extent to which they were active in the very planning of the initiatives.

5-3. Single company relationships: strategic alliances

The emergence of strategic alliances is often quoted as one of the most visible and significant changes in MIT-industry relationships in the 1990s. 1994 saw the first strategic alliance, with one company committing to an outlay of 30 million dollars over the following 10 years. Since then, there have been eight more cases of such "strategic alliances" (see Table 5-2). While nine may seem like a small number, no other university in the country has yet reached this number. Other universities, such as Berkeley, struggled to establish even one such case, and others are only emerging as a result of observing the example of MIT. In 1994, for a company to invest several million dollars annually was a huge departure from the previous norm – in which individual research sponsorship contracts would typically be several hundred thousand dollars. These alliances collectively produce sizable revenues for MIT. If all of the alliances that were established between 1994 through 1999 were fully operational, their annual contributions in 2000 would have been about $30 million, as compared with the total industrially funded research of $74 million. In reality, all alliances experience considerable pump priming periods, and the actual spending in the early years tends to be smaller than originally envisaged. Nonetheless, this quick calculation shows the significance of this new type of relationship.

Table 5-2: Strategic alliances at MIT

Year	Company	Size	Departments/fields
1994	Amgen	30M in 10 years	Biology Brain and cognitive science
1997	Merck	15M in 5 years	Biology Brain and cognitive science
1997	Ford	20M in 5 years	All MIT
1998	NTT	18M in 5 years	Artificial Intelligence Laboratory Computer Science Laboratory
1999	Merrill Lynch	20M in 5 years	Sloan Engineering
1999	DuPont	35M in 5 years	Chemical engineering Biology Biomedical engineering
1999	Microsoft	25M in 5 years	All MIT
2000	Nanovation	90M in 5 years	Microphotonic Center
2000	HP	25M in 5 years	All MIT

Source: MIT press releases

Origin of strategic alliances

"Success has many parents, and everybody will tell you a different story, but I will tell you the true story," says one central academic administrator with a smile. " If there is a hero anywhere in this, it is B" and he names one professional administrator, B. B was recruited to MIT as a corporate relations officer in the early 1990s having had 20 some years of R&D experience at a technology-intensive company close to MIT, and having been an active MIT alum with two degrees from MIT. Because of the special relationship between MIT and his previous employer and his personal experience as an active alum, B was very familiar with the culture and organization of MIT. As he reflected upon his new role, he developed the idea of forming a large partnership with a single company. He was familiar with several examples of alliances between pharmaceutical companies and universities and personally had the experience of working with R&D partnerships in his previous jobs. All his instincts told him that there was a real opportunity for starting a new kind of relationship. He identified one company as a possibility and approached an MIT professor who had been a founding member of that company. Through the professor, B was able to contact the company's CEO, who indicated his willingness to explore options. B made his first visit to the company in early 1992. Favorable discussions led to other meetings where the Provost and President as well as other academic administrators representing relevant disciplines were gradually brought in.

There was still a lot of work to be done to make the idea fit the MIT ethos. B remembers many faculty critics who were fearful of industrial influence. The question was whether it was possible to come up with an appropriate mechanism to match and link industrial interest and faculty interest, without upsetting faculty autonomy. The active engagement of one academic administrator who fortunately had a great scientific reputation was particularly helpful as he openly decided to exclude himself from the beneficiary group. MIT interest was thereafter represented by an academic administrator with no personal stake. The criticisms and concerns were reflected in the final design of the collaboration, and effort was made to make the mechanism look similar to government funding. It was to be proposal-based – so no faculty would feel pressured to conduct a specific kind of research. Proposals from individual faculty members were then to be reviewed by a committee comprising both MIT and industry representatives. Another concern was that faculty may be stranded should industry be unpredictable in pulling out of its own will. Some clauses were included in the agreement to protect faculty from the possibility of industry withdrawing funding without notice.

The experience of developing this first alliance had a huge impact on the way the central academic administration saw the future of working with industry. It happened right at the time when MIT was exploring options to diversify its sources of funding. The strategic alliance immediately became a new category of relationship that was potentially replicable and multiple efforts were made to replicate it. Several discussions were initiated by central academic administrators with senior executives in industry.

> "By the time that (the first alliance) got moving,....we thought that this was a terrific model. The next thing that happened, just as I was making my rounds....I got to know (the chairman of the company) because we work on the board of (another company) together. We were just getting to know each other. I went to see him and I said to him "you know, we really should be doing things together." (He) said, and this is almost a quote, "Well, I agree. You've got a group of some of the smartest people in the world, and our people are pretty darn good too. I bet if we put them together, they will find something worthwhile doing. Let's try. " So we basically agreed that if two organizations could find something that added value to the organizations, that were consistent with our goals as an academic institution and had some long-term value for the company...that he would support funding at....$3-5 million a year up front."

Faculty members in the relevant field of expertise would then be brought into the picture to carry on the conversation at the technical level, supported by professional administrators.

In another case, the initial visit to a company was made by a group of three, one central academic administrator, a head of one MIT laboratory and a professional administrator. Though the original objective of the visit was to solicit funding for a new building, it became clear in the course of the meeting that an alliance was a more suited avenue given the company's interest. The laboratory head then made a second visit together with other academics in the relevant technical areas to push the discussion forward.

Professional administrators were also quick to catch on. Although the first alliance agreement was put together in an exploratory manner, it became clear that it was an "umbrella" agreement for all sub-projects. Clauses on intellectual property rights, for instance, were to apply to all sub-projects to be funded by them, thereby avoiding repetition of lengthy discussions each time. The second alliance agreement was put together more deliberately, and it became the model for later agreements.

By the time the fifth or sixth alliance was being negotiated, central administrators were specifically targeting their visits around strategic alliances. There were several cases where strategic alliances were negotiated but eventually aborted. In one case, the company lacked a research culture and it was not possible to find a match of interest in research activities between faculty and the company. In another case, the executive-level interest was confirmed, but there was insufficient interest from the R&D group of the company. In yet another case, all the preparatory work had been completed with documents ready to be signed, only to have a sudden change in the corporate leadership. The norm was established whereby the first step was to agree on broad collaborative terms through top level discussions, to be followed-up with detailed discussions involving interested faculty members in related fields.

Nature of relationships with industry under strategic alliances

The nature of the relationships varies significantly both within each of the strategic alliances, as well as between them. This is partly because different alliances represent different interests and objectives, and reflect different structures. Some alliances have a narrow focus on research in a specific field, which means that they focus more on specific departments or laboratories. One alliance has an almost exclusive focus on recruitment of graduating MIT students, while others give less priority to recruitment. Some alliances have a strong focus on training, and others hope to explore several new fields through interdisciplinary research.

Relationships at the project level have also demonstrated a wide range in the depth of interactions. In some projects, there were detailed interactions, with principal investigators reporting how much they gained from their collaborative interactions, and how novel a perspective the interaction brought to them.

> "It was the most intellectually interesting interaction I had in that period of time.... because I don't have company connections, and there was a whole industry side of (the field). And, if I hadn't had that exposure, I would have been excluded from that interaction, because I'm not on the board of any small companies.... this was my access to it. And, I think, without it I would not have been able to keep abreast of what was really happening in the field of (.....). Yup. It was essential to my whole way of thinking."

For others, it was business as usual with minimal interactions with the sponsors beyond regular sponsorship meetings.

> "So, it was pretty much unobligated money. They asked for a progress report each year, which was one page....It was really nice. And then, they did invite me out to give a talk at (----). But they never required anything else of me, and they have a (company)-MIT Symposium where, twice a year, they have some scientists from (the company) talk and some scientists from MIT talk. And so, I've given talks in that forum a couple of times."

One structure common to all was a joint committee comprising MIT and industry representatives to oversee all alliance related matters. For each alliance, there is one central academic administrator designated as representing MIT along with a high level corporate executive on the industry side. Several company representatives saw this as a helpful device to deal with any issues as needed.

What is new? Even though strategic alliances were "new" in their contractual size, they certainly were not the first time that MIT had had a close but bounded relationship with individual companies. Indeed, every decade, there have been a handful of companies that were close industrial allies with MIT. Examples would include the petro-chemical industry in the 30s through the 1960s, and companies such as DuPont, Kodak, IBM, DEC, GM in other periods. It is essential that the nature of these relationships be understood so that the "newness" of the strategic alliances can be appreciated.

Digital Equipment Corporation (DEC) is a classic example of one such "close" industrial ally for MIT. Ed Roberts, in his summary of his 25 years of research on high technology spin-offs in Greater Boston, describes DEC as one of the most significant examples of MIT spin-offs (Roberts 1991). In 1957, Ken Olsen, an MIT graduate and an employee of Lincoln Laboratory, formed DEC together with another Lincoln colleague. They obtained start-up funding from American Research and Development Corporation (AR&D), the first institutionalized venture capital fund, which had been founded through the heavy involvement of MIT President Compton in 1946. Thereafter, Professor Forrester, an engineer, who headed the Digital Computer Laboratory group where Olsen had worked, was on the board of directors for DEC from the beginning. Many key personnel of DEC had come from MIT, several faculty members had close ties either through executive education, research sponsorships or consulting activities, and there was a constant flow of MIT students joining DEC as employees. Olson became a member of the Corporation (MIT's Board of Trustees) in the 1980s and eventually became a life member. DEC was not only a classic high-tech MIT spin-off but also a classic example of a good and dense relationship based on multiple ties.

There were some large research sponsorship projects that entailed deep collaborations between MIT and DEC, the most well known example for which is Project Athena. Project Athena was an extra-ordinary six-year collaborative effort between MIT, DEC and IBM to develop the computing infrastructure to support the entire campus community. The project included 50 million dollar grants in kind from the two companies, and represented the largest ever donation made by DEC. It was unique in MIT's history of industry relationships for two large and competing companies to work together. At the height of activities, there were 10 or so technical staff from IBM and DEC working on campus on this project. How did such an unusual partnership come about?

In the early 1980s, MIT came to realize clearly that they needed financial sponsors to meet their computing goals. A year before the vision of ATHENA was developed in MIT, Carnegie Mellon University (CMU) had announced its Project Andrew with IBM as its exclusive partner. This news came to DEC as a shock, because they had also made a generous offer to CMU to work on Project Andrew (Champine 1991). Following that announcement, DEC was in fact in search of an alternative university to work with on a similar project. The proposal for Project ATHENA arrived at the right time for DEC. It was around that time that one high level executive of IBM learned about Project ATHENA and the possible involvement of DEC during a research meeting with MIT. IBM made it clear that they were also interested in working for Project Athena. MIT eventually reconfigured their proposal to a more ambitious one that covered the entire Institute, and negotiated with IBM and DEC to work together. What the story of Project ATHENA demonstrates is the depth of MIT's underlying relationships. MIT had deep enough relationships with both DEC and IBM to be able credibly to negotiate a joint effort.

What is the difference between these deep relationships and today's strategic alliances? There appear to be two key differences. First, there are contractual and organizational norms in the latter that did not exist in the previous deep relationships, and which developed organically over the years. Strategic alliances are characterized by joint committees, stylized proposal solicitation processes, up-front agreements about the intellectual property rights; and central academic administrators being formally designated. Moreover, these organizational and contractual norms were replicated through the administrators, both academic and professional. The most significant difference may be the underlying change in the role of administration in managing the relationships.

Second, at least some of these alliances were started "cold" and did not emerge over time as did the traditional deep relationships. The relationships were sometimes "forged" rather than allowed to emerge, except that even in these cases, underlying and existing relationships played a key role in the subsequent activities. If one MIT faculty had not been a founding member of Amgen, the initial meeting with the CEO may not have taken place, or would have been more difficult to arrange. Another alliance benefited from long-lasting informal relationships between the MIT research group and its corporate counterparts. DuPont represents one of the oldest ties for MIT with many alumni at all levels of the organization. Whenever the new "strategic alliance" was forged along the contours of existing but largely unarticulated relationships, it worked well. Whenever there were efforts to create one artificially without the underlying relationships, there appears to have been tension.

5-4. Characterization of change

How can such changes be characterized? In this section, I will discuss: (a) the change in underlying values about working with industry; (b) the degree of institutionalization and why some initiatives remain single shot while others become more widely institutionalized; (c) the level of engagement with industry and to what extent the relationship has become more of a dialogue; and (d) the overall size in terms of the number of faculty engaged.

Underlying values: new but not so new. The change in values is difficult to document. However there seems to have been a significant change in the overall values among faculty in terms of working with industry, from one of suspicion to one of acceptance over the last thirty years. One administrator notes that there has been an increasing number of faculty members interested in working with industry.

> "Another change is that a larger and larger fraction of them are getting interested in working with industry and are realizing that you don't have to sell your soul to do so. And that interaction with industry can be very beneficial to the academic process if managed right. A lot of them used to think that it was inherently contaminating."

One former academic administrator remembers

> "Almost all my research has been supported by industry – but I was an exception not the rule. Most of the faculty have had and still do have their money come from the federal government. So, there was a suspicion of industry."

Another faculty member who undertook extensive work with industry in the 1970s recalls distinctly how often he received discouraging or disparaging signals. Though there was some variation across departments, by and large, engineers at MIT had become much less industry-oriented through the 1960s and 1970s. So, it was only in the 1980s and the deepening national competitiveness crisis that brought back to MIT the emphasis on relevance to industry.

It is not too far-fetched to imagine that other universities may be going through similar changes today. What is different in MIT's experience, however, is that the new set of values was nothing new in the history of MIT. The values may have been new to specific individual faculty members or administrators, but they were often those that existed at an earlier period in the history of MIT. The fact that there were historical precedents appeared particularly helpful in legitimating change. If it is not new, then it is reasonably safe.

Images of Institutionalization. The three examples of institutionalization, namely the consortia, the strategic alliances and the educational partnerships, appear to share two common characteristics. First, in all three cases, the process involved an individual or small groups of individuals establishing the first example in some locale. Second, replication appeared to be mediated by administrators, both academic and professional. Faculty members had to be central to each of the local initiatives, but professional administrators played a critical role in enabling the actual implementation. "Imitation" can have a negative nuance, as the attitude of individual faculty may be to prefer to be "innovative" rather than imitating precedents; but it seems that professional administrators were better placed than faculty to create "templates".

Salience of internal boundaries. The LFM case demonstrates vividly that there were in fact two types of boundaries at issue in MIT-industry relationships. There are the obvious organizational boundaries between MIT and industry, on the one hand. On the other, there are the internal boundaries within MIT. The LFM experience showed that these internal boundaries can be as important in meeting the industrial needs, and as tough to deal with, as the external ones. Indeed, discipline based communities in academia extend well outside universities, and they engender a kind of loyalty from their members that can be deeper than those engendered by a university. It is not surprising that these disciplinary walls are difficult to cross.

One critical change in the past 20 years may be that the alliances and partnerships have contributed to crossing such disciplinary boundaries. LFM and its successor program have helped penetrate the disciplinary wall between engineering and management. One strategic alliance with NTT brought together two large established laboratories, LCS and AIL, to work together in a way they had not previously done. That collaboration across the laboratories was made more solid through the joint creation of multiple partnerships named Oxygen. The experience of collaborative work in one Center shows the critical need of interdisciplinary collaboration if scientific work is to support technological development with relevance to application. One professor describes the nature of collaborative work he recently experienced as follows:

> "I've been at MIT for 27 years and my first 17 years, (there was) nowhere near anything like this. And all my other theoretical colleagues (have) nowhere near this type of interaction. And the reason is because this field maybe is unusual in that there is room for fundamental work, basic work, and immediate applications."

Another professor with 20-years work experience in an industrial research laboratory spoke about his surprise in finding little team work on campus when he joined MIT.

> "What I found is that, typically at a university, a professor lacks the infrastructure to support his full research. So, in response to that, they build that infrastructure locally around their own group research effort. And the consequence of that is to more or less isolate that professor's research from their colleagues who may have similar or complementary interests. So, I would say that the one difference that I found (was)...greater parochialism at universities.... Conversely, in industry, particularly in (INDUSTRIAL LAB) environment, the resources are more plentiful....(and) they are distributed in a way to encourage interaction among very competent people...I think MIT has...competent people, but the fact that the infrastructure encourages individual achievement makes it very difficult to take the risk of doing something jointly that may not be supported adequately."

Even simple reporting sessions can be interesting to faculty who get to hear other faculty present their work – something that does not happen in the daily life of an academic, whose work is heavily channeled into a specific area. These are indicative of how infrequently there are collaborative opportunities on campus or elsewhere across disciplinary lines.

Level of Engagement: measured depth but definitely wider. Several observations can be made about the level of engagement between MIT and industry. The emergence of consortia clearly demonstrates a deeper level of industrial presence on campus as compared with collegia or ILP. Similarly, both LFM and SDM involved industrial partners in a far deeper manner than before. Industrial perspectives were actively sought in shaping the curriculum and program design. However, when it comes to the strategic alliances, the evidence is far more mixed in terms of whether they represent "deepening" of relationships in comparison with the other more organic relationships that MIT has traditionally had. Indeed it seems appropriate to see some of these strategic alliances or partnerships as arising from existing deep relationships, as in the case of Athena, LFM, or DuPont. These are the cases where the formalized structure allowed far deeper engagement than before. However, there are other strategic alliances that could not rely on existing relationships and that have not reached the same level of depth in the relationships.

The main change may be that the opportunity to work with industry became available more openly and systematically to a broader range of faculty members, and not only to those who happened to stumble into informal relationships. The strategic alliances also provided a more systematic avenue for the involvement of companies in the selection of research projects. Companies share selection responsibilities with faculty, providing an opportunity to get to know and work closely with key faculty representatives on campus. They can then influence campus research and education through funding and subsequent interactions. There were cases where this was explicitly done, as in the case of LFM.

In most research activities, however, it was rarely "explicit demands" from companies that influenced research agendas, since these tended to invoke the opposite reactions by upsetting the sense of academic autonomy. It was informal interactions and active interest expressed through discussions by industrial representatives that could subtly guide researchers into new directions. One faculty describes the pull of an appreciative audience as follows:

> "Let me tell you what an MIT faculty member is most interested in. It's that somebody walks in and says I am interested in what you do. [...] "I read your paper, professor, and I am interested in what you do." Well I can tell you it's very seductive to have a big important [INDUSTRIAL] company walking into your office saying "I am interested in what you do, we are willing to pay you to do more of it faster and we would like to work with you in that regards. Because, well, I can't tell you the details, it is extremely interesting and important to us." That's extremely seductive to an MIT faculty member. The alternative is I send the proposal to NSF – there is a wall there. I don't even know who reviewed it... I get the money and I am working on this idea in the hope that when I publish it somebody will be interested. I think you can see the difference. There is a very nice feeling of being appreciated while you are doing it. In fact in the other mode, you may not be so appreciated because it is so very competitive. Your real audience is the guy in Stanford or Berkeley and you are competing to do it before they do. One is a negative push and the other is a positive pull."

5-5. Underlying institutions: External and internal boundaries

In the preceding section, the nature of institutional change in the last 20 years has been summarized. In this section, I argue how various organizational practices and mechanisms within MIT influenced both the initial agreements for new relationships as well as their evolution over time. More specifically, I argue that MIT's external organizational boundaries are characterized by three distinct dimensions: membership, knowledge and physical location. I then argue that administrators, both academic and professional, played multiple and apparently evolving roles in managing, negotiating, and crossing these boundaries. Finally, I argue that, for administrators to play such critical roles, they had to work closely with the academics they support.

Crossing external boundaries: membership, knowledge and physical boundaries. Many initiatives were undertaken around or by individuals who were penetrating the organizational boundary from one direction or the other. Faculty members might serve as board directors in industry, work as consultants, or have had direct industrial work experience in the past. These "live" experiences appear to underlie many of the deepest relationships, and influence heavily the formation of the others. Similarly, industrial representatives could also be present on MIT campus, through the Corporation (MIT's Board) or visiting committees. The experience of MIT seems to show, not that the nature of boundary crossing changed, but that existing "deep relationships" led more systematically to new structures such as strategic alliances, consortia or partnerships, which in turn expanded the opportunities to work with industry to a greater number of faculty members.

These formal structures also required up-front agreements about the nature of collaboration between MIT and industry, particularly with respect to the main output, knowledge. Central in all contract discussions have been negotiations about ownership and user rights of intellectual property and confidentiality or publication clauses. A clear understanding on those issues up front has been critically important in enabling companies to commit significant resources.

If people and knowledge are the dimensions of the organizational boundary that shaped the initial agreement for collaboration, physical space appeared to shape the nature of subsequent interactions. One MIT researcher talked about his experience of working with a visitor on campus.

> "It's definitely best to have a visiting scientist here (with whom) we can be collaborating on a day-to-day basis. It's so much easier when you can walk down the hall, and not only that, it's so much better when you're working on a joint project."

One representative from the partner company saw that it was very helpful in collaborating to be able to make short or long visits and treat them as business trips.

There are several examples of Japanese manufacturers who invested in R&D facilities close to MIT in the 1990s. These provide an interesting contrast to those that went to Cambridge, UK. For one thing, MIT rules did not permit a significant campus presence by companies beyond visiting scientists and liaison functions. These R&D laboratories were therefore established outside the physical MIT boundary, a contrast to those in Cambridge which are inside the university. There are different ways in which these companies tried to engage the MIT academics. One did so through consultancy arrangements, which meant that they could not obtain student inputs in their work. The other did so through formal contracts, which were not easy to maintain over time. All in all, these labs remained at arm's length from MIT.

Role of administrators

Administrators, both academic and professional, appeared to play increasingly important and multiple roles in MIT-industry relationships. There were three specific roles that they appeared to play in supporting the relationships: (a) managing external boundaries; (b) replicating the lessons of experience from one locale to another; (c) scaling up.

Managing external boundaries. The most obvious way in which administrators managed external boundaries was through the establishment of norms for IPR conditions and through negotiations on specific terms and conditions. For instance, the norm to insist on MIT ownership, while allowing for the possibility of exclusive user rights for sponsors was a practice that has been developed over the past two decades. The administrators can even come up with standard explanations about why this is important to MIT. MIT is mandated to own all inventions arising from federally supported research work by law, and it is impossible to fence off these activities from those sponsored by others. The default is that MIT must own everything. In the process, the administrators also demonstrate that they are savvy enough to understand the nature of concern of industries and assure them that their opportunities to commercialize would not be jeopardized, and that it is in MIT's interest to have its technology commercialized.

As the industrial demands become harder to push back, new lessons are learned, and new ways of persuading them are developed by these professional administrators. However, the knowledge dimension is not the only dimension the administrators manage. Both people and physical dimensions can be changed over time as there are changes in the rules, norms, and practices about external work, conflict of interests or hiring. While the practice of one-day-a-week consultancy dates back to the 1940s, the special scrutiny of faculty's external interests, such as board representation or consultancy, and their role with respect to students occasionally gets re-evaluated and changed.

How physical space may be used by industrial representatives on campus is another thing that administration can directly influence. The Media Lab now has a concept of "embedded laboratories" for industrial partners interested to be on campus. "Disruptive Laboratory" is the name of the BT laboratory on campus, comprising one permanent representative and various other visitors who visit the campus from time to time. The idea is that these companies pay a higher level of membership fees, and in return obtain some space on campus. The motivation for industry to come and live on the MIT campus, however, is influenced in turn by the conditions associated with intellectual property rights arising from their activities on campus. At MIT, all campus-based inventions must be owned by MIT, lest MIT's legal position as a not-for-profit organization may be jeopardized. This means that BT will not conduct research and development activities on campus that would be likely to lead to patentable inventions.

Instead, they use the facilities as a point of access to the rest of the campus. In Cambridge, this condition is relaxed, giving room for a much greater industrial presence and a different version of embedded laboratories on campus, as we will see in the next chapter.

Replicating experience. Administrators often carried over the lessons from one experience to another. Whereas there is a limit to how many initiatives an academic may experience in his/her career, administrators see a greater number of similar initiatives, network more readily across departments or disciplinary boundaries, move from one location to another, or oversee a larger number of similar cases. Specialized administrative offices such as the Technology Licensing Office, intellectual property counsel and contracting office can also strengthen the level of institutionalization.

Professional administrators seemed to play a central role in developing the "template" for relationships, such as collegia, consortia, or strategic alliances. MIT is also characterized by one type of professional administrator who looks very much like a member of the research staff. These individuals may have started out as researchers or may be doing research work part-time; they therefore live and understand the meaning of research content and environment, but for one reason or another choose to undertake administrative work on campus for their livelihood. These people appear to be a particularly effective conduit for carrying the lessons of experience from one setting to another, as they well understand the significance of the administrative arrangements on the content of research.

Scaling up and crossing internal boundaries. Academic administrators such as the provost and the deans play a dual role in affecting the overall scale of activities. On the one hand, they influence the internal allocation of critical resources such as space and the number of principal investigators. On the other, they can raise the level of sponsorship by lending credibility to specific initiatives by actively engaging in front-end discussion with sponsors. One professional administrator commented:

> "if you're a company signing a $15 million dollar deal with MIT… you want to make sure that MIT's President is aware of it and that you've got a personal connection to the people in charge because you want to make sure that… it gets the appropriate attention and the appropriate resources are allocated to it."

Scaling up usually also requires crossing internal boundaries – to engage faculty members from other departments or disciplines. Academic administrators can facilitate this structurally by designating certain programs/centers as institute-wide, school-wide or departmental and providing resource support. When it comes to specific ventures, particularly in developing educational programs, clearly support from academic administrators would be critical in implementation.

Evolving administrative infrastructure

For administrators to be able to perform such critical and pervasive roles, they must be able to work effectively with academics, at least in ways that did not upset the academics unduly. To be able to cope with inter-departmental work, they themselves had to be seamlessly connected to the academics. In other words, the boundaries between academics and administrators could not be too problematic. What are the factors that enable them to operate in this way? In this section, this question will be examined for the two classes of administrators, academic administrators and professional ones. In the process, I will also highlight key changes in their roles and profiles over time.

Academic administrators. There is a strong current of sentiment that the power of academic administrators has increased over time. One senior academic administrator reflects:

> "It seems to me that there has been an enormous shift… beginning in the 1960s and continued. If you look back at the pre-war time, these jobs were part-time jobs that people took on the side. But all of these academic jobs, department heads, deans and provost, have become enormously more demanding steadily since the war. All the interactions with Washington carried your own baggage, regulations have piled up and up and up."

Against such a backdrop, people point out that so many more of the new initiatives are centrally-driven, be they the nine alliances, the Singapore-MIT alliance or the partnership with Cambridge University, UK. And yet, it is not easy to see how comparable such voices are to those under previous administrations. For instance, when the Whitehead Institute was created with the strong support of Paul Gray and with a controversial and novel arrangement of having a separate governing board, what did these voices say on the ground? When the Media Lab was created with strong handed support from Jerry Wiesner? What about Compton when he brought back the scientific focus? All in all, without the possibility to resurrect the voices of these times, it is not easy to compare perceptions of the power of academic administrators.

However, it is possible to think about tasks that were not performed before that are part of the role today. For instance, department heads have a much greater formal role in monitoring and evaluating academic performance. The number of departments with associate department heads has increased (give figures). The position of chancellor, once an irregular position used only at times of conspicuously high demand, is today an integral part of the central administration.

Within that "same" organizational structure, there have been several "unusual" appointments in the choice of individuals. One was Chuck Vest as one of the first external candidates to be appointed to MIT in the past 40 years, one that was particularly conspicuous as he succeeded Paul Gray who had been part of the central administration for an unusually long period (he was Chancellor for a decade before he proceeded to the presidency for another decade). Another is the appointment of a Vice President for Research, who was again an external candidate. These recent external recruits corroborate the fact that academic administration is today a well-established career ladder, with mobility across universities.

Professional administrators. There have been three significant changes in the professional administrative infrastructure in the last three decades: the reform of the Industrial Liaison Program in the 1970s, the re-formulation of the Technology Licensing Office (TLO) in the mid 1980s; and general strengthening of administrative functions such as the Corporate Relations and Intellectual Property Counsel.

Significant efforts were made in the 1970s to strengthen the Industrial Liaison Program (ILP), a membership service program to provide information services to corporate members dating back to 1948. The tight financial conditions prompted the need for massive campaign efforts and the administration decided to rejuvenate the sleepy ILP by appointing an academic administrator to head it for the first time. Supported strongly by the then President, Jerome Wiesner, and by Chancellor Paul Gray, the new director introduced a series of changes to invigorate the program. An ILP office was opened in Japan to attract Japanese corporate sponsors. To elicit more active faculty participation, a new mechanism to reward faculty for their participation, a kind of points system, was introduced. The significance of having an academic, faculty member, to head what had been an administrative office, was significant. It enabled "peer-to-peer" solicitation that would be hard for non-academic administrators to provide. There were two other academics who subsequently served as Directors. In the mid-80s, the ILP became once again a normal administrative office, headed by a non-academic.

In the 1980s, it became evident that the patent office organized by lawyers was not meeting the technology transfer expectations. The Technology Licensing Office was virtually created anew and represented a sea change from a sleepy office that reactively handled patent applications to a proactive office that actively helped in the process of commercialization of MIT-owned technology. The process of change was as salient. A new Director was brought in, together with a consultant who had shaped up the TLO for Stanford, which at the time was seen as the most successful TLO among US universities. Indeed, the same consultant was invited by the group who founded the first TLO for the University of Tokyo a decade later, as the legitimate "guru" who helped the current TLO director at MIT in developing MIT's TLO. There was also an active effort to bring in "technology specialists" instead of lawyers, people with a significant background in industry as well as in research. These people not only needed to understand the legal aspects of licensing, but also needed to be able to engage in "techno-gossip," to understand the nature of the potential for various inventions.

The third change was tangentially related to the changes of TLO. There had to be a place for lawyers, but one that was not limited to licensing but also to research contracting. Since MIT's organizational infrastructure developed not by rational design but through historical evolution, there was a divide between the contracting office which handled all research contracts and the patenting office which handled the licensing of inventions. And yet, the Bayh-Dole Act, coupled with increasingly active university participation in patenting and licensing, required there to be far more integrated thinking about how to manage the intellectual property rights that arose out of MIT inventions.

The office of intellectual property rights was thus created, outside the TLO and the contracts office, but headed by a lawyer, who had worked previously both within the patent office, the predecessor to the TLO, and also within the contracts office. At the same time, the general corporate relations function was strengthened, following a set of recommendation made by the out-going ILP Director, the last academic to head it. The idea was that each corporate client should be served seamlessly by one representative who could speak on behalf of MIT.

In 1989, the Office of Corporate Relations was created, merging the corporate development, responsible for gifts, and ILP. The idea was that instead of having them operate separately where they optimize for narrower program goals, they could work together to effectively develop corporate contacts for all types of corporate support for MIT. The informal role that used to be played by the ILP officers in bringing about greater research sponsorship or consulting possibilities became more "formalized" by an explicit understanding that these were the legitimate goals of Corporate Relations. In other words, to be instrumental in the creation of new relationships became an explicit goal, most significantly demonstrated by their officers' role in forging strategic alliances.

As mentioned previously, some professional administrators have extensive research backgrounds, including doctoral training at MIT. Such people have tended to be working on specific research program/center activities, but they could connect across the campus readily and easily through the administrative network in a way in which academics would not have the time or interest to do. They, along with those professionals with research and industrial backgrounds in units such as ILP and TLO, appear to form an interesting and informal human network within MIT. One administrator coined the term, "techno gossip," to characterize those administrators who are interested and sensitive to the content of on-going research work on campus, to such an extent that they would "gossip" about it. It is not difficult to imagine what kind of backbone information flow these techno gossips would provide to bind the campus.

5-6. Degrees of institutionalization: the role of individuals

So far, organizational structures that appear to influence the pattern of change have been the focus of the analysis. Another important characteristic observable at MIT is the different degrees of institutionalization. There are many initiatives being formed at any given time. Some of them wither after a while. Some survive and are sustained over time in a given locale. Others become scaled up and attain a visible status within the community. Yet others become models and are replicated across time and space. The question is what differentiates those initiatives in terms of their survival.

Two factors appear to influence the pattern of survival and replication. The first is the role of individuals as founding fathers in shaping these initiatives. The second is the process of debates about these initiatives, through which differences in the understandings among key players are surfaced and dealt with.

Getting started: founding fathers. Every major initiative had one or more individuals who worked as founding fathers. Many of these individuals articulated their commitment to the initiatives in very personal terms. One center was established by an academic who come from many years of research experience in industry, where he witnessed major technological breakthroughs. He explains the rationale for the center in terms of these personal beliefs: he would like to see better work relationships between university and industry; he would like to share with the students, in particular, the excitement of technological breakthroughs; and the desire to forge another technological breakthrough through organizing partnerships.

Another consortium was initiated by an academic who had come to MIT with a substantive industrial background, where he learned that polymers represented a key field for manufacturing. His belief about the importance of introducing the field for teaching was so strong that when he realized that there was insufficient research being undertaken to support teaching, he decided to do so himself. Since it was not easy to attract industrial funding, he even negotiated with one company with whom he consulted that the company could convert payments to him into contributions for a new consortium. He was willing to sacrifice his personal income in order to get the activities started.

The former Dean of Engineering who was an active initiator of LFM developed his ideas and commitment through active dialectics. Industrialists came to him "railing and pounding" and demanded a new department of manufacturing. He disagreed but proposed a research program based on extensive discussions with industry representatives. When that proposal did not win support, he engaged in deeper debates with industry, from which the raw concept of LFM as a graduate level program developed. It is as though these debates helped him consolidate his commitment.

Getting both sides engaged. Individual commitment, however important, is clearly not a sufficient condition for ensuring longevity of these activities. There has to be some shared understanding between MIT academics and industrialists about the nature of the joint activity and the roles they each play. Active debates in preparing LFM were not only important for the former Dean to firm up his own commitment, but provided opportunities for industrialists to voice their views, build ideas and develop commitment on their part.

Interestingly, the importance of shared understandings often became apparent when some external events shook up the relationships. In one strategic alliance, a top management change led to a re-examination of their relationship with MIT, with a new company representative placed on campus who asked many hard questions. It was the active debates he initiated that helped surface the differences in a way that eventually led to new understandings. In the process, the industrial representative admits to "going native" where he came to develop a deep understanding and appreciation of MIT's culture and values.

Visibility. When initiatives are scaled up, they become more visible on campus. Strategic alliances had certain visibility from the outset because of their scale, which implied that they affected a greater number of academics and administrators. The Media Lab won visibility partly because of active publicity work they themselves undertook, but also because the laboratory scaled up rapidly, culminating in having its own building on campus. LFM was also visible partly because of its scale, but also because its activities span two large disciplinary communities: engineering and management. Visibility is helpful in sustaining activities, especially because it is important to attract new members and participants.

Replication. At MIT, there were three types of replication: those undertaken by the founding fathers; those undertaken through the use of a template developed through earlier initiatives; and those undertaken without such clear mechanisms of learning. For instance, one of the founding fathers of LFM went off and founded another educational partnership program – where lessons he had learned were to be reflected. Strategic alliances represent a case of replication through a template. The template here was a set of stylized understandings about what organizational structures might help these alliances work. The template was developed through debates among corporate relations officers, lawyers, and academic administrators, who worked together to come up with acceptable organizational and legal arrangements for a specific alliance initiative. Once a couple of successful cases were established, and acknowledged publicly as such, these alliance structures became a template to be replicated by others. Other corporate relations officers began to play similar roles in initiating other ventures – in cooperation with successive provosts, deans and department heads. What had been roles played by specific individuals became "organizational" through the templates. The third type of replication takes place without there being a clear understanding of what the "model" is. Early examples of consortia perhaps fall into this category. Imitators were replicating through observation without direct access to detailed knowledge about how the original model worked.

5-7. Concluding remarks

MIT's relationships with industry appear to have changed little in terms of depth. The new patterns of interaction appear to be close but bounded, just in the way that MIT academics have always had it. One major change is that the formal structures are being replicated, such as joint selection committees and calls for proposals, which in turn provides access to industrial sponsorships by a wider group of academics. The working relationships with industry also are much more wide-spread today than they were before, and much larger in size both in total and by average project size. In the process, there developed a greater sense of assurance that one could work with industry without jeopardizing the integrity of academic interests. The belief that academics could be working on fundamental science even as they remain application-oriented became endorsed through practice. Another important characteristic is the pattern of institutionalization: some initiatives became not only sustained, but scaled up significantly and replicated. Replication took take place either directly by the founding fathers, through others imitating or through organizationally defined templates.

The initiatives were shaped by regulated external boundaries, and permeable internal boundaries. These boundaries developed historically and appear to have become well defined over the years. Particularly important were specific events such as public crises or critical media reports that made the need for such "principles" more pronounced. Today, while these rules and norms are not strictly monitored or enforced by administrators, there are processes in place to ensure that it is in the interest of individual academics to take them seriously. Policies and procedures are written, articulated and exercised through systems such as annual self declaration by academics of their outside interests. It is interesting to note how much of the new developments, such as consortia, strategic alliances or educational partnerships rest upon past experiences. It is the legacy of past practices, such as faculty consulting and internships integrated into curricula, that have provided the platforms for new developments.

The role of administration appears to be the singularly important characteristic that differentiates MIT from the other two universities. Administrators at MIT include academics such as deans and department heads, and professional administrators who often come with either industrial or research experience. Together, they are a credible source of new ideas and initiatives, as the cases of strategic alliances or LFM show. They can more readily bring in resources from multiple disciplines or departments in order to create larger ventures. They are professionals in their working with outsiders – as they constantly come into play with industrialists, government officials and alumni through their boards, visiting committees, meetings for capital campaigns and other miscellaneous events organized to meet societal leaders in Japan as well as Europe. They form a particular type of constituent who functions as the institutional glue for the organization. They also play critical roles in extracting and developing templates, based on experiences from individual initiatives, so that they can be replicated.

However, recent developments on large scale partnerships, largely the products of the administration, are beginning to place certain pressures on the most vulnerable resource at MIT - faculty time (Lerman 1999; McKersie 2000). There is a disconnect between time commitments implicitly made through large partnerships and the time that individual faculty have to commit. Indeed, MIT faculty appear to be the busiest of the three groups, often not answering emails, and allocating as little time as possible for activities with little tangible outcomes, such as interviews for their graduate students. This provides an interesting contrast to Cambridge, where there remains an ethos of informal networks and timelessness, where academics appear to have more time for reflection and informal dialogue.

Chapter 6: The Cambridge Phenomenon

"A century slips by, and we will be here when Microsoft is long gone."
(a senior academic, Cambridge)

In 1985, when the spin-off and start-up activities in Cambridge were examined in the study "Cambridge Phenomenon", the authors noted several key characteristics of this 700 year-old university: informal communications arising from the collegiate structure, flexible employment, and liberal policies on intellectual property rights(Segal Quince Wicksteed 1985). They argued that these characteristics helped maintain the network of people loosely connected with start-ups, and later called it "paradoxical permeability of the University's medieval structures."(Segal Quince Wicksteed 1998). In this chapter, I develop their argument further and argue that Cambridge's boundaries are not just permeable, but indeed "fuzzy," and that these fuzzy boundaries enabled the development of characteristically deep industry-university relationships. I do so through defining the essence of "fuzziness" and by distinguishing it from the permeable nature of the organizational boundaries characteristic in MIT on the one hand, and the impermeable ones in Tokyo on the other.

In chapter 4, it was found that the main change in Cambridge's university-industry relationships in the 1980s and 1990s was the emergence of the so-called embedded laboratories and their variations. The purpose of this chapter is to characterize further the nature of institutional change and to understand the organizational factors that shaped these changes. The main argument I present here is that Cambridge's organizational boundaries are fuzzy for all three types of boundary crossing: people, knowledge, and physical space. These fuzzy boundaries allow the development of a variety of deep relationships between university academics and industrialists. They permit companies to bring in proprietary information and know-how, which sometimes lead to secret research that restricts the academics and students from publishing, but more often does so without jeopardizing the public nature of scientific production. Informal and sustained interactions enabled by the sharing of people, knowledge and physical space, appears to lead to deep engagement in which problems faced by companies are reflected in the production of science, and where proprietary technology can be used for scientific production. However, these deep, informal relationships are not ubiquitous. To the extent that they are becoming more prevalent on campus, with recent arrivals of larger partnerships, there is greater concern being voiced about the very fuzziness of the boundaries.

One other feature distinguishes the Cambridge phenomenon from MIT's experience. Relationships may cross departmental boundaries, but inter-departmental activities are not easily sustained or readily scaled up. Contrary to the usual claim that the collegiate structure facilitates interdisciplinary activities, I found few cases where academics from multiple departments had come together to work on a joint theme. Some of the past inter-departmental initiatives took place by bringing in outsiders to occupy new structures outside existing departments, rather than to help existing academics work together.

While inter-departmental initiatives are rare, disciplinary boundaries within each department appear to be quite flexible, with room for individual academics to take on interdisciplinary work within existing walls, but without needing to collaborate with others from other departments. I argue that these reflect harder inter-departmental boundaries, which in turn reflect both the decentralized university governance structure with a relatively weak central administration and the strong leadership at the departmental level.

I end the chapter by describing the key changes that have been taking place in the governance of Cambridge since the late 1980s, mainly in response to tightening resource conditions following government cutbacks. Triggered by a letter to the Council signed by nearly 200 academics calling for reform, the governance of the university has been reviewed and reformed with considerable strengthening of the central administration. Moreover, these changes in the central administration appear to have led to new types of university-industry initiatives that were larger in scale and inter-departmental in orientation. However, causality runs both ways. These large ventures certainly appear also to have made salient the need for stronger central administration, and to have fed more changes.

The chapter is organized as follows. First, I describe the emergence of embedded laboratories and their variations. Then I examine the few examples of relationships with multiple companies that exist in Cambridge. I summarize the characteristics of these changes in terms of (a) the greater number, size, depth, and variability of these relationships; (b) increased number of industrial academics; (c) the absence of change in the multiple company relationships except in specific locations. In the third section, I explain these changes in terms of organizational characteristics: fuzzy organizational boundaries in terms of people, knowledge and physical space; and the role of administration. I conclude by contrasting the Cambridge Phenomenon with the MIT Way and the Tokyo Story.

6-1. Single company relationships: embedded laboratories and their variations

The most pronounced development in relationships with individual companies has been the rise of so-called embedded laboratories. Interestingly, in spite of frequent references to them, users of the term do not necessarily agree on their definitions. The campus-wide debate about one renowned case of an embedded laboratory made some people reluctant to use the term, which gave rise to another term, "proximate laboratories". There is distinct haziness about what these terms mean and what they represent, at least in part owing to a lack of shared knowledge about what is happening in each of the operations. While specific individuals and their associations with specific industrial laboratories may be widely known, little is known about what their relationships entail and how their laboratories are run. This section will describe their emergence and the nature of relationships, first to demonstrate their variability, and second to show how there have been new developments in the recent past.

Embedded laboratories. The term "embedded laboratories" appeared rather late. One Hitachi representative recalls hearing the term for the first time in the late 1990s when the vice chancellor extolled his laboratory as one extraordinary example of embedded laboratories, in which an industrial laboratory embedded inside a university contributed significantly to the production of science (Mizuta 1999). Indeed, the arrangement for the Hitachi industrial laboratory to be on the university grounds in West Cambridge in 1989 was somewhat novel, although nobody appeared to acknowledge it as such at the time. Hitachi Cambridge Laboratory was to occupy half of the new building which was built specifically to house them and another university laboratory. The industrial laboratory was started with two representatives on site, and the team was gradually built up to the current size of about 10 researchers, roughly matching the university team headed by one professor with full time researchers and post docs, and with a total of about 30 students. Industrial researchers were qualified to supervise students – and often did so with government support under CASE awards. The industrial scientists and university academics established a norm of weekly joint meetings where research agendas were openly discussed.

What was novel in this arrangement, and why was it not acknowledged as such at the time? It was new in the sense that the same building housed an industrial laboratory and a university laboratory, with a single door separating the two. It was as though the industrial laboratory was an integral part of the university. There had previously been industrialists on campus, and there had also been close relationships with industrial sponsors funding projects and exchanging personnel on campus. However, these prior arrangements had taken place with far less conscious building design. The industrialists had occupied rooms on campus, or had funded university scientists to undertake proprietary research, but not in a way that created their own space for their own activities inside the university. The new building design enabled seamless communication between university academics and industrial scientists. They could informally meet 2-3 times a week, and hold formal meetings every week. At the same time, the company could bring some proprietary know-how onto campus without upsetting the university scientific production.

From the perspective of the department (the Cavendish Laboratory), on the other hand, nothing was new or unusual. West Cambridge already had an industrial laboratory (of Schlumberger) whose researchers occupied a large conspicuous building. So, there was nothing novel about industrialists occupying space on the same university grounds. There had been other exclusive sponsors for university laboratories, the most famous example being the Whittle Laboratory with Rolls Royce which had been on the same West Cambridge site since the 1970s.

The university and the department paid more than 60% of the costs of the building shared with Hitachi and so there was no sensitivity about high dependency. The professor who headed the university lab had previously worked with a laboratory in Cambridge's

Science Park which had had large industrial support, so this arrangement was also a comfortable variation of the same theme for him also. Each of the two adjacent laboratories has won recognition in the international scientific community for their work. Interestingly, several observers speculated that the university laboratory, which had a heavy engineering orientation at the outset, grew more scientific through its collaboration with Hitachi. One mark of their success was their ability to draw good students into their research activities – and it was clear to the others in the Cavendish that they were doing well. Table 6-1 summarizes embedded laboratories and their variations in Cambridge.

Table 6-1: Embedded Laboratories and their Variations in Cambridge

Year	Company	Affiliation	Initial funding (sterling pounds)	Research funding in 1999 * (thousand pounds sterling)1
1973	Rolls Royce (Whittle)	Engineering	NA	942
1986	Olivetti Laboratory (later acquired by AT&T)	Computer Laboratory (later moved to engineering)	NA	178
1989	Hitachi	Cavendish (physics)	0.5 million	477
1990	Toshiba	Cavendish (physics)	NA	266
1992	Glaxo Welcome	Pharmacology	NA	1,542
1994	Rolls Royce	Material science	NA	942
1997	Seiko-Epson	Engineering, Cavendish, Biotech Institute	NA	155
1997	Microsoft	Computer Laboratory	12 million	NA
1998	Unilever	Chemistry	10 million	765
1998	BP	Earth Science, Engineering, Mathematics, Chemistry	13 million	160
2000	Marconi**	Computer Laboratory, Engineering etc.	10 million**	3 million**

(Source: Cambridge Reporter, University Press Release, Innovation Pamphlet)
Notes:
* Total sponsorship by the relevant company to the university as a whole, not limited to funding to the partner laboratory. As reported in Research wholly or partly supported by funds from outside bodies, Cambridge University Reporter, July 12, 2000.
** For Marconi, figures given are planned ones used in the announcement by the university, but were subsequently cut back drastically owing to financial problems faced by the company in Autumn, 2001.)

Variations. Cambridge has witnessed other "novel" arrangements, for instance, academics holding dual positions, one as an academic and another in an industrial laboratory. The experience of two such cases provides a good illustration of three salient characteristics of Cambridge. The first characteristic is that of the decentralized governance structure, which has meant that the central administration is often irrelevant for key decisions. One department head made an informal inquiry about the legitimacy of dual appointments to the Secretary of the General Board, the central university body responsible for academic affairs, and was told that such arrangements were up to the department. The department head saw no reason to reject the proposal and gave the academic informal approval. The main rationale was that the academic was performing more than satisfactorily for the university in teaching and research. In the second case, the academic consulted another senior academic in his department as to whether to contact the university office about his dual role. He was advised that it would be unnecessary and merely "informed" the Secretary of the General Board two days before the press release. In both cases, the duality of employment was seen as something that had little to do with central university rules. It was largely up to the academics as long as they were performing their duties.

The second characteristic is the lack of clarity as to whether these two industrial laboratories, headed by academics, are in fact "embedded". The professors themselves consider their industrial laboratories to be clearly distinct from the so-called embedded laboratories. However, administrators and other academics do not see the clear distinction and often refer to them all as embedded laboratories. Why is there any confusion? Both the above professors with dual roles expressed their dislike of the real "embedded laboratories" as causing confusion and bringing industry too close into the university. They defined embedded laboratories as being industrial laboratories that are adjacent to the relevant university laboratories, and see their own situations as clearly distinct, since the industrial laboratories in which they work are geographically set apart from their university laboratories. Other university people, however, do not see such a clear distinction. To them, the very fact that the industrial laboratories are headed by academics make them look as if they are very close and effectively "embedded" in the university.

The third characteristic exemplified by the two cases concerns the different ways in which industrial laboratories can be located in the university. One of the industrial laboratories rents its space from the University in a building that only has miscellaneous offices, although in the same building complex as another, but unrelated university department. The laboratory looks as if it is part of the university complex, though the building itself is not used for university activities. The second laboratory rents its space in Trinity College's Science Park – which was built by Trinity to house companies in Cambridge. Since Trinity College is a separate legal entity, the land has technically nothing to do with Cambridge University as a legal body. However, colleges are historically bound to the university through their symbiotic relationships and many of them have properties scattered around Cambridge. (Trinity is particularly well known for its wealth, which at one point gave rise to a famous story that people could walk from Cambridge to Oxford on Trinity's land alone.) In other words, Cambridge University can be a landlord to industry in the normal university buildings, or in buildings used for commercial purposes, or in some combination of both. Colleges can also function as landlords, leading to differing degrees of being "inside" the university.

Microsoft. In October 1997, the William Gates Foundation announced its intention to donate funds for a new Computer Laboratory building, and Microsoft clarified its intention to set up its European arm in the same building. The announcement had a huge impact on the university. One former student remembers thinking how times had changed, when she saw the university newsletter with a cover photograph of Bill Gates and Sir Alec Broers, the Vice Chancellor (who had had 20 years of work experience in IBM), on the Bridge of Sighs, an architectural symbol of Cambridge as ivory tower. For many academics, this represented a far more serious threat. The image of Microsoft as an aggressive American company made many academics fearful that their ideas might be "stolen" in coffee room conversations. For anybody who understands the universality of "elevenses" and tea times as institutionalized breaks in England, it is easy to see why to be constrained in the informal conversations at these occasions would be viewed as a serious breach of trust.

After a whole year of negotiations, the framework agreement reached was a mere skeleton agreement that outlined the process of negotiation for subsequent individual agreements. It was not possible to reach an umbrella agreement on tricky issues such as intellectual property rights with terms and conditions acceptable to both sides. One academic remembers how it was clear that there was no common ground – principally because the university could not make an up front agreement on behalf of all the academics. Individual cases had to be negotiated separately. The dust settled as Microsoft Research grew too quickly to share a building and accelerated its plan to build a separate building next to the Computer Laboratory. The fear of invasion gradually subsided.

Microsoft Research Laboratory in Cambridge was novel in several ways. It was the first case that could affect a large number of academics in a whole department, in this case the Computer Laboratory. It was also the first time there was heavy involvement of the central administration and the department head from the outset. Indeed, it was the development office that organized the first discussion with Microsoft as part of fund raising. Second, Microsoft Laboratory was headed by a well-respected Cambridge academic, who did everything to recruit excellent academics from all over the world. One researcher joked that the Microsoft Laboratory may even have more professors than the Computer Laboratory. It looked almost like a second university department with higher pay scales; indeed many of these "academic" industrialists enjoyed partial affiliation to the University by being fellows of colleges or through supervising students. The laboratory was very different from a heavily commercial group of industrial researchers.

The third way in which it was novel was that it was the first case in which there had been a campus-wide debate about an industrial presence. On January 19th. 1999, a discussion was held in the Council, the executive body for the university, where there was a more than usual attendance and active discussions. Perhaps, one outcome of such an open debate was the shared feeling that some principles needed to be articulated to maintain the integrity of the university and individual rights of academics, while recognizing the need to work with industry. In 2000, the administrative units that support contracting and industrial liaison were consolidated to form a new Research Services unit, and work has been undertaken to clarify, articulate, and enforce general principles.

"Microsoft" variations. The arrival of Microsoft was so visible that it became an instant benchmark for all the ventures that followed. One professor remembers how another industrialist approached him saying "we want to do a 'Microsoft'". Another industrialist carefully analyzed his plan against what he perceived to be the Microsoft model. And yet, as more companies "did a Microsoft", the category of embedded laboratories became even more blurred.

One extreme was the BP Institute, which was based on a 25 million pound sterling donation for a building and an endowment for 5 permanent positions in the field of fluid mechanics. This was investment by BP in fundamental science. BP has no claims on intellectual property rights arising from research activities of the Institute. The BP Institute is an example where it went all the way to become fully a part of the university with all its academic traditions.

The only part that may be different from the normal university operations is that there is a single BP representative embedded in the structure who orchestrates events to encourage academics and industrialists to work together. The role of this industrial representative on campus is to make sure that the company "remain(s) passionately interested and listen(s) like mad." It is like having an "aperture" to the world of academia, and indeed BP has actively used the linkage through the Institute to reach out and learn from the broader academic community. For instance, a series of executive seminars was organized by the representative through the Cambridge Programme for Industry. Another example was a workshop with business practitioners, who came to discuss their technical problems with the academics from the BP Institute. These workshops turned out to be mutually beneficial, since academics were interested to learn about technical challenges faced by the operations so that they could then guide their exploration of fundamental science - particularly as the operations would typically have important data to which they could have access.

For operations people, these activities provide a unique opportunity to be questioned by intellectually curious academics, which can help them understand the nature of the problems they faced. The activities are not bound by contracts, and academics are by no means obligated to undertake specific kinds of research. They are simply orchestrated conversations to engage both parties, and it is left up to the academics to do what they wish. There are no restrictions placed on their publications – they are expected to engage in open science.

Another interesting case was Marconi, which in 2000 announced a 40 million pound commitment to a relationship with Cambridge, but scaled it back to negligible levels within two years, when the company faced a financial crisis. The original intention was to donate about 10 million for a Marconi Building and several endowed positions, with two million pounds to support the establishment of Marconi's own laboratory in Cambridge, and 3 million pounds for supporting research activities within the University community through contracts, with the resulting intellectual property rights belonging to Marconi. The use of such funds was to be overseen by an advisory board comprising both Marconi and university representatives. However, the company suffered near fatal financial problems in Autumn of 2001, which took place minutes before the framework agreement was signed, and the inevitable scaling back resulted. In contrast to the initial expectation of a laboratory with 25 staff, a smaller Marconi Laboratory with less than 10 people sits today within the new Computer Laboratory building, with a handful of contracted research activities. They will negotiate the terms and conditions for collaboration including intellectual property rights for each of their future projects, a condition that would have been the same even if there was a framework agreement. What may change, however, is the meaning of future negotiations, now that Marconi is clearly not a large benefactor.

6-2. multiple company relationships

There appear to be far fewer examples of multiple company relationships in Cambridge than at MIT or indeed at Tokyo. As shown in Table 6-2, the few that exist appear to fall into two types: organizational structures such as institutes that are supported by multiple companies through multiple projects, and membership-oriented activities where multiple companies pay annual fees to participate in some activities. What is striking is that there is no firm sense of "categories" among the organizers as far as relationships with multiple companies are concerned. They are all different. They remain largely isolated structures or efforts, often not well understood or known by peers within the university. They are reviewed below with an emphasis on identifying the underlying constraints that prevented them from becoming more prominent features in the university.

Organizational structures. Several of the examples are newly created organizational structures that attempt to address interdisciplinary fields not covered by an existing department. Behind each case have been one or more academics wanting to create a new field that was not covered by their own departments. The fact that there are so few overt inter-departmental efforts provides an interesting contrast to MIT, where there is somewhat more of a tradition of creating inter-departmental laboratories and centers as virtual and/or matrix organizational structures. Except for the Institute of Manufacturing, which actually is an integral part of the Engineering Department, they are isolated structures or are only loosely connected to a department with definite affiliations with several disciplines. There seems to be no common route for the establishment of these new organizational structures. Two of these examples were first established as informal structures. It is only once their activities stabilized that they were granted proper official status by the university:

"The way something becomes formalized in Cambridge is that an ordinance is passed that governs it, but at the start we didn't know what this thing was going to do, how it would work. And if we had an ordinance established, we would have risked the difficulty of being entombed in our own ordinance. We wanted to have some years of experience before we developed an ordinance." (a laboratory director, Cambridge)

Table 6-2 Examples of relationships with multiple companies in Cambridge

Name	Year	Type	Number of academics/researchers (2002)	Number of companies
Institute of Biotechnology	1982 - Professor hired 1988 - institute established	Organizational structure	5 established 1 non-established 30 post-docs)	10+
Melville Laboratory	1990	Organizational structure	2 established 8 post docs)	3
Center for Communications System Research	1995	Organizational Structure	1 non-established 8 post-docs	6-8
Computer Laboratory Consortium	1981	Department based informal collegium	department	50+
Cambridge University Local University Links	1989	Membership collegium		
Cambridge Vehicle Dynamics Consortium	1993	Research consortium	1-2	8
Center for Technology Management		Research consortium	3	10-12
Institute for Manufacturing	1998	Organizational structure With a membership collegium		20+

Notes: 1. These are fixed term, full-time research positions.
Source: interviews, websites

And yet, it is not easy to fund these informal entities.

"And if I've learned anything in these last six years, I have learned that the core people in any research arrangement should be on an established basis (paid directly by the university)... And if I had those [core positions]..then I would be able to put some money away and wheel and deal a little bit. But as it is, I have to run very hard to just pay for salaries." (a laboratory director, Cambridge)

Some face difficulties in attracting funding from traditional government sources such as research councils, which are organized along traditional disciplinary lines. Others were designed to undertake application-oriented work, with explicit expectations about attracting industrial sponsors. But in these cases, relationships with multiple companies have been established, not by design, but by default because a single company was not willing to provide a sufficient amount of money for the desired scale of activities.

Membership-based activities. There are several examples of low-level membership activities that date back awhile. The Computer Laboratory has had a small informal membership collegium since 1981, for which companies pay a minor fee (around 1,000 pounds a year) to participate in social events and recruitment visits. It was established in at the time of announced government budget cutbacks to fill the possible gaps in funding. The Cambridge University Local Industry Links (CULIL) was established in 1989 and has been running dinner seminars principally for local businesses. A more formal consortium arrangement is rarer but some have sprung up in the 1990s. The Cambridge Vehicle Dynamics Consortium is one such example, run principally by one academic with 9 relevant companies. The Center for Technology Management also has over a dozen members for its activities, in which members are expected to play more proactive roles in their action-oriented research. The latter is becoming institutionalized with administrative support from the Institute of Manufacturing, which has specialized professional administrators in charge of industry liaison work. The professor in charge of the former consortium, in contrast, complains of a lack of support and of having to do everything himself. While other academics are also waking up to the value of working with multiple industries, their ability to sustain such a relationship beyond a short-term project may be limited without stronger administrative support.

6-3. Characterizing institutional change in Cambridge

What are the characteristics of institutional change in Cambridge? Over time, there has been a growth of more, deeper and larger single company relationships, characterized by at least partial relocation of industrial laboratories into Cambridge. However, the greater number does not mean any standardization or similarity in the nature of the relationships. Indeed, there appears to be as much, if not more, variability in the nature of relationships with the rising numbers. Yet, in terms of multiple company relationships, there have not been significant developments in the past, with exception of the Institute of Manufacturing. In the following section, these points are elaborated.

While there has been a significant industrial presence on campus dating back to the 1970s, most notably by Rolls Royce in the Whittle Laboratory, the number of significant relationships on campus increased in the late 1990s. In contrast to the early relationships that were confined to a particular disciplinary space in the University, the recent relationships are larger, more likely to be inter-disciplinary and touch a broader group of Cambridge academics than before.

Table 6-3 contrasts the characteristics of embedded laboratories and their variations between 1980 and 2000.

Table 6-3: Characteristics of Embedded Laboratories and their variations

	1980	2000
Total	1	11
Proprietary research	1	3
Headed by academics		2
Open science oriented		3
Next to departments	1	8
Large (more than 1M)		4

Often, these embedded laboratories are "deeper" relationships because industrial laboratories or representatives are located in Cambridge to sustain regular interactions. The relationships involve more informal interactions, such as repeated seminars or discussion sessions, rather than simply being organized around contracted research. Interestingly, even where there are no formal contractual relationships, there can still be a deep engagement as is seen in the case of BP. They are also "deeper" in the sense that academics often work as consultants for their sponsors. As a result of such assignments, academics learn more about the nature of problems faced by their industrial sponsors. The arrangements also provide a better platform for industries to share their problems in greater confidence than is possible in general research activities.

With the rise in the number of these cases, the types of arrangement have also widened. Cambridge's relationships with individual companies now vary from highly proprietary research to completely open science. Some are based in industrial laboratories on campus, while others are based simply on mutual visitation.

Another significant change is the sheer increase in the number of industrial researchers in Cambridge who have research ties with university academics. Whereas industrial research centers are not new in Cambridge, their connections with the university were often unclear. What is also characteristic is that many of these "new" industrial researchers in fact look like academics. They are former doctoral students or post docs who would have left Cambridge, or they are university academics who have been recruited into these positions, attracted by the "academic" atmosphere of the job. There has also been an increase in the number of university academics who have been specifically recruited to undertake application-oriented research.

There is no evidence of increasing multiple-company relationships. Indeed, the individual academics who work with them find them difficult to sustain as they demand a lot of administrative attention. The only location where a membership-based relationship appears to be institutionalized is in the Institute of Manufacturing, where one of the centers developed an innovative membership structure. The center brings together a handful of academics and their students to undertake research on technology management. The concept of corporate members has now been adopted by the Institute as a whole and increasingly by centers within the Institute. The industrial relationships in the Institute are managed by the professional administrative unit specializing in industrial sponsor relations.

6-4. Underlying organizational factors

What are the underlying organizational factors that influence the way in which Cambridge academics develop their ties with industrial partners? I argue that fuzzy organizational boundaries have helped them to develop deeper relationships. The weak central administrative infrastructure, on the other hand, made it difficult for Cambridge academics to cross departmental lines and to sustain activities that involve multiple academics. In the final section, the changing role of the central administration is reviewed and its implications discussed.

Fuzzy organizational boundary defined

What do the organizational boundaries of Cambridge look like? And why are they "fuzzy"? The fuzziness of Cambridge's organizational boundaries can be understood in terms of the way in which three types of assets are "owned" by the university: people, knowledge and physical space.

People boundary. In Cambridge, there are no clear rules about what academics can or cannot do outside the university. In fact, even the meaning of what is legitimately inside or outside the university is not well defined, because a typical academic in Cambridge holds both a university appointment at an academic department and a teaching position with a college. The academics can work as consultants for anybody, including their research sponsors, or as executive managers of industrial laboratories, or they can run a start-up company, as they please. There is no special limit as to how much time they can spend on such activities. There are loosely defined minimum expectations in terms of what they should do for the university, particularly in teaching – although the academics who are externally active are often also highly productive in research and teaching and it would be rare for any of these active academics to get into trouble on the grounds of their service to the university. What is "appropriate" to do is left up to individual discretion.

The espoused belief is that Cambridge academics should have good enough judgement to know what is appropriate. Another underlying reality is that neither the university nor the colleges have sufficient resources to pay the academics at a level reasonable to claim full-time commitment given the expected standards of living.

The People boundary is as fuzzy for industrialists as it is for academics within Cambridge. Colleges can have many informal and formal ties with industrialists, and indeed they have traditionally done so to keep good relationships with potential benefactors. An industrial research scientist living in Cambridge could be a visiting or even a formal fellow of a college, perhaps with teaching responsibilities there. Since it is the colleges that promote key social functions in town, by hosting lunches, dinners and various other events, even those who do not work for a university department can still be part of the largely and loosely defined university academic community. If an industrial R&D laboratory is established in Cambridge, it could attract academics from other universities under the condition that they might still be loosely affiliated with this world-famous university. "Fuzziness" runs in both directions.

Here fuzziness appears to arise from the multiplicity of Cambridge as an entity. Since Cambridge University comprises both the legal university and around 30 colleges with their symbiotic relationships, no single legal body has the monopoly in determining where the organizational boundary should be or what university members should do. In addition, both the university and the colleges are willing to have a wide range of memberships. The other aspect of fuzziness arises from the strong sense of individual autonomy deemed appropriate for academics. Different ways in which academics and industrialists can cross the Cambridge's organizational boundaries are summarized in Table 6-4.

Table 6-4: Different ways in which people cross the organizational boundary

Academics	**Industrialists**
Part-time work Consulting/serving as non executive board member Consulting or working for industrial sponsors	Part-time teaching Giving lectures Supervising students
Dual positions working as executive managers in industry	Dual positions: college fellows
Quit university and move to industry	Quit industry and join university

Fuzziness in the people boundary makes it possible for academics and industrialists to see what the world on the other side of the boundary looks like, and therefore enables relationships to be based on better mutual understanding. One industrial researcher recollects the days when he was on the other side of the boundary, working as a university academic. He was asked by an industrialist to think about why it was difficult to identify good projects for the company to fund, when there was a lot of obvious overlap in thematic interest.

> "I have come to the conclusion that the problem was that there wasn't anyone who actually understood what the company's real problems were in detail (inside a university)... (There wasn't anyone inside industry who) understood the university environment... I don't just mean the particular Cambridge environment or group. But, generally, the thing that...drives and motivates academics and the way in which they seek reward. It wasn't actually in anyone's economic interest within [company] to fund projects...In the back of their mind they are thinking, 'Why on earth should I do all this work to get Cambridge funded?'"

He proposed that he work as a consultant for the company, so that he learned the company's needs better and could then propose better projects as an academic. The idea worked. That way, he could "write research projects that are appropriate for a university context". The key issue was that the university environment is not a good place to bring in too much confidential information, particularly when the students are involved.

> "In my view, the average research student is not trained at that point in their life, career, to make the fine distinctions that are required between whether it's suitable to talk about this thing or whether it's not. And it's very easy for them to get confused... and Ph.D. students get more supervision from their peer group than they do from their supervisor... If you're an industrialist sponsoring a Ph.D. student and you sponsor them in such a way that they can't talk to any of their peers about their work in the detail required to actually have a decent discussion of it, then as an industrialist, you're not getting a good deal for your money because this person is not working effectively. And as a student, they're isolated. They're not getting personal development out of it."

The answer had to be to have someone in the middle, who understood both worlds. "One way to do it is bring in an academic as a consultant." The other way is what he does today, for a former university academic to work as an industrial researcher "performing the same function, which is understanding the company's problems and being a researcher." In other words, Cambridge's fuzzy people boundary allows different ways for this intermediary function to be served.

There have been no specific changes on the people boundaries in Cambridge, although people are beginning to talk about the need for academics to make their outside interests explicit and public. One university committee is currently examining the possibility of requiring all academics to state publicly their private affiliations and activities outside the university (as is done at MIT).

Knowledge boundary. The fuzziness of Cambridge's knowledge boundary is somewhat different from the fuzziness of Cambridge's other boundaries. First of all, there are few fixed policies or expected norms about ownership or user rights about inventions arising from sponsored research; government sponsorship is the only exception, where the ownership will be held by the university. Every situation is considered to be different and unique, and to deserve separate treatment and consideration. As such, intellectual property rights may be assigned to sponsors in some cases, or owned exclusively by the university in others. The ownership, subsequent user rights, and confidentiality conditions are all negotiable – with the opinions of relevant academics reflected. In other words, the knowledge boundary is variably determined in different locations and is subject to negotiation.

There is also the possibility of change over time. One industrialist noted that Cambridge negotiators are willing to recognize industry's past contributions in renegotiations of contracts. Even if the original conditions were not so favorable to industry, if their importance to the university is demonstrated in the meantime, they might get better conditions. Conversely, even if the original conditions were favorable, they cannot be taken for granted for good. The knowledge boundary remains negotiable over time.

Here, fuzziness arises not from the multiplicity of the university as an entity, but from the fact that the conditions are variable across locations and time so that no-one can know, ex-ante, where the expected boundary might be. The only thing people know is that it is negotiable.

Once IPR ownership is assigned to industry, industrialists feel "safe" to bring their proprietary technology and know how into campus. The expectation on the part of the industrialists is that when they themselves bring in a lot of knowledge, and if they are also paying for the work, the intellectual property rights should be assigned to them. One "industrialist" academic, who is a full time academic at the university while serving as a research manager in a private company (and thereby personifying the fuzzy people boundary of Cambridge), explains the logic as follows.

> "We have more (knowledge) here than in the university by miles...We (the company) require that universities assign the IPR exclusively and immediately for any joint work... If it is not joint work – and we don't do too much of that because it is waste of time....(but when we do give money without getting the IPR, we say 'here is some money, you can have no access to us... Good bye.' (Giving money like that works) only (as) marketing for students... But if I got [the IPR], you can have access [to] everything I've got to help you make that property better, because I own it, and you will get your cut."

Table 6-5 shows different ways in which knowledge can cross the organizational boundary of Cambridge.

Table 6-5: Different ways in which knowledge can cross the organizational boundary

Type of rights	**Acceptable range**
Intellectual property rights ownership	University, individual academics and industry
IPR user rights	Individual academics and industries
Publication rights	Restricted with no time limit, to complete openness

Recently, the university has been making considerable efforts to strengthen its management capacity of intellectual property rights. Related units were re-organized in 2000 to establish a much more cohesive Research Services group, whose responsibilities range from research sponsorship contracting to patenting and licensing. One key activity undertaken by the new group was to have its advisory committee produce a far clearer statement with respect to the ownership of intellectual property rights. While the statement issued in 2001 is not a "change" in policy, it clarifies the university position, which is that all inventions under externally sponsored research would be owned by the university, except when the university specifically agrees otherwise.

In fact, such a policy has been in place since 1987, though there were some ambiguities in interpretation and it was not actively enforced. Particularly clearer is the position of individual academics in terms of the ownership. It is only when academics invent without explicit external funding (apart from research infrastructure support from the

Higher Education Funding Council of England), that they could claim ownership. What the policy statement does not clarify is the university position with respect to industrially supported research, where the university could still agree to assign the rights to industry. For the moment, the administrators voice their views that IPR ownership will continue to be negotiable, with the possibility of industry ownership.

Physical boundary. The physical boundary of the university is as fuzzy as the other two boundaries. Industry can reside in land or buildings owned by the university, or colleges, inside or outside their "campus" premises. For instance, there are industrial laboratories that rent spaces in commercial buildings owned by the university or colleges in Cambridge; there are industrial laboratories renting space in university buildings or college-owned science parks; there are industrial laboratories renting space from non-university land-lords, which sit between departmental buildings.

The fuzziness of the physical boundary is a result of the multiplicity of the university as a legal entity. However that is not the whole story. It is reinforced by the fact that Cambridge as a town is relatively isolated geographically and dominated by the university whose buildings are found all over the town. The result is that many of the commercial buildings in Cambridge would be encircled by the university geographically.

The fuzzy physical boundaries have not only attracted industries to relocate their laboratories to this small town, but have also allowed them to develop much more multi-faceted relationships with the university.

One company started out with a research contract with one professor. When the relationship turned out to be successful, they started working with several other academics, introduced to them through informal networks. They eventually started their own laboratory in Cambridge by renting space in two departments, with an office space rented from a college in a commercial building. Now they are convinced that they should go further; they are renting a bigger single space from the university near their West Cambridge site, but just outside it. It is as though the university is willing to incubate industrial laboratories inside it. Table 6-6 shows the different types of physical space affiliated to the university that can be available to companies for their use.

Table 6-6: Types of space made available to industry

	University owned	College owned
Academic building occupied by relevant departments	Cavendish Computer Laboratory	NA
Commercial buildings in the same ground as academic departments	West Cambridge etc.	NA
Commercial space set apart from university buildings	Buildings in town	Science Park Buildings in town

There has been no specific "change" in the way that space has been managed in Cambridge. However, there is clearly a sea change in the way new buildings and developments are planned. For example, a master-plan for West Cambridge was developed under the leadership of the current Vice Chancellor and the land use was approved by the local planning authority in April 1999. While the plan for West Cambridge has been there in theory for a long time, this was the first time that it became a reality to be implemented. The plan made the goal explicit for the first time: to create an intellectual hub in the sciences, including industrial laboratories. Actual building and relocation plans await specific benefactions; however, each of the departments is today far better organized to raise funds for their "dream" development plans.

Image of a relationship affected by the fuzzy boundaries. For one company, Cambridge's fuzzy boundaries were critical in setting up their own laboratory in Cambridge. Two professors became their key research collaborators, and were also appointed as consulting directors to their laboratory. This meant that the professors provided assistance in setting research directions in the laboratory, and helped with key issues such as personnel selection. Indeed, the first employees in the laboratory were post docs who were working with one of the professors. They were happy to be recruited by the company because their work was similar to what they had done before, but their salaries went up. This was a seamless transition for them, almost an internal promotion, because they continued to work in the same laboratory within the University, where the company had rented space. They had to spend more time reporting to the company, but they could still teach or supervise, because the department recognized their qualifications, even though they were not on the university's payroll.

The same company brought its own technology into the university laboratory where they had their employees in order to conduct research with proprietary technology under the direction of one professor. The proprietary technology was used as an input for developing new technology and also to explore a new set of phenomena. The availability of the proprietary technology enabled their counterpart professor to explore science at a level of precision hitherto not possible. It also prompted another professor to focus research efforts in a new direction. Public science was being undertaken, but using proprietary technology which would have been both expensive and time consuming if the university had had to develop it by itself. The professor summarized the position as follows:

"...(there was) a symbiosis between the university and the company... The company does development and therefore has done engineering of materials... all the things that make it work well, which are extremely uninteresting activities. The university had access to most of that know-how. So the university has had a big leg up in terms of having a platform of technology to exploit in order to understand the underlying (science) and understanding the underlying (science) has actually generated a lot of understanding which helps the technology." (Cambridge academic)

There are other examples where the sharing of technical infrastructure was mutually beneficial. Several professors found that the partnership allowed them to access facilities of the partner companies which then enabled them to continue their line of research at the frontier. The companies often benefited from extra analytical work on materials or devices of the kind they would not have had the time or capacity to undertake internally. There can be a symbiotic relationship between the academic need for facilities for scientific production and the company need for technical analysis. But at the same time, the academics have seemed to find ways to publish in comfort without jeopardizing company secrets.

One company representative saw his role explicitly as one of translating the technical problem of his company into a set of scientific problems that could be best addressed through open science. He emphasized that the information about the nature of the technical problems of the company can be very sensitive and that he can ill-afford it to be leaked. And yet, without revealing something about their problems, they cannot engage in productive discussions about possible solutions. While he was passing on more than the usual amount of proprietary information to the university side, he also recognized how it is in the best interest of both parties if he and other corporate side researchers could "translate" the information well enough so to shield the interests of both sides. In his own words,

"The real problems we have with our products, we cannot make public. The critical task for us (the embedded lab) is to break down these real practical product problems into a set of [academic] problems...These are the issues that are tackled through repeated conversations between us (from the embedded lab), the central research laboratory and business units. It is hard to involve university people directly into this."

What is interesting is that if he and others were not physically in the embedded laboratory, daily encountering their counterpart academics, there may not have been anyone in the company to engage in such intensive translation work.

Another company representative who used to work as a university academic also emphasized the importance of proximity and constant monitoring.

> "Someone needs to understand at the same time what's happening on the research projects and what's happening in the business...If you're a corporate lab and you're funding a university and you're 1,000 miles apart, you are not going to be involved in the thought processes of that project because you simply will not be there during the sort of formative meetings when the ideas are getting bandied around. And the danger is, maybe you start turning up every quarter for a presentation of, this is what we've done, but you've lost the tracking of what the thought process was. So you can be a smart person, you can understand what the company's problems are, but you're not actually very closely engaged with the research that's going on. So now you're back to relying on reading the research publications."

For another company, the key benefit of having the embedded laboratory was the sharing of the intellectual climate. Through regular seminars, both at the university department and at the industrial laboratory, there was a diversity in the kind of visitors they could bring to the region, and through open academic discussions alone, industrial researchers felt that they could get sufficient inputs from the university.

The image of relationships enabled by these fuzzy boundaries is one of close partnership, where both the academics and the industrialists learn about each others' needs and interests.

Role of administrators

In Chapter 5, the role of administration was described as critical for MIT in crossing its internal boundaries, particularly across disciplines. In Cambridge too, there are strong divisions that separate disciplinary groups, though moderated somewhat by social functions provided by the colleges.

In this section, I demonstrate the weakness of the central administration in Cambridge, and particularly its inability to facilitate activities that cross internal boundaries between departments or individual academics.

Difficulty of crossing the internal boundaries. Cambridge does not appear to have effective mechanisms for bringing together academics from different departments without creating new structures outside the existing departments. One department head recollects a case in which four heads of departments got together to create a separate laboratory with external funding:

> "Again and again there were projects, or intellectual projects that could well be industrial projects... areas of interest that were not within the domain of one of the departments. They had economic aspects, they had computer science aspects or engineering or mathematical aspects. But they were not in one department.... Now, those projects were not really getting a proper kind of administrative structure. There wasn't a way of sort of taking them on by the university and managing the overheads and everything. And so we attempted to set up a structure [the laboratory], whose aim would be to be interdisciplinary... So we all had enough power in our own department to do anything and yet we all judged that it would be easier to do this...joint thing... [the laboratory] has been very interesting from my point of view and involved people from different disciplines in a way that would have been very difficult for me to construct in my own department."

Indeed there are at least three similar examples in the past 20 years where a new interdisciplinary structure was created through recruiting new academic staff. In one such case, the academic remembers how little support he got from the university, and how he had to establish the center through hard work in attracting external resources. In another case, academics from different disciplines were recruited to newly created positions in a new interdisciplinary center. The center director from the sponsoring company is clear that the key challenge has been to make sure that these academics work together, while maintaining ties to their disciplinary departments.

Two other cases demonstrate that it is not easy to sustain inter-departmental structures. The superconductivity center, established with government sponsorship for multiple departments, eventually got taken over by the Cavendish. Another inter-disciplinary laboratory, Melville, was founded with collaboration among several departments but eventually got absorbed into the Chemistry Department.

These examples point to another characteristic of Cambridge: the fuzziness of disciplinary boundaries as defined by the departments. This was arguably the more classic way of dealing with interdisciplinary work: simply to expand the disciplinary boundary of an existing department. Indeed, Cambridge departments appear historically to have had a large tolerance for expanding their disciplinary coverage. The Cavendish Laboratory, Cambridge's physics department, went as far as housing biologists such as Crick and Watson. One mathematics professor remarked that mathematics in the UK and especially in Cambridge is a much broader field than in the US. Others noted that the lack of structured teaching requirements at the graduate level provides perhaps a greater flexibility in the choice of disciplinary contents within a department.

The difficulties of establishing interdisciplinary centers may stem from the long tradition of established subjects such as mathematics and physics, which, in turn makes it difficult to legitimate applied subjects.

The changing role of the central administration. One clear change over time in Cambridge's relationships with industry is the increased role of academic administrators, particularly department heads, in setting the tone of overall agreements. In contrast to the earlier ventures, where academic administrators were brought in only when the negotiations had some policy or space issues to be resolved, interactions between the Vice Chancellor and CEOs, or department heads and high level industry representatives have been decisive in shaping the nature of relationships in later ventures.

In the aftermath of the debate about Microsoft, department heads and central academic and professional administrators all became much more actively involved in setting the tone of the discussions. How did this happen? Was the change in the role of the central administration the cause or effect of the changing relationships between the university and outside bodies?

The beginning of the sea change in the role of the central administration in Cambridge goes back to the 1980s. During the 1980s, central government applied repeated financial cutbacks and demanded increasingly explicit and greater accountability as well as better financial management by university administrations. It took Cambridge some time before they realized that the government was serious about the recommendations in the Jarratt Report of 1985. It was not until November 1987 that a recommendation to review the governance of the University was sent to the Council signed by almost 200 members, including some of the most respected academics in Cambridge. Their main concern was that the current arrangement was unsatisfactory for "the modern requirement for rapid, firm and effective decision making."

A syndicate was established subsequently to consider the issues, and its recommendations were delivered and adopted in 1990. The status of the Council was to be elevated to become the main executive and policy making body, chaired by the Vice Chancellor and comprising about 20 representatives elected by Regent House. The General Board, which had always been responsible for all academic matters, and the finance committee were both to become accountable to the Council. The Vice Chancellor's office was to become a full time position with longer duration. Thereafter, the Regent House, which comprises some three thousand teaching and administrative officers of the University, became less managerial and began to take a more strategic role similar to that played by the governing body of a university.

While the role of department heads is clearly important with respect to relationships, what is less clear is whether the role itself has changed over time. Most departments have had the tradition of long tenure for their academic heads - who had considerable authority to get things done. There is no doubt that they played a leadership role in setting broad disciplinary directions, particularly in the recruitment of new people. On the other hand, it is also the case that the role of academic administrators changed considerably from one of academic leadership to one of academic management. One head of department acknowledged that his role evolved as more budgetary pressures developed, to the extent that he had to assume a role in setting rules about resource allocation, particularly in the late 1980s and early 1990s.

There has also been a significant strengthening of the professional administrative units. In the early 1980s, the Wolfson Industrial Unit was re-configured to service the entire university. The development office was established in 1988; the Cambridge Foundation was set up in 1989, as an independent trust, but acting in the interests of the university to seek voluntary funds for the support of education. These are developments that preceded the sea change in the central administration of the university. Indeed they were contemporary with the early evolution of Cambridge-industry relationships. It is in the mid-90s that they begin to play a much more proactive and critical role in prompting the next round of developments, by supporting the Vice Chancellor in fund-raising visits to potential benefactors, or in developing the master plan for West Cambridge.

What is interesting is that the development of the Microsoft and other relationships are also putting additional responsibilities for the central and departmental administration. Principles had to be clarified and administrative work had to be undertaken quickly. In 2000, a new unit called the Research Services was formed, integrating the contracting office with the Wolfson Industrial Unit, with slightly increased staff. A new unit was created to be responsible for corporate relations in 2000, and the Cambridge Programme for Industry, a unit responsible for executive training, was re-configured to become a university unit independent of any faculty, with a small management board to oversee its activities.

6-5. Degrees of instituionalization: the role of individuals

In Cambridge institutionalization does not take place as readily as in MIT. Rather, each of the local initiatives provides a colorful and powerful variation and appears to have the potential to be sustained for a long time. As in the case of MIT, these initiatives invariably have visible founding fathers, who often stay with the initiatives for a long time. Interestingly, there is a less clear image of active debates up front. Rather, debates appear to take place through sustained interactions among key participants over time, and provide a firm basis for personal relationships and mutual understanding.

Getting started: founding fathers. Lasting initiatives do appear to have committed founding fathers, whose commitment can be explained in terms of their personal experience and backgrounds. Interestingly, these personal reasons were more often articulated by surrounding people rather than by the individuals themselves. For instance, several people explained how one founding director of an industrially active institute had worked with industry before re-joining Cambridge to explain his passion and suitability for the task. Evidently, they observed personal commitment through his actions and in between his lines – or through personal discussions over the years. For another academic, the embedded laboratory relationship followed several attempts to work with other companies, and lessons learned from these earlier experiences fed into the design of the laboratory. Founding fathers appear to have personal backgrounds that explain why they are more committed to the initiatives. However, they seem to be less willing to communicate these directly or explicitly.

Getting both sides engaged. Academics and industrialists appear to develop personal relationships and mutual understanding of each other's idiosyncrasies through sustained debates and interactions. In one case, an academic demanded that his sponsor company ensure continuity in resident personnel lest relationships have to be built from the ground repeatedly. The company agreed and had one Chief Scientist positioned in Cambridge for over a decade, with another manager having spent seven years in Cambridge. Differences in expectations were worked out over the years through such personal relationships and dialogues. Through a decade of partnership, industrialists learned about the way academics would like to work, for instance their inability to cope with too much proprietary information, and learned to translate proprietary knowledge into a form that could be disseminated more openly to the academics by extracting only the essence of the company's information base.

In another embedded laboratory the closeness with which one leading academic and the resident industrial representative worked was evident from the fact that they each understood what values they brought into the relationship and what they got out of it. The academic and the industrialist both articulated clearly how their relationship was symbiotic given the need for the academic to have access to production facilities, and how the company needed better analytical expertise. The academic understood the nature of industrialist concern about proprietary knowledge and the industrialist respected the academic need to be open and to publish. This fine-tuned understanding appeared to rest upon very frequent and open communications. They often used similar terms in explaining what they do, and referred to the same events as examples.

Scale and visibility. Early initiatives were typically small and demanded few organizational resources such as space from the university. Indeed, in many cases, the space was provided by industry, sometimes through donations for buildings. These early initiatives remained largely unheeded by the rest of the university. With the governance reform and strengthening of the central administration, central administrators became more involved in the new initiatives, raising both the scale and visibility from the outset. With scale and visibility came the need for a wider debate, as exemplified by the Microsoft case, as many more people needed to be "bought in" to the value of these initiatives.

Interestingly, in the four cases where I interviewed multiple representatives on both university and industry sides, there seemed to be greater shared understandings on the industry side than on the university side about why they needed to work in partnership. In one company case, a resident manager, a resident researcher and an R&D Director in their headquarters explained the rationale for being in Cambridge in ways that were remarkably compatible with each other. And yet, it was not that they were articulating an empty slogan. They all clearly articulated the need for the company to develop deeper scientific expertise, in much the same way from each other, but were able to illustrate the points with slightly different examples. They also articulated a different set of issues that underscored their different roles in the organization. The R&D director was concerned about institutionalizing the partnership beyond certain personalities, such as themselves. The resident manager was worried about keeping his researchers focused on issues relevant to the company, and the researcher voiced his hope about expanding his relationships with multiple research groups. It was clear that there was a shared understanding about the partnership with Cambridge, and yet, they each had a different but compatible set of concerns and issues. Such consistency was underscored both by close communications and on-going dialogue among them, and a sense of trust. In order for a company to scale up its investment, not only in terms of monetary resources but more importantly through committing its own human resources and time, it was important that there was a shared understanding among the key players within the company about why they were doing so.

Not replicating? In Cambridge, initiatives do not appear to be replicated readily because of several reasons. Many founding fathers remained within their original initiatives, and did not move on to new initiatives that replicated the successful patterns. It was only in later initiatives where academic administrators began to operate as founding fathers that replication through them became plausible. Indeed, the term "embedded laboratory" was coined when the Vice Chancellor became actively interested in the success of the model. Even then, the density of replication was not high, in the sense that replication led to new variations, rather than the recreation of the similar models. This pattern perhaps owes to the fact that there were no professional administrators who were ready to develop "templates": they were either too busy and spread too thin, or not sufficiently interested in the substance of activities to care about replication.

6-6. Concluding remarks

Compared with MIT, Cambridge's relationships with industry are smaller and fewer, but appear to be deeper and more personal in nature. Initiatives may be sustained but tend to remain in specific locales without scaling up, and replication takes place haphazardly. One consequence of haphazard replication is that there is a greater variation among similar types of initiatives in terms of the way they are structured. These characteristics appear to derive directly from Cambridge's fuzzy organizational boundaries and the way its administration is defined, and the pattern of dialectics among the key players.

Cambridge academics play a wider range of roles in their university-industry relationships compared with MIT or Tokyo professors: as consultants, as managers and as owners. At Cambridge, there is a much greater trust about professors and their academic integrity, and the judgement call is essentially left to the individual. Similarly, there are far less defined rules and principles about knowledge or physical boundaries. The administration does not play a clear role in helping to scale up the initiatives nor in creating organizational templates from them. Fuzzy boundaries allow sustained interactions which in turn help establish deeper mutual understanding. Institutionalization takes place at a given locale, but the lessons from the experience are not readily learned elsewhere in the University.

The overriding sense of trusting individual judgement may be an artifact not only of the University, but may also reflect the way UK society defines what is acceptable. Interestingly, there appears to have been no significant public scandals about academic conduct in its relations with industry, neither in Cambridge nor in the UK more widely. In contrast, in Tokyo University, there is a constant fear about what the media would pick up and how they would interpret existing practices, mainly as a result of the civil service status of the professors. There have been several well-known cases of scandals, in which civil servant academics were publicly criticized about their conduct with respect to their relationship with industry, and in their use of external funds. The media also play a role at MIT, albeit to a lesser degree than in Tokyo, with cases such as Akamai in 1999, in which a newspaper article about one close relationship between academics and industry (in this case, spin-off companies), was claimed to be jeopardizing the ability of students to do homework because they were bound by a nondisclosure agreement. These events at MIT have tended to lead the administration to change its policies - or at least to scrutinize them more carefully (Marcus 1999).

Nonetheless, there is a definite change in the air in Cambridge. People are becoming more articulate in voicing the need for clearer principles and transparency, if not for rules. Also, in the aftermath of a financial fiasco related to the introduction of a computerized accounting system, a new set of recommendations has been made further to reform the governance structures. This will produce greater centralization in some respects, and more decentralization in others. The initial reform process was started largely in response to government policies and a public climate that demanded relevance and accountability. It was the same environment that prompted some academics to venture into fund-raising or into deeper relationships with industry. In the late 1990s, both sets of university responses to the environment, stronger central administration on the one hand and increasing interest on the part of academics to work with industry on the other, have begun to enable the development of larger partnerships with industry. However, the manner in which these partnerships are shaped is significantly different from MIT. Indeed, more non-monetary resources appear to be flowing into Cambridge from industrial sponsors than is the case at MIT. Why is this the case?

I have explained the emergence of the deeper engagements in Cambridge in terms of its fuzzy boundaries. The image I have portrayed is one of an organization that is expected to outlive most of its partners and which is confident enough about its survival to keep its boundary permeable enough to absorb the necessary energy, resources and knowledge from other organizations. This picture leaves open the question of whether Cambridge is better off than MIT, if Cambridge appears to be able to absorb more from the outside than MIT can.

The answer is not clear – perhaps because the starting points were so different. Even though MIT had its own era in which its engineering science was isolated from detailed work in industrial applications, perhaps it was never as isolated from such work as Cambridge was. Perhaps it managed to keep itself abreast of changes in industry and technology through mechanisms unavailable to Cambridge. Indeed, that difference is observed by some of the MIT scholars who visit Cambridge – they are surprised to see the unevenness in the level of updatedness in different facilities across the university.

There is also an interesting contrast with Tokyo University. In Cambridge, organizational boundaries are fuzzy. In Tokyo, they were impermeable until recently, largely because legal restrictions on boundary-crossing between industry and the civil service were applied to the national universities, all of whose employees, including academics, were defined as civil servants. In the next chapter, the consequences of such impermeable boundaries will be examined. Tokyo University also faces a period of rapid change, which is expected to culminate in changes in the governance structures.

Chapter 7: The Tokyo Story

A hypothetical conversation among engineers from three engineering units

Faculty of engineering: "Engineering as a discipline failed, because we maximized production without regard to externalities such as the environment and human welfare. We must reconstruct engineering as a discipline that can cope with such larger issues."

Institute: "That is not the point. We are behind, but we must not just catch up and follow the style of money-centered American universities. We will go our own way, mindfully."

Center: "You pseudo-cosmopolitans! You speak as though you understand what is happening in the world, but you don't have a clue about the way markets work!"

7-1. Overview

The previous two chapters examined the experiences of MIT and Cambridge in developing new types of relationships with industry. I also began to argue that the two universities appeared to define their internal and external organizational boundaries differently, and that these in turn appeared to have had an important influence in shaping their new relationships. Where does the Tokyo Story fit?

The purpose of this chapter is the same as the preceding two: it is to characterize further the nature of change in the university-industry relationships in Tokyo University, and to understand the underlying organizational factors that shaped and influenced the change.

The Tokyo Story is a complex case, whose surface level changes appear contradictory and difficult to interpret to an outsider. On the one hand, there are many highly visible and celebrated changes, particularly in the administrative infrastructure, but often with a certain twist that appears to make implementation difficult. For instance, a technical licensing office (TLO) was established as a private company, outside the university because it was not possible to link it to the university legally. A consequence of this is that it led to competing initiatives for different units to build their own TLOs. As another example, liaison activities were initiated through the creation of a database in a newly created laboratory for collaboration with industry, but without central commitment to sustain the database. There are also constant and incremental improvements in the regulatory and procedural rules, which, contrary to their intent, appear to create a new web of complexity about what is permissible to do, at least in the short term. For example, faculty members have been permitted to consult since 1996, but even today, the administrative processes for obtaining the annual ex ante approvals are cumbersome and not encouraging (though some units have moved faster than others in dealing with this problem).

On the other hand, there are many local initiatives that are breaking new ground in terms of relating with industry. These are usually undertaken by specific academics in their respective fields of expertise, and seem to be increasing in number. Curiously, these initiatives remain isolated from each other and even unnoticed by the rest of the university. There are no official records, and most administrators are unaware of their existence. It is only close peer academics who are vaguely aware of them.

What are the sources of these complexities? I argue that there are three primary ones, each arising from one of the historical developments described in Chapter 4.

The first source is the supra-centralized governance structure in which Tokyo University has no legal autonomy from the Ministry and many of the normal administrative tasks of the central administration are divided between Ministry officials and university administrators. This makes university activities subject to rules and procedures that are apparently non-negotiable. While academic freedom has been respected, in the sense that MOES has never used its power to influence academic personnel decisions, supra-centralization, most notably in the administration of money, is an every-day reality that everyone at Tokyo would know about. University administrators who deal with these rules and procedures every day are too junior within the Ministerial hierarchy to be able to use their discretion actively. Neither would they feel empowered enough to go back to the Ministry to negotiate changes. They are left with the tasks of making ends meet on the ground and of running a smooth operation without causing too much trouble. This sense of heavy-handed micro-management in administrative terms paradoxically coexists with a sense of extreme autonomy, in which individual professors are subject to surprisingly few constraints on their teaching or research. This micro-management is expected to change with legal autonomy in 2004, but it is not clear that this will resolve all the complexities.

The second source is the manner in which the external history has affected the university in dramatic ways that have left it with a motley concoction of values. The values are not evenly shared, in the sense that individuals may secretly disagree with the espoused values, and it is an open secret that there is hardly any consensus. One factor that exacerbates the mix is generational. Younger academics, for many of whom both the war and the student unrest belong to a distant past, are much more open to norms and values more akin to those of US academics, for whom it is perfectly acceptable to work with industry with real applications in mind. The events that prompted the dramatic change in values were external, after all, and there were no social or other processes, either before or after, among academics to enable them to construct shared values. Espoused values have been forced on them, irrespective of their true beliefs. In effect, individuals enact their own values as long as they can remain invisible to those who may be upset by them.

The third source of complexity is that espoused values have developed in different ways in different locations within Tokyo University. As far as engineering is concerned, there are three somewhat competing organizational units of varying size: the Faculty of Engineering, the Institute of Industrial Science (IIS) and the Research Center for

Advanced Science and Technology (RCAST). These are the legacies of the three large engineering groups in operation during the war, the First Faculty of Engineering, the second Faculty of Engineering, and Aeronautical Laboratory, respectively. As described in Chapter 4, the post-war changes led the Second Faculty to remold itself into something more directly useful for the industrial development of Japan, and the Aeronautical Laboratory to reform itself into a generic engineering laboratory. The latter had to go through several more rounds of reforms before it finally became RCAST, an event that was publicized with considerable fanfare. Exactly what dynamics occurred in the intervening years among the three is not something that can be readily recovered from history.

What is clear today, however, is that this organizational structure has spawned a certain sense of competition among the three units, with the Faculty perhaps the most oblivious of it. Two of my interviewees used the metaphor of three brothers to describe the three organizational units: the Faculty being the eldest brother, growing up without competition and with all the attention being taken for granted; the IIS as the middle brother, squeezed between the two, and with a fierce need to proclaim his own identity; and RCAST as the little brother, brought up as a rebel in the family and a little spoiled with the attention he always managed to get from the world. In the latter two units, there appears to be a far clearer sense of organizational identity and shared values. Not surprisingly, shared values are hard to come by among the three units. The Faculty may be best described as "romantic." The IIS's accomplishments as well as plans appear the most "grounded." RCAST appears to be the institutionalized "rebel" that spins off daring initiatives.

I argue that in Tokyo, initiatives can be either formal or informal. Formal ones are those which follow all the organizational rules, are visible on the surface, openly talked about by peers in the community, and are sustained and replicated. Informal ones are based on local initiatives, led by one or more academics, follow the organizational rules only superficially, and bypass them in critical ways. The Tokyo Story is about the duality in the spheres of action, formal and informal, with the organization called Tokyo University being unable to have a firm grasp of the informal initiatives. It is a story about the lack of connectivity between individual desires and organizational action.

The chapter is organized as follows. In the next section (II), I first discuss the formal initiatives and changes introduced in the 1980s and the 1990s. Those are the ones that people in Tokyo point to as examples of change. They comprise changes in the organizational rules that allow new types of financial and contractual relationships with industry on the one hand, and, on the other, the development of new organizational structures to deal with university-industry relationships.

I then go on to discuss the informal, more local initiatives within the University, originating from academics, in a manner which parallels the preceding two chapters: initiatives to establish relationships with single companies; and initiatives to relate to multiple companies. Most of the initiatives remained isolated and not known to the community, and were short-lived. There have been a handful of these initiatives that look as though they are going to have a longer life by the way they are structured. In my description, I pay particular attention to the nature of barriers that have prevented initiatives from becoming sustained.

In the third section, I characterize the institutional changes in the University of Tokyo, first, by characterizing the nature of "formality." Formality implies institutionalization of organizational forms, usually introduced programmatically or system-wide by design. Interestingly, formality does not necessarily lead to institutionalization of activities. As a second characteristic, I discuss several breakthrough cases where activities are sustained over time and attain a more permanent status with or without "formality." Third, I discuss institutionalized low engagement.

In the fourth section, I discuss the organizational underpinnings that have been responsible for shaping such changes. I argue that a set of institutions that collectively define organizational boundaries shape both the initial agreements between university and industry and the subsequent interactions. More specifically, I demonstrate that certain sets of rules and practices define organizational boundaries in terms of people, knowledge and physical location both internally and externally. I argue that academic and other administrators are the critical actors in refining or changing these boundaries over time.

Finally, I examine the role of individuals, using the apparent differences among the initiatives in terms of their activity sustainability. Formal or informal, some initiatives have attained a more permanent status, and appear to take a sustainable path, while others remained a single shot and died a quiet death. The question is what differentiates the survivors from the non-survivors. The full answers to these questions will be developed in Chapter 10.

7-2. Formal initiatives

Emergence of new financial and contractual relationships

In the 1970s and 1980s, the most prevalent type of industrial collaboration came in the form of scholarship grants (shogaku kifukin) from sponsoring companies. As the name suggests, these were essentially philanthropic, and required no formal contracting between industry and the university. The typical size of scholarship grants was several thousand US dollars. In spite of the small sums, academics appreciated these grants because they came with relatively few of the line item restrictions which were typical of other monetary resources, and so could be used freely: for instance, for international travel to attend conferences, which was difficult to finance from other sources. On the part of industrial sponsors, a strong norm of equitable funding developed to such an extent that there was a sense of "going rates" at 5,000-10,000 dollars a year. Scholarship grants were almost like "name cards" or "a box of cookies" that companies brought to academics to keep themselves acquainted for the sake of successful recruitment.

Patents arising from research supported by scholarship grants were owned by the individual academics, according to a 1978 ruling by the Ministry of Education and

Culture (MOEC). Individual academics therefore sometimes worked with sponsoring companies with an informal understanding that the companies would take over the patenting responsibilities along with the rights, with the names of the academics listed as inventors. Some industrially active professors developed their own individual contract forms with companies to clarify the conditions of collaboration and so that they could earn their share of IPR provisions. However, these were strictly informal practices and were not institutionalized.

Contracted research was another form of contract that existed from the early days, in which academics conducted research as requested by outside bodies. Intellectual property rights arising from research funded under such arrangements were to belong principally to the government. There has also been a system in which industry could send their researchers to the university to participate in the contracted research. It was in this context that, in 1983, the Ministry of Education and Culture introduced "joint research" as a new format for collaborative contracts in which larger contracts had the promise of matching government funding. "Joint research" allowed the sharing of any resulting intellectual ownership between the government and industry, in contrast to the traditional "Contracted Research", for which the ownership was exclusively with the government. However, formalized relationships under "Contracted Research" or "Joint Research" contracts brought in additional bureaucratic problems, such as time-consuming contracting and line-item budget restrictions, and were unpopular among academics.

Several academics remember being told by the administrators that their projects fitted into the Joint Research category. They do not appear to have understood the full implications of the new schemes, or the differences that this represented in comparison with the other existing schemes. They simply followed the words of the administrators in preparing the necessary documentation, only to learn that the Joint Research scheme was also fraught with rigidities in line item budgets, and did not bring in money that was easy to use. Some academics admit to having reverted to scholarship grants, with informal "memoranda of understanding" drawn up between the sponsoring companies and themselves as individuals in order to avoid the problematic rigidities.

In 1987, a new category of industrial support called "Endowed Chairs" was introduced by the University. It was a variation of scholarship grants and was administered in the same way, but it could pay for 2-3 visiting professors over a 2-3 year period. The scheme was proposed by the former Dean of Engineering to bring "liquidity" into the rigid personnel system in Tokyo University, by enabling the recruitment of external expertise from abroad and from industry in order to develop new fields needed in the society. Starting from the first cases which were used to establish new fields for the revamping of the Research Center for Advanced Science and Technology (RCAST), the scheme has now been used in a total of 55 cases by faculties all over the university, 18 of which are still currently running. Endowed chairs represented unusually large-scale industry donations with an annual commitment of 200-400,000 dollars (compared with the then norm of 5,000-10,000 dollars for donations normally expected under Scholarship Grants).

As described in Chapter 4, the proposal met tremendous opposition within campus, mainly from the political left who saw it as a possible infiltration by corporate interest into the campus. After debates and modifications, the endowed chair system was made independent of any influence or connection with the donating company. Indeed, these endowed chairs are more philanthropic than those in MIT or Cambridge, where chairs are created in fields relevant to donating companies in order to boost research in their areas of interest. Endowed chairs in Tokyo usually have little to do with the specialization of the donating companies. While chaired professors at MIT usually play some role in maintaining informal relationships with the donating company through exchanging visits, no such follow ups have been expected or provided in Tokyo University.

Another feature of the Endowed Chairs has been their administrative isolation. The Endowed Chairs only provided sufficient funding for several positions for a 3-4 year time horizon, and therefore could be used only for "visiting" professors, and not for regular academic positions. Since there was no additional university budget allocated for the Endowed Chairs, visiting professors had either to make do within the limited budget from the industrial donation or to raise funds themselves. The short-term nature of their tenure made it difficult for them to establish research programs with graduate students.

Since the mid 1990s, the government has initiated many incremental changes in the rules about working with industry. For instance, in 1996, there were regulatory changes in civil service practices to allow academics to work as consultants for technical advisory activities. In 1998, there were further changes in the civil service regulations to allow academics to become board members in companies in which their own technology was being used. As of early 2002, these have been implemented within Tokyo University in ways which are highly variable across the units. However, the bottom line remains that "approvals" have to be obtained from the administration up front before academics can engage in outside activities. Several academics complained that the approval process was unnecessarily cumbersome, with bureaucratic requirements such as providing detailed tabulations for their weekly use of time. It is only in a minority of units where academics appear to get active support in undertaking such activities.

Evolution in organizational structures

The late 1990s were characterized by a rapid change in the organizational structures for collaboration with industry. In this section, three examples of how these organizational structures evolved are described: the Center for Collaborative Research (CCR); another on-going initiative to establish a laboratory dedicated to collaboration with industry; Technology Licensing Offices (TLOs). These initiatives highlight the gradual manner in which organizational objectives are developed, and how organizational forms are selected early and then dictate the course of subsequent organizational development. The manner in which these organizations evolved provides an interesting contrast to MIT and Cambridge, particularly with respect to the role of individuals, as will be discussed later.

Center for Collaborative Research (CCR). CCR provides an extreme case in which its establishment was based on multiple organizational objectives that were not shared among the concerned parties. One of the early organizers thought that it would house collaborative activities at a stage close to commercialization, by providing adequate space to encourage joint research activities with private companies. Another recollects having the image of the Media Lab with its unique draw on industries. Several saw the CCR as an administrative ploy and an incentive for IIS professors to agree to move from their centrally located Roppongi campus to a new campus.

The center was started in 1995 with eight "industrially active" professors, who were selected and seconded from two research institutes, IIS and RCAST. The first center director, who oversaw the first three years, had a different rationale for the center's activities – to examine the process of industry-university collaboration in order to understand the nature of problems. His question was deeply rooted in the concern that universities in Japan lagged behind many American peers in establishing linkages with industry. The intention was that the eight professors were to return to their original institutes in 2-3 years, with fresh people selected; for them, the opportunity to be part of CCR was like having special status and rewards for being industrially active.

When the second director assumed office in 1999, he took up a new initiative to create a liaison function through a database of professors and their research activities in UT. The center's central activity then became to establish a database of the research of UT professors, which would provide information to facilitate collaboration with interested companies. The database activities required administrative manpower. Given that new administrative positions were difficult to claim under the MOES budgeting process, the Director opted to bring in local government civil servants on secondment and visiting professors from companies. The role of the eight professors assigned to the center was again unclear in the light of these new activities, though they began to provide an effective advisory committee. One interesting outcome was that the academic senate of the Center, comprising eight academics and six industrialists, became an excellent forum for informal discussion. Even the most industrially active professors found it interesting to hear industrialists' comments on the academic research data that were being collected.

The center started as an organizational structure, and not as a place for specific activities, with its mission handed over through one leader to another, each contributing something new. There seems to be an underlying assumption that individuals are replaceable. There were no founding fathers who oversaw the planning and implementation, a typical process of evolving centers at MIT, nor were there newly hired leaders brought in specifically to lead the effort as in Cambridge. The two center directors were genuinely committed to fostering industrial collaboration, and each has left an interesting legacy. However, they had to work with organizational forms that were forced on them, and had to work within the time limit to accomplish their own goals. Indeed, when all the professors, including the director, change every 2-3 years, it is not easy to maintain consistency of institutional goals. In 2001, with the third Director in place, the center may again be experiencing a new direction.

Proposed laboratory for collaboration with industry. A similar pattern of gradual evolution in the early planning days is also evident in the proposed laboratory for collaboration with industry. This laboratory was opened in 1999 by the previous academic administrator, with a view to establishing a new field of engineering that would examine the process of collaboration. A junior faculty member was appointed as the temporary head of the lab. What the laboratory mission was going to be or how it was to operationalize its mandate is still evolving. On the one hand, the former Dean had aspirations that the laboratory might provide functions similar to those of industrial liaison. The junior faculty member had to enact the new organizational goals – and he experimented through working closely with various companies in his area of research and through developing low-key ties with others working on university-industry relationships across campus.

One year later, the new academic administrator came into office with somewhat different ideas about the direction of the center. He has a more explicit vision to study the process of industry-university collaboration through an examination of 10 or so cases of collaboration, which has led to the appointment of another professor to head the laboratory in 2001. Interestingly, everyone seems to agree that the laboratory's mandate is to create scientific knowledge about the process of collaboration, rather than to collaborate with industry. The aim is not to undertake specific collaboration projects, but to study collaboration itself.

There appears to have been a constant discussion with the MOES, with the two successive academic administrators actively seeking budgetary support from the MOES. What is interesting is the apparent disconnect between the negotiation with the MOES on the one hand, and the process of developing the activities, on the other, mainly because these tend to be conducted by different people. The same disconnect was evident in other examples where the academics were preparing proposals for the MOES. The negotiation with the MOES has to do with obtaining resources, most notably for additional positions, through presenting justifiable goals. However, the MOES appears to have developed particular and peculiar ways in which plans must be "justified," perhaps because the MOES has to then turn around and justify the plan to the Ministry of Finance, who has the final say in judging what is justifiable. This contrasts sharply with the image of MIT or Cambridge academics developing proposals, which they would keep submitting until they find the right sponsor. The meaning of proposal writing is apparently very different.

This is a case representing early days of organizational evolution. Again, there is a notable absence of "a founding father," though the newly recruited professor may indeed evolve into one. It also highlights the background "negotiation" that goes on with the MOES, that seems to distract, rather than help the process of planning the content of activities.

Technology Licensing Offices. Relationships with industry in terms of patent licensing had been insignificant or informal until the late 1990s. As mentioned before, patents arising from research undertaken with explicit external funding were to accrue to the university and hence the government, while those arising from research without external funding were to accrue to individual academics. Licensing income from government owned patents is still insignificant even at the national level, with a total of 1,142 patents producing licensing income of 191 million yen in 1999. There are no official records of licensing income arising from patents owned by individual academics, since these are considered private. This latter individual patenting activity became institutionalized through the establishment of technology licensing organizations in the late 1990s.

In 1998, the first technology licensing office, Center for Advanced Science and Technology Incubation (CASTI), was established through the initiatives of RCAST academics. The original idea was developed by two RCAST professors who were encouraged to come up with innovative proposals for the Ministry of Education, at the inaugural party of their intellectual property rights laboratory at RCAST. They focused on ideas that were relevant to their own specialization; one idea was to create an organization that supported the development of intellectual property rights of academics.

Based on a careful examination of legal options, they proposed to establish a private company, owned by a small number of academics. The owners were carefully selected to be non-scientists – to avoid possible criticisms from the civil service commission about conflicts of interest. However, as the private company became operational, it rapidly had to expand its base to cover all relevant faculties and institutes within the University. The original organizational structure, a private company owned by several professors from one Institute, no longer made sense. A new organizational superstructure to enlist "ownership" by a greater number of faculty members across UT became necessary. In other words, three years into its existence, the organization had to re-establish and reinforce its linkages with the university – another kind of "work-around" for the fact that the university cannot legally own the company.

In 2000, the Institute of Industrial Science (IIS) announced the establishment of its own TLO based in its affiliate foundation. Their TLO was apparently to compete against the RCAST's TLO, which they deemed as illegitimate because of the "external" nature of the company. They asserted the necessity for a TLO with more concern for technical liaison activities, deeply embedded within the university. The central administration had to take a clear stand with respect to these multiple initiatives. Their answer was to accept diversity in responses, and to endorse multiple and duplicative efforts, particularly in the light of the imminent future when the overall governance structure of the university is to be changed.

Interestingly, here again, there was a political undertone with respect to the role of Ministries. Any new TLOs under the TLO law could win an "approved" status from MOEC and MITI, and obtain government subsidies. For the competing TLOs, the issue was not only one to do with the central recognition in a general sense, but a specific survival issue of obtaining start-up funds.

7-3. Informal local initiatives

The above section has described the most obvious institutional changes in terms of new types of financial relationships with industry and organizational changes related to working with industry. These were not the only changes introduced in the university-industry relationships. Indeed, even though there are no simple lists or official records, a number of local initiatives have been undertaken by individual academics, leading to different types of relationships with industry. In most cases, they remained one-shot activities which were not sustained, or have not yet become institutionalized. In other words, these are one-off and local institutional changes for which local practices and behavior patterns may be changed for a period of time, but may not be sustained or replicated over time or across space. In this section, I discuss such initiatives to understand how and what kind of local institutional changes took place, and why they did not become institutionalized in wider settings. I do this through the examination of three types of initiatives for change: working with individual companies; working with multiple companies; and administrative infrastructure.

Working with single companies. There have been relatively few visible cases in which professors have worked with individual companies on large projects in the University of Tokyo. A more common collaboration model has been that of a professor working with multiple companies for pre-competitive research. Deeper relationships with individual companies that have led to commercialization have been relatively rare, partly because of the academic resistance to getting too close to individual companies, but partly because the sponsoring companies want to appear fair and equitable in their relationships with academics.

Nevertheless, there have been cases in the 1990s in which Tokyo University took an initiative to solicit significant support and collaboration with individual companies. The first, in 1992, was a research project with an electronics giant, Company A, initiated by the then President of the University. The second case was a project in 1998, again with a major electronics manufacturer, Company B, initiated by the Director of the Center for Collaboration Research (CCR). This section examines each of these cases to clarify the origin of the relationships; the obstacles faced by the relationships; and the outcomes, including discussions as to what became institutionalized.

In 1992, the then President of Tokyo University came to an agreement with a senior corporate executive of an electronics giant to implement a collaborative project. This was an unusual event, prompted by the President whose platform was to rescue Tokyo University from further infrastructure decline following the budget tightening during the 1980s. Various options were discussed including the possibility of setting up an international research center. However, fear of negative publicity that could result from a large corporate presence on campus was a constraint. Eventually, the idea of collaborative projects was introduced to engineering professors through the Dean of Engineering, who solicited specific proposals from the academics. One such proposal ended up as an international tripartite collaboration between Tokyo, Cambridge, and the company, involving annual support of the order of 400,000 US dollars , which was unusually large for corporate support at the time.

The project implementation experience amply demonstrates the negative role played by administrative support. Administrators were keen to make this project a flagship international collaboration project under the Joint Research Scheme, and Cambridge was duly selected as a foreign partner. The use of the Joint Research Scheme also required the foreign partner, Cambridge University, to become a "sponsor" to Tokyo University, since it was designed as a contractual device between the university and a sponsoring organization. It must have been quite a vexing experience for Cambridge researchers first to be approached for collaborative work and then to be asked to pay. In the end, a portion of the corporate support for Tokyo University was channeled through Cambridge to satisfy this administrative requirement.

Another issue arose regarding a patent that was filed in Cambridge under Cambridge's name. The filing process was undertaken in a hurry with an oral understanding that the ownership would be worked out later. While it has been sorted out between the company and Cambridge, the company has not been able to negotiate with Tokyo University, apparently because administrators were reluctant to deal with such messy irregularities that were not supposed to have happened in the first place.

The project proceeded, based on two separate collaborative relationships: Company A and the University of Tokyo which remained at arms lengths throughout the period, on one hand, and Company A and Cambridge University becoming increasingly collaborative with each other. The relationship with the University of Tokyo was readily terminated when money became tighter owing to the deepening recession in 1997. The relationship with Cambridge, on the other hand, survived for several more years, albeit much diminished in scale as the recession deepened in Japan, squeezing R&D budgets for many manufacturers.

The difference in survival between the two relationships may reflect the fact that there was a fortuitous match in the research agenda between Company A and Cambridge. There are, however, other differences between the two relationships that are likely to have contributed to the difference in survival times. For one thing, the relationship with Cambridge appears to have started with more active demands by Cambridge about the nature of collaboration. Cambridge academics were initially reluctant to collaborate until they saw clear areas of common interest. Even after they began collaboration, they did not shy away from voicing their discontent, when they felt that the Company was demanding too much from them. The other side of the coin is that the company expectations in the two collaborations appeared to have been different from the outset. The company was willing to provide financial resources to the University of Tokyo, almost on philanthropic principles, while their contribution to Cambridge was motivated more directly by their research activities, as they had initially hoped to establish a research center there.

The second initiative was in 1998, when the then Director of the newly established CCR decided to develop a model case of collaboration with an individual company. At the time, the most common collaboration model was that of a professor working with multiple companies for "pre-competitive" research in which technological issues were sufficiently generic. Deeper relationships with individual companies were rare. The director's intention was to experiment with an "American type collaboration" within the Japanese cultural and regulatory context.

Detailed discussions and examinations of options with an interested electronics company led ultimately to the formation of a virtual laboratory, in which three UT professors were to work with the company. However, none of the contract forms that the university could offer was acceptable to the company, mainly because of the requirement that the resulting intellectual property rights were to be owned by or co-owned with the government. Government ownership was not acceptable to the company because the government has little capacity to engage in negotiations about the subsequent use of its patents, which makes co-ownership particularly cumbersome and unwieldy for companies. Final agreement was only reached when the three faculty members agreed to consult for the company. Under such an agreement, the project became the private activities of participating professors rather than an official university activity with the university itself playing a minimum role beyond providing clearance for the individual faculty members to consult.

What do these two cases show? First, they appear to indicate a gradual change in the shared values on campus about university-industry relationships. Compared with the late 1980s, when industrial collaboration was seen as negative, by 1992, joint research activities could be undertaken more neutrally, and in 1998 individual collaborations were actively sought. Even now, one of the academics who consulted for Company B still admitted that he did not like to discuss his consulting ties publicly. The tradition of isolated civil servant academics as a legacy of the war and of student unrest remains slow to change.

A second interesting feature is the negative role of the university administration. The first project experienced a series of confusions related to administrative complications. With the second project, the original designers abandoned the idea of working within the formal university structures early, and the project became virtual and external to the university administration.

Third, these cases are surprisingly unknown among other academics within the University. The first project was a flagship project for one of the research centers at the University, and yet, the current director of the center knows only vaguely of its existence and little about its substance, only 3 years after the project ended. The lack of institutional memory is partly the result of the short tenure of center directors, which is typically 2 years. It may also be due to the lack of any established medium through which information about projects can be disseminated within the campus, which in turn perhaps reflects the shared values about academics doing their own thing without heeding others. The second project has been used as an interesting example, for instance, in a public forum to discuss university-industry relationships, and is known among some faculty within the organizational unit where it took place. There were also newspaper articles written about the projects. Even then, the project is little known outside a small circle, perhaps because the participating professors are less prone to discuss their consulting activities openly, and perhaps because the director of CCR who first initiated the relationships has since left the job.

Relationships with multiple companies. There are more numerous examples of faculty members who have worked with multiple companies. It is not easy to say exactly when were the earliest examples of such activities. One source of ideas for working with multiple companies may be the prevalence of MITI-sponsored national projects, in which multiple industrial giants as well as academics from many universities joined forces to work together. Indeed, the goal of obtaining national project status, with massive government funding, was often lurking in the discussion when founding academics talked about their consortia projects.

The earliest examples that I could find dated back to the mid-80s, during which several projects were funded by the government that involved multiple companies. In the late 1980s, there was a rise of consortia funded solely by companies. One such case was a consortium initiated by a young academic in 1989 with annual membership of 50,000 US dollars involving about a dozen companies. Another one was started in 1990 by an older academic with an annual membership fee of 20,000 dollars with each of 30 companies. These were considered expensive, compared with the standard rate of Scholarship Grants at 5-10,000 dollars.

Interestingly, both academics recount stories of their struggle in negotiating the appropriate price. The senior academic's original aspiration was to collect 200,000 dollars each from 5 companies. Corporate sponsors persuaded him that it was not in his interest to demand so much, because such a high price will inevitably raise corporate demands for tangible returns. "I suppose I was taken aback," he said, but he backed down to a figure of 20,000 dollars. The junior academic also faced a difficult corporate audience who were saying that 5,000 dollars was the standard donation that junior academics such as himself could legitimately expect. Infuriated that companies were treating all academics and their research work alike, the junior academic stuck to his proposal and decided to work only with companies who were willing to commit significant resources as a result of their active interest in his research.

The resulting patterns of collaboration went along two separate trajectories. The young academic had to work hard to satisfy his corporate sponsors, starting from the creation of a detailed memorandum of understanding to clarify the conditions related to patent ownership, confidentiality and publication rights. He also obtained many more inputs from the companies, in the form of visiting researchers, equipment, and technical know how to support the research. The consortium rested on a high level of industrial participation. The senior academic managed the resources to encourage university researchers from all over Japan to focus on research in a given field of industrial relevance. It had less industrial involvement and the number of supporting companies declined over the years as the recession deepened. Another academic who closely observed the activities of the latter consortium remarked that if the price had been kept high, perhaps companies would have voiced their views more actively, leading to more solid collaboration. What these examples demonstrate is the fact that price can reflect the level of industrial commitment: the higher the price the more serious companies may be.

Though there are no official records, individual accounts indicate that the incidence of multiple company activities accelerated in the second half of the 1990s. Another consortium was started in the mid 1990s by a senior academic in collaboration with academics from other universities, with about 11 companies paying 100,000 dollars each. This consortium had the participation of academics from multiple universities, and contributed significantly to better understanding of who was doing what kind of research within the field. It was also carefully structured to ensure industry participation through their presence in the operating committees and their on-going evaluation of the research activities. Two junior academics, as well as an industrialist who participated in the consortium, felt that while honest effort was made by the organizers to engage industrialists, industrial involvement fell short of expectations, partly because their participation was formal and pro-forma, rather than informal and active. One view was that the amount of resources available was too small to produce any significant research; another was that formal rules and structures made it harder for honest dialogue to take place.

Another characteristic of this consortium was that the administrative function was out-sourced to an outside non-profit body. This was because it was not easy to find a mechanism for collecting membership fees and distributing funds across laboratories and universities using the university administration. While research agenda as well as the amounts to be allocated were established through the consortium structure, which heavily relied upon leading academics within the University of Tokyo, the actual money was collected by the outside body and distributed in the form of scholarship grants to designated academics. This tendency to bypass university administration appears to have become a definite trend. Three other consortia founded in the late 1990s each used outside bodies to administer the finances. It was not only the isolated initiatives of individual academics that took such an option; initiatives with significant University support also resorted to such external administrative mechanisms, as will be seen in the examples in the next section.

One common way of avoiding the internal administration has been to use an affiliate body. Indeed, most faculties and institutes in Tokyo University have legally autonomous affiliate bodies, whose links to the university are manifested through individual academics working on their boards, and through the location of their offices being inside the campus. They are subject to MOES supervision, as MOES has the authority to sign off their continued existence. Interestingly, because their legal statutes do not officially state their affiliation to Tokyo University, they can come under MOES pressure to extend the scope of their activities to work with other universities – not just Tokyo University.

There are some concerns about the legitimacy of such external options. One academic jokingly referred to it as "money laundering." Another academic openly speculated about the legality of such arrangements, since the use of these affiliates would allow them to avoid the overhead that the government charges to universities on externally funded projects[1]. Yet another made it a point always to be talking openly about everything and

[1] Because national universities are an integral part of the central Ministry, a portion of the overhead is retained by the Ministry.

trying to generate newspaper articles, so that the sense of secret dealings could be avoided.

The rationale given by the organizers for resorting to external bodies is to avoid the red tape associated with the normal finance administration within the university. As the legal autonomy of universities from the government develops, these external administrative arrangements are increasingly seen as a stop gap device while they await larger changes in the administration itself.

7-4. Characterizing the institutional change

How can the institutional change in Tokyo be characterized? Clearly there is a difference between new patterns of behavior that get sustained over time, and replicated across space; and those that remain as a local initiative, with a limited lifetime. By and large, the former include formal initiatives introduced purposefully at the system level with the active involvement of the Ministry and its university administrators, and the latter include those informal initiatives started by individual academics. There are some exceptional cases, however, in which changes were introduced through local initiatives and were built around individuals who actively sought them, but which subsequently managed to win a more permanent status. The question is what differentiates the paths between those local initiatives that remain local, and those that manage to win a wider and/or more permanent status? Another question concerns what these changes mean in terms of the depth of relationships between academics and industrialists.

In this section, I first revisit the meaning of formality. I then turn to several breakthrough cases where a greater stability and permanent status were achieved for their activities with or without formality. Finally, I discuss the nature of engagement between academics and industrialists.

Formality vs. informality. The examples of the initiatives show that there are three types of actors involved: academics, academic administrators, and professional administrators. In all of the formal initiatives, administrators were active, most notably Ministry and university professional administrators, as they handled changes in government financial or personnel practices. What is interesting is that these changes were mostly designed from the beginning to be applicable system-wide and by definition to be "institutionalized" within the national university system. In no cases, were these changes introduced as a result of a specific need expressed by individual academics.

On the other hand, informal and local initiatives arose from individual academics who were interested in undertaking specific activities with industry support. Most of these fell short of influencing University-wide mechanisms, though some do appear to have won a more permanent status than others. This provides an interesting contrast to the more evolutionary changes in the other two universities as have been shown in Chapters 5 and 6. At both MIT and Cambridge, initiatives led by individual academics often did lead to institutional changes over time.

In other words, Tokyo University appears to represent an interesting case of separation between initiatives undertaken by administrators that are motivated by an explicit desire to change the forms of collaboration, and other initiatives that are motivated by activity content, typically led by individual academics. The contrast between the two types of institutional change may be a result of different institutional logics at work. The logic of institutional change in Tokyo University may be provided by the government, which introduces changes at a programmatic level with the intention of being applicable uniformly to all beneficiaries in order to maintain fairness and impartiality – as a result of the supra-centralized system with the Ministry at an apex. On the other hand, at the other two universities, both of which are in effect private, the logic dominating the changes may be professional rather than governmental, in which individual excellence, expertise and skill may be more dominant than any concern about equity or fairness across the system.

There appears to be one distinct trend among local initiatives within Tokyo University: to obtain administrative assistance from external bodies. In other words, the university administration appears to play less and less of a role as a secretariat for such activities. This is largely a result of the initiators' desire to avoid red tape within the University administration. By the same token, however, their informal status with respect to university administration makes the activities much less directly visible to the rest of the university. Many initiatives remain isolated and unnoticed, and do not readily come into the organizational limelight. Even those initiatives that are backed from the outset by organizational leaders such as presidents and deans are not necessarily institutionalized in a formal sense. They do not become an organizational template for later activities.

Breaking through. While formal initiatives appeared to be better known than the informal ones around the university, they did not necessarily produce stability in terms of the content activities. Interestingly, there is a distinct group of initiatives that has won a more stable status than the others, irrespective of whether they were formal or informal initiatives. I describe below four examples.

Two of these examples are "hybrid" in the level of formality: they were initiatives undertaken by academic administrators, but with little support from professional administrators inside the university. The third example is one of the TLOs, which was initiated as a formally discussed initiative, but grew external to the university, winning in the process, a certain coherence of its activities. Fourth is an informal initiative, where the founding academic stabilized the relationships and activities through establishing a non-profit organization outside to support his activities. In each of the four cases, one cannot help noticing an extra-ordinary passion and commitment of at least one individual, whose sense of direction guided the subsequent developments.

One hybrid initiative that won a more permanent status is the Alliance of Global Sustainability (AGS), which was the initiative of the then President of Tokyo University to work with MIT and the Institute of Technology in Switzerland. The former president explains that "environmental issues were something that I cared about." Such a statement understates his personal commitment to the cause. Indeed it was he who had been instrumental in proposing to create the "Research into Artifacts Center for Engineering (RACE)" in 1992. The underlying concept at the time was articulated as follows:

"The motivation of this research program comes from the irrevocable consequences on our finite planet caused by the interactions among artifacts. These often lead to unprecedented environmental changes and major accidents. When we think about the fact that these artifacts were created through human knowledge, it is clear that we need to re-think the structure and implementation of knowledge that created these artifacts in the first place. The objective of RACE is to establish a new academic discipline for the design and manufacturing of artifacts, and to clarify the use and recycling of the manufactured artifacts."

The former President actively solicited participation of several engineering faculty members in its first meeting in January 1994 in Boston, who in turn became the core members who actively created the network of professors. There already was another inter-faculty community among Tokyo academics with environmental concerns, which was helpful in mustering people power in support of the AGS. However, it was not until a larger conference was held in Tokyo in 1996 that a discussion about a formal tri-partite agreement started. The organizers at Tokyo University recall how difficult it was for them to host the meeting, with little budget or other support. They made extensive use of campus facilities, which was not a simple task, because there were few administrative precedents. The then president explains the administrative difficulty in terms of another event that took place shortly before the AGS conference, where he had to work actively with administrators to use Yasuda Hall, the biggest lecture hall in Tokyo University. The point is that the administrative norm was that a major facility such as the Yasuda Hall was used only for specific and recurrent annual events. One professor felt that it was the success of the Tokyo meeting that helped demonstrate Tokyo's commitment to the other two universities.

Even to enter into an agreement was not easy for Tokyo University as it had no legal authority, nor the budgetary resources to commit. They managed to do so through two separate agreements similar to the format they used for academic exchange with other universities. For monetary support, the only option was to raise money from corporate donors. With the full support of the President, the organizers managed to raise about 700,000 US dollars annually for the AGS research fund to support research activities. This is rare internal funding open to proposals from individual faculty members at Tokyo University. Though company participation was initially limited to financial support, they became more active participants in annual conferences.

One organizer recalls how difficult it was to use the internal university administration. For instance, they found it difficult to channel foreign source money into the university or to keep financial records in the manner required by the international agreement. In the end, they decided to use an external foundation affiliated to the faculty of Engineering for administering money. AGS is currently in its 7th year of implementation, with the second 5-year plan agreed in January 2002. The organizers feel proud of their success as expressed by increasing numbers of participants - including a large number of students.

One organizer remarked how essential it had been to have had the President's commitment. Indeed, if it were not for his support and willingness to break new ground, many of the above steps would not have been taken.

1998, the Institute of Industrial Science (IIS) introduced a new mechanism called the Special Research Committees, for which individual academics invited multiple companies to become members for a given research topic. This is a case in which individual Committees may come and go, but the Committee structure remains stable over time. This is an unusual case in several respects. First, it is an unusual case of "institutionalization" where a new scheme was introduced top-down, but with bottom-up inputs. Several members of IIS who were already actively working with multiple companies were asked to start "model" Committees, including the junior academic mentioned above who was the first within the institute to start working with multiple companies. As a result, one professor started a new Committee. Another folded an on-going activity into the new structure, only to find that the lack of contractual clarity of the Special Research Committee was not suitable for undertaking extensive collaborative activities.

The scheme is administratively supported through a foundation, the Industrial Productivity Promotion Society, which is an independent legal body affiliated to IIS. As with other cases, the nature of "affiliation" is somewhat informal. The foundation has no "legal" link with Tokyo University, but is informally "linked" to IIS through the practice of IIS Directors serving as its chairs, and through its location within IIS. It has corporate members who pay small annual dues to receive information about IIS related matters, such as its annual reports and event announcements. It was therefore in a good position to advertise the scheme and to solicit new members to participate in this new scheme. It is not easy to trace the origin of the Special Research Committees. The administrators refer to them as an initiative of the Director of the Institute, who had been a core member of a group of reform-minded junior professors who actively debated the need for new approaches within IIS since the 1970s. The original design of the Special Research Committee dates back a while, where the stated objective was to raise the corporate commitments for scholarship grants. Before the current Director took office, however, his predecessors did not buy into the idea. So, it was only after he assumed office that the idea could be implemented. His commitment to working with industry is clear from the time he was responsible for an external review of IIS by a panel of industrialists in 199-, an unusually thorough event that led to a follow up meeting to ensure lessons were being learned effectively.

The Special Research Committees rapidly increased in number, and by 2001 there were 21 of them with about 200 members. However, in contrast to some of the original consortia activities in which tight collaborations had taken place, many of them appear to be operating more loosely to facilitate conversations rather than solid collaborations. Interestingly, even though the Foundation provides administrative support to these Committees, the administrators there are not familiar with the nature or content of their activities.

The third example was the TLO which was established as a private company. As described above, two professors were asked to come up with "an interesting proposal" on university-industry relationships by the Ministry, and developed a plan to create such a company. It is interesting that they considered the possibility of using existing "sleeping affiliate bodies," but then decided against such an option on the basis that it would be too complicated to change the existing organizations. Perhaps, the proposing professors had too little power to do what the UT president or IIS Director was capable of doing: to demand a change top-down.

The initial years were fraught with difficulties, particularly in finding the right expertise to head the company. However, the founding faculty kept trying until he found a new president, who had considerable expertise in technology transfer as he had worked closely with a Guru from Stanford. While it is too early to assess the overall performance, the company has won a certain senior status among its peer TLOs, and is well on track in calibrating its organizational positions. The changes introduced by the new president included de-emphasizing the corporate membership structure, which provided undesirable restrictions for their marketing possibilities, and developing tighter linkages with the broader Tokyo University community through formalized representation of key individuals ex-officio.

Behind the story of this TLO appear to be two individuals who had considerable stakes in making it a success. One was a law professor, who strongly believed that law as an academic discipline should be reformed so that it was useful to the society. Intellectual property rights represented a topic of critical importance in his ambition, and the TLO was indeed an instrument through which he could accomplish his mission. The other was the new President who came into office with considerable work experience in services to support graduate recruitment from universities. The experience of thinking about personnel issues from early on in his career made him think hard about his own core competencies. He concluded that technology transfer, which had been his undergraduate thesis topic, was the area in which he wanted to become an expert. He had entered an internal company competition for business ideas, won it with his proposal to start technology transfer activities from universities, and was eventually given a responsibility to head an experimental unit to this end. He traveled extensively to the US, a country which he thought was ahead in technology transfer, and managed to get one of the experts to work for him as a consultant. When he was asked to join the TLO, he was ready for the task.

The fourth example was a case of a group of professors who created a non-profit organization to serve as the secretariat for their activities. The original idea was developed by one professor, who had left a large corporate research laboratory to join another university (and joined Tokyo University later), in search of greater freedom to conduct research in an area of his own choice. He remembers his days at the corporate laboratory with some anger against the inflexible bosses who did not see what he saw and who were unwilling to take risks. He was already passionate about the area of his current research as early as 1991, when he was interviewed by a magazine reporter. The reporter noted that the moment he started to talk about this area of research, his attitude changed dramatically, from one of subdued intellect to passion.

If it were not for his perseverance, red tape would have prevented him from creating the non-profit organization. The group now has regular meetings and activities supported by the organization.

Institutionalized low engagement. An important characteristic of these cases is that there appear to be fewer inputs and less engagement on the part of companies than in either Cambridge or MIT. While there is a tradition of industrial researchers attending UT as visiting researchers or students, there is no evidence of these visitors playing any significant research role on topics specific to their company's interest. Industrialists appear more to play the role of an audience rather than be active participants in consortia settings. There is little evidence of companies bringing corporate technology onto campus in the form of hardware – although there are a few exceptional cases. Efforts made by individual academics to reach deeper relationships get rebuffed by companies either on the grounds of inadequate contractual conditions or more generally by the culture of non-interaction.

This is not to say there are no instances of deep engagement. There are several examples of consortia in which companies invested significantly in terms of employee time to work together with the academics. The monetary contribution may be minor in comparison with the contributions expected in consortia in MIT. However, these contributing companies brought much to the experiment both in kind (through equipment) as well as in staff involvement, with one consortium where each company sent two staff for a whole month each year. There are other cases of individual academics who have managed to sustain deep relationships with companies. One professor maintained unusually close ties with companies through a network of alumni from his laboratory, who met on a regular basis to discuss his research agenda. At one point, their comments prompted the same professor to revamp his research portfolio, to make it more updated and relevant to modern industrial needs. However, these appear to be isolated exceptions, rather than the norm.

7-5. Organizational underpinnings that shape institutional change

The above cases have highlighted some of the difficulties academics face in getting industry engaged, and the evolution of initiative objectives that often resulted in incoherence with the organizational structures. How can these characteristics be explained? In this section, I make two arguments. First, I argue that the sharply defined organizational boundary has had a strong influence on the way initiatives could develop. Second, I argue that the way the administrative infrastructure is organized, with weak central administration, weak professional administrators, and the very limited extent to which money functions as a medium of exchange, all contributed to difficulties for these local initiatives to become diffused or be sustained over time.

Organizational boundaries

Tokyo University has long been characterized by sharp organizational boundaries, in terms of people, knowledge and physical space. In the late 1990s, there have been rapid changes in all these boundaries, with them becoming more porous and more open. In this section, I first describe the traditional boundary conditions before the change, and then describe the nature of the changes taking place.

People boundary. The organizational boundary in terms of people's ability to move across it was sharply defined first of all by a highly decentralized personnel decision making processes. In the old system, the individual professor could essentially select his successor from among his students, appoint one into the position of lecturer or assistant professor within his Koza, and expect him to take over when he retired. While the Koza system is now largely the product of the past, with larger groups similar to departments emerging and with recruitment increasingly advertised openly, the legacy of the past remains in the minds of existing staff as well as in some of the values that are hard to change.

This old system created two types of barriers to the people traffic. First, it was difficult for anybody to be recruited who had an unconventional background, including those from industry. Second, the collective distribution of expertise was designed not to change over time, thereby creating higher boundaries for those in new fields. One junior professor laments that there is a large gap between the distribution of expertise in Tokyo University and the distribution of needed skills in the society. Another remarks that it is scary that the same field structure has been kept for over 40 years. In new fields such as information technology, the problem has been particularly acute. One professor who helped created the new faculty of IT pointed out that even with the new organization, Tokyo can house 100 IT students compared with 1600 at MIT. When juxtaposed against the societal skills shortage, this seems particularly ironic.

The hard people boundary was reinforced both by the culture of isolation and the civil service ban on undertaking consulting activities. University professors expect to be treated with respect and industrialists are not supposed to argue with them. Even today, five years after the revision of civil service regulations to permit technical consulting, there is little culture of openly discussing such activities. One professor who experienced consulting for the first time was surprised to learn about the technical know how of the company. Another professor who became involved in spin-off activities expressed his surprise as to how much had been hidden behind the corporate curtains. Even the very industrially active professors who are gathered around the CCR are finding the forum of the CCR senate interesting because of the large presence of visiting professors from industry. There may still be much that is hidden from the daily lives of Tokyo university professors.

Knowledge boundary. The organizational boundary in terms of knowledge ownership is impenetrable because of the government's position. All patent ownership and user right conditions are automatically set according to the source of funding at the time of contracting. Even though an invention committee, which plays the role of delineating government versus individual ownership, does so with considerable bias toward individual ownership, companies still do not feel sufficiently protected unless their ownership is stipulated up front in their contracts.

As described above, one company opted to take the route of virtual collaboration through consulting when it became clear that joint ownership of patents was unavoidable under any other form of formal collaboration. The problem was not so much the fact that they could not claim the entire ownership, but the fact that the government was such an unwieldy partner for negotiation. The lack of negotiation capabilities on the part of the government is amply demonstrated by the case of one company awaiting Tokyo University's decision on past patent disputes on ownership for several years. Administrators in Tokyo University are clearly not equipped to handle these issues.

These formal boundaries co-exist with informal ones that are created by individual academics who often develop informal understandings and agreements about confidentiality, publication, and intellectual property rights with their collaborating companies. Since patents arising from basic research support are owned by individual academics, professors could obtain scholarship grants from companies, on one hand, and develop informal agreements about IPR on the other.

Physical boundary. The physical organizational boundary has also been sharply defined and has divided the university community from industry in two senses. No company can claim space inside the university premises and no university professor can claim space in a company. Tokyo University campuses are also located in the midst of the urban areas of Tokyo where there is limited space for industry in the immediate vicinity.

Evolution in boundaries. Starting in the late 1990s, there have been rapid changes in all these boundaries, and they are all becoming more porous. On the people boundary, there are more industrialist researchers being recruited into professorial positions. Consulting and serving as board members in technology transfer activities have become permissible through regulatory changes in 1997 and 2000. A greater number of visiting professorships have allowed more industry researchers to enter the university.

The creation of the TLO has led to a greater institutional capacity to examine and negotiate terms and conditions of patenting and licensing systematically. Whereas in the past, negotiation rested exclusively on the individual caliber of professors, they now have professional resources to whom they can resort for advice and transaction.

For physical boundaries, greater allowances have been made for industrial research as well as non-governmental licensing activities to take place on campus through regulatory changes.

What is striking in Tokyo University is just how many of their boundaries are governed directly by the central government, and how little is managed internally by the university. This is perhaps the most striking difference between Tokyo University, as part of the central government, and Cambridge or MIT both of which essentially operate as private universities, albeit with heavy government funding.

Internal boundaries

The internal boundaries are less visible but as pervasive as the external ones. Interestingly, the academics at Tokyo University seem to be acutely aware about the need to cross-disciplinary boundaries. There have been several major organizational additions in the recent past precisely to address this issue: the Faculty of New Disciplines; the Faculty of Information Science; and the inter-departmental group on information. These perhaps reflect strong boundaries that existed in the past, not only between faculties, but between divisions (senko). A division typically comprises 6-7 Kozas or 20 professors and is the smallest professorial group with decision-making capability. While they rarely make decisions other than to maintain the status quo, they are important units when it comes to the survival of a given field. They are fiercely protective of the number of positions in the division – presumably because it is one of the most scarce resources. There also appear to be invisible barriers between senior and junior academics. Some junior academics had comments about their joint work with senior academics that they would not be prepared to voice face to face. Senior academics often made comments about and to "junior" academics in a way that made it clear that they thought of them as being "junior" and that indicated a lack of respect for their opinion. The Japanese linguistic tradition of referring to anybody who is either a "peer" or a "junior" using "kun" instead of "san" or "sensei (teacher)"also makes this division an important part of everyday life.

Academics are also very conscious of their "cohort" – and about who joined before or after them. Although there is a significant variation among divisions even within a single faculty, the power of senior professors used to be absolute (until recently) with it being necessary to obtain their unanimous agreement for anyone to be promoted to a professorship. One junior professor recollects that it used to be the case that they needed to make sure they made no enemies among the professors around them, lest their promotion be blocked. Junior professors also often depend critically on the good will of their patron senior professors to be able to establish their laboratories at the beginning of their career. This is in contrast to MIT where junior faculty often have seed money as part of their starting package to set up their labs.

How does administration relate to such internal boundaries? The role of administrators appears to constitute the most pronounced difference between Tokyo University and MIT or Cambridge. Professional administrators form a very different population within the university from the academics. They are themselves divided into three layers: those who are locally hired and employed; those who started as university employees but were then promoted into a managerial cadre who rotate among the national universities; and those who are MOEC career civil servants who are posted to term assignments in managerial positions. Most administrators rotate and change positions on a regular basis – every two years, if not more frequently – and so they rarely become experts in the area they serve. Frequent rotations are justified in two ways: to avoid stagnation or the concentration of power which might lead to corruption and collusion; and to give individuals a fair chance of promotion. While they pride themselves in their service activities, they rarely come with specialist qualifications. Most of the managers have bachelor's degrees and generalist career paths, in striking contrast to many administrators who come with research qualifications and background both in MIT and in Cambridge.

Academic administrators exist, but only partially, in the sense that the academics hold these positions as temporary diversion from their main research work. They rotate in and out quickly from these offices, based on strong beliefs among the academics themselves, that having people in these positions longer could lead to micro-management and impingement on their freedom.

As seen in MIT and Cambridge, the administrative infrastructure can provide important mechanisms to manage and modify the organizational boundaries by changing the practices that affect them. Policies on outside activities may be changed, or stances on intellectual property rights may be revised. What is striking in the University of Tokyo is that there is no administrative infrastructure that is authorized to make such changes at the level of the university. The organizational boundary is not only relatively harshly defined at the outset, but it is also not changeable at the organizational level. This leads to a forbidding and rigid institutional environment that constrains new initiatives.

Another differing characteristic is that, in the University of Tokyo, money is hardly fungible within the organization. Each stream of budgetary resources comes with its own strings attached, and even with recent rounds of deregulation, different categories of monetary resources continue to have distinct identities, although some types of money such as Scholarship Grants have long been more fungible than others. Further, some types of expenditure items, such as post docs or research students could not be freely "bought" with most of the monetary resources. Money arising from outside has clearly been a weak medium of exchange for research activities. This has led to an interesting consequence: when the money works less well as a medium of exchange, the demand for it is not as high. This is in striking contrast to MIT, where monetary resources earned by academics can help hire students and post docs, and go some way to influencing space allocation.

7-6. Degrees of institutionalization: the role of individuals

In Tokyo, formal and informal initiatives were dramatically different not only in their visibility but also in their sustainability and replicability. Formal initiatives were programmatically designed for replication or entailed establishment of new organizational structures which were expected to be sustained for a long time. The expected duration was often part of the formal design, and those "schemes" that were supposed to last lasted, while others such as endowed laboratories which were designed to last about 3 years, typically lasted exactly that, with only minor exceptions. Informal initiatives on the other hand, tended to remain isolated and invisible and while some lasted longer than others, they were rarely replicated.

Two factors appear to characterize these patterns of institutionalization in Tokyo: the role of founding fathers, that has a different feel in Tokyo from that in MIT or Cambridge; and the frequency and nature of debates that appear to take place around these initiatives.

Getting started: founding fathers. There were two types of founding fathers. The first type was academic administrators who would develop these visible and formal programmatic initiatives such as endowed laboratories, special research committees or formal organizational structures such as the Center for Collaboration Research. These founding fathers established the structure, rather than the content of activities. The second type was similar to those found in MIT and Cambridge: individuals developing initiatives with specific activity contents.

The founding fathers of programmatic initiatives of formal organizational structures were academic administrators who were given the task to do so. Interestingly they appeared to have had more debates with professional administrators within the university and at the Ministry than with other academics or industrialists. The academics who were engaged in the specific and first endowed laboratories, or those who started the first research committees, never appeared to have strong commitment to the initiatives, as they were brought in by the academic administrators to set them up. These were top-down initiatives. Similarly, for the Center for Collaboration Research as well as the other evolving laboratory, the central rationale for their existence, in terms of the specific role that they were to play, changed continuously as there were no founding fathers who stayed with the initiative for a sustained period.

It is not that the traditional type of founding fathers were absent in Tokyo. Most of the "informal" initiatives were developed by individuals with active interest, and indeed some of these appeared to "break through" into the realm of formality, winning visibility and certain permanence. And yet, not many of these individuals explained their motivation in the interviews, (although younger academics were more vocal than senior academics). For those who were reticent, their motives could be inferred only indirectly through other people close to them, or by learning about what they did over time through other sources of information. For instance, the industrialist-turned academic, who founded a non-profit organization outside the University, explained his current activities at the University in terms of how he can now do what he wanted but was not permitted to do in an industrial context. That was a comment that he made in passing, but not as a purposive explanation for what he was doing. It was only when I read one article from his former company magazine a decade ago, that I became aware of how serious his passion for the topic had been and for how long. The article was about a major research project the academic was responsible for, but included one tiny paragraph about his small pet project, where the reporter noted that the academic became passionate.

The former president of Tokyo University, who founded the Alliance for Global Sustainability (AGS) is described by an MIT professor as a "renaissance man," and is indeed known for his romantic vision for engineering. He argued that the traditional field of engineering failed in that it only helped individual industrial interest – and the technologies created to serve industrial interests were exactly those that destroyed the environment. He argues that the discipline of engineering must be re-constructed so that broader human needs are taken into account. However, those explanations for his motivation and philosophy are not given by him directly. They are provided by those who are close to him. Archival sources, such as reports from the laboratory he created or from AGS meetings that he participated in, give evidence of his words from the past, which resonate with the image of a man who progressively developed that philosophy. His philosophy lives today – but interestingly, in the words of academics a generation younger, his philosophy now sounds less convincing. A senior faculty would refer to the philosophy respectfully, but a younger faculty is more likely to paraphrase somewhat mockingly "according to the great master."

Getting both sides engaged. Initiatives tended to cluster into two camps: those with distinctly arm's length relationships, and those with close relationships. There seemed to be two principal routes through which closeness could be attained: active and open discussions between academics and industrialists; and the past industrial experience of the academics. Close relationships appeared to be based upon trust relationships between the founding academic and key industrialists. One academic who maintains several close relationships with industry noted that one thing he does in all relationships is to spend some time up front in discussing with the partner company about how to work out the division of labor. Without such clear specifications up front, he felt that relationships could easily sour later. It was also the case that many of the industrially active academics had worked in industry previously.

More generally, however, there were not many signs of active debates between academics and industrialists. When industrialists disagreed, they simply asked for lower prices or simply exited and did not turn up for further meetings. Wherever there were debates, they appeared to lead to more meaningful relationships, as in the case of the young academic who did not give in to the demand to "lower prices."

Scaling up and visibility. Formal initiatives were those that were large from day one and visible, as they would have resources from the Ministry. Informal initiatives were those that tended to be small, lacked administrative support and were almost invisible within the university community. For informal initiatives, scaling up was no trivial issue, at least in part because it was difficult to involve more than a couple of academics from Tokyo University. Given the legacy of traditional Koza, where a senior faculty is directly linked with a junior faculty or a research assistant, that Koza-like pair or triplet was often the base unit of participation in any given initiative. However, there was little evidence of active debates even within Koza-like units. The founding senior academics would see things one way, and their junior academics would often see things quite differently, but did not question their senior. As for administrators, they had very little ideas about the content of these activities. It was not easy to win additional resources to scale up activities.

Replicating. In Tokyo, there were two types of replication processes going on. On one hand, formal programmatic initiatives such as endowed laboratories were developed top-down by academic administrators in collaboration with professional administrators with replication in mind, In sharp contrast with the top-down initiatives at MIT or Cambridge, however, these programmatic initiatives did not include faculty founding fathers in the initial debates. Faculty members were "asked" to fit their activities into the schemes, rather than be active participants in the formulation of the templates.

Certain characteristics of informal initiatives appear to be replicated indirectly through hearsay. For instance, it was clearly becoming common to use external secretariats for handling the finances, mainly to avoid red tape associated with the university bureaucracy. However, there was little shared knowledge about how the past initiatives had been undertaken. New founding fathers appeared to be replicating without having the access to details.

7-7. Concluding remarks

The Tokyo Story is characterized by an interesting duality of formal and informal initiatives. Formal initiatives are visible, tend to represent detached relationships from industry, and are designed either to be sustained or replicated. Informal initiatives are usually invisible, with little administrative support and often with external secretariats where sustaining and replicating them are not easy.

One set of organizational boundaries are defined through official rules and norms, governed both by laws and by governmental regulations that are hardly negotiable. Even with recent deregulations about academic consulting and financial accounting, the ethos of civil servant professors remains strong. These conditions lead to relatively impermeable boundaries that are only gradually opening up with recent reforms and deregulations. The effect of such impermeable boundaries provides perhaps the biggest contrast with either MIT or Cambridge, as a result of which, academics at Tokyo have found it difficult to negotiate and sustain close relationships with industry.

This is not to say that all academics blindly follow these rules. Some academics have developed different ways of working with industry through informally created boundaries, sometimes through personal agreements about inventions and at other times through the use of outside bodies. People can and do create and enact very different informal boundaries for themselves. Such informal boundaries also clearly exist in other places such as at MIT (whereas Cambridge's fuzzy boundaries encompass both formal and informal boundaries), in the sense that academics may not necessarily adhere to the rules and norms, and nor does MIT rigidly monitor or enforce the rules. However, the distinction between "formal" and "informal" boundaries at MIT is likely to be much smaller than at Tokyo, given the clearly stated rules and mechanisms through which individual academics are held accountable if they diverge too far in their behavior from the expected norms.

In Tokyo, informal boundaries are defined and enacted by individual academics, and remain largely invisible. To the extent that formal rules have often been so restrictive as to be ridiculous, there is a lesser felt need to abide by them rigidly, provided that the informal activities remain invisible in the official books. The main source of trouble for these individuals in the past has been public scandals, most notably through media reports. Indeed, there have been several cases in which industrially active Tokyo University academics have been criticized for their financial arrangements – one as recently as in 2000. In most of these cases, the problem arose when entrepreneurial academics began to develop their own internal arrangement to avoid the red tape so that they could spend more flexibly the money from external sources. The most well known historical example occurred in 1967 when a reputed academic in Tokyo University was criticized for his "irregular" handling of huge sums of scientific grants. A similar line of attack was made in 2000 when another academic was criticized by a magazine for his financial arrangements, even though the amount involved was very small. The point is that Tokyo University academics continue to face public scrutiny that is actively searching for misconduct.

Media criticisms are today even more sharply focused on the misconduct of civil servants, as ministerial workings have been one of the targets for the blame for a decade long economic recession. New regulations have been instituted to clarify what civil servants can do and should not do. This climate is complicating the environment for academics to work with industry. On the one hand, there has been de-regulation to allow the academics to work as consultants to industry; on the other, civil servants face tougher rules about "socializing" with private interests.

One interesting issue is the manner in which deregulation takes place in Japan. There is a strong directive throughout the government to deregulate and streamline so to reduce bureaucratic burdens. There are constant deregulatory changes within national universities, and there are many things that professors can do today that they could not do three years ago. However, because these changes have been introduced incrementally, the net effect is to introduce more confusion.

For instance, it has gradually become possible for professors to use externally contracted funds for hiring research staff. However, the extent to which it is possible depends on the category of contracts and types of recruits, and it is not easy to understand why some rules have been relaxed in one type of contract but not the other. At any point, it takes some detailed understanding of the rules to figure out which money can be used for what purpose. Indeed the need to learn the rules may have increased in the short term, because of their constantly changing nature. The question is why it should be difficult to introduce more comprehensive packages of de-regulation. It is as though no one has the power to dismantle the complex structure of the regulations and laws. Individual civil servants can only tinker with the rules at the margin.

With the accelerated pace of deregulation which is expected to culminate in the planned legal separation of the University from the MOES in 2004, the differences between informal and formal actions is likely to shrink even in Tokyo. However, the tight conditions surrounding civil servants may or may not be changed, depending on whether national university employees opt to remain civil servants – an issue unresolved to date. Another issue of strategic interest is whether different groups within the university could be brought together to work as a single unit, as the university becomes an independent entity rather than an appendage of the Ministry. As shown in this chapter, different groups have formed strong and different ethos, and often compete with each other for funds, students and space. They have also begun to take different paths in creating their own administrative arrangements in key areas such as technology licensing. Whether and how these energies can be brought together to work as a single organization is another tough issue facing the University.

Chapter 8:
Contrasting across the cases

Previous chapters have described the historical contexts as well as the detailed processes of how new relationships have evolved. The objective of this chapter is to bring forward similarities and differences across the cases at three levels: (a) the organizational level where three universities are contrasted; (b) the level of institutionalized patterns, where the institutionalization processes are contrasted; and (c) the university-industry initiatives level where individual sub-cases are contrasted. For the three universities, contrasts will be drawn both in the characteristics of emerging relationships and in the dynamics of institutionalization. For the emerging institution level, the contrast is drawn in terms of the degree to which certain behavior patterns became institutionalized, as measured by the scope of replication elsewhere and whether there were sets of practices that form the basic template for replication. Individual university-industry initiatives will also be contrasted in terms of the extent to which they were institutionalized, but with a greater focus on their longevity in a given locale and the degree to which they influenced other initiatives. The differences as portrayed in this chapter will be the dependent variable, so to speak, to be explained in Part IV.

Contrasting the university cases

Characteristics of emerging relationships. The three universities have undergone significantly different developments in their relationships with industry. Table 8-1 summarizes the main changes and new developments since the 1970s as discussed in Chapter 4, but incorporating the greater details described in Chapter 5, 6, and 7.

Table 8-1: Main changes in university-industry relationships

	MIT	Cambridge	Tokyo
Multiple company relationships	Consortia and collegium/centers in the 1980s (50+)	Few	Formal: Research committee (20+) Informal: consortia
Educational programs	Educational partnership (2)	One in 1990s	None
Single company relationships	Strategic alliances in the 1990s (9)	Embedded laboratories and variations (10)	Formal: Endowed chairs (15+) Informal: 2 cases
Organizational structures	Numerous centers large and small	Several (inter-disciplinary institutes)	Several (interdisciplinary institutes and TLOs)
Administrative units	ILP revamped TLO reform Intellectual property rights counsel	Wolfson industrial liaison office revamped Research services created	Research support units established in External secretariats being created in the

Table 8-2 provides a qualitative characterization of these changes in the three universities. The size and number of the initiatives, be they strategic alliances or consortia, have been increasing over time at MIT. This means that greater numbers of faculty are likely to have the chance to get exposure to industry in their research work on campus. Looking at the depth of these relationships, they are close but bounded, in the sense that there are definite activities from which MIT faculty participation is ruled out, such as secret research, or consulting extensively with their own research sponsors. The variation among the relationships in terms of the size, structure, and depth is low, in the sense that all the strategic alliances or consortia have some common features.

Table 8-2: Summaries of changes in relationships

	MIT	Cambridge	Tokyo
Size	Larger	Increasingly large	No significant change, remaining small
Prevalence	Frequent	Few	Formal: frequent Informal: few
Depth	Close but bounded	Deep	Formal: Detached Informal: detached or close
Variance (size and depth)	Narrow range	Wide range	Wide range

At Cambridge, in contrast, individual initiatives remain smaller in scale and fewer in overall number, with a limited number of academics directly engaged. The depth of the individual relationships, on the other hand, can be high. Academics and industrialists are sometimes engaged with each other in a way that is almost personal. However, the variation between relationships in terms of their structure, style, and depth is quite wide.

In Tokyo, new types of individual initiatives are small and/or harder to find, partly because there are no official records that distinguish new types of activities within the standard categories that are regularly reported. Most of the acknowledged changes are formal changes supported by the government. There remains a certain distance between the university and industry, and it is only exceptional cases in which individuals strike up strong and deep relationships with industry. The variation across relationships is large.

Contrasting the dynamics of institutionalization. What about the manner in which changes have taken place? Were there pronounced differences or similarities between the three universities? Table 8-4 summarizes the characteristics of the dynamics of change in the three settings. In all three settings, there is considerable freedom in what individual academics can do. Innovative relationships are often developed simply on the initiative of individuals. What is different is that, while at Cambridge and Tokyo these individual initiatives are isolated and largely unnoticed, at MIT they appear to receive a good degree of active organizational support and can be scaled up, through access to bigger space or as a result of permission to hire more staff. Initiatives at MIT also get picked up as organizational templates and become models for others to replicate. There is sufficient cross-campus information about what is going on for this to happen, perhaps owing to the extensive network of administrators.

Table 8-4: Characterizing the dynamics of institutionalization in the three universities

	MIT	Cambridge	Tokyo
Old	Individual-led initiatives become scaled up, and lead to organizational templates for replication	Individual-led initiatives remain isolated and unnoticed	Individual-led initiatives remain isolated and unnoticed. Administrator-led schemes designed for replication
New	Administrator-led initiatives	Administrator-led initiatives beginning to appear	Individual-led initiatives increasingly externally situated

In Cambridge, there are limited mechanisms by which the central administration can support individual activities. It is interesting to note that Cambridge does have fuzzy networks of people, particularly through the college system, but these networks do not facilitate the mobilization of additional resources such as space or people. Initiatives may be known informally by a wide group of peer academics from different disciplines, but do not lead to any organizational support.

In Tokyo, individuals innovate as they do elsewhere, but their initiatives remain isolated and unnoticed. On the other hand, there were initiatives, such as the creation of new schemes, centers or institutes that had been largely proposed by academic administrators in negotiation with professional administrators and Ministry officials, and that were designed to be consistent with other national universities. Individual initiatives have never turned into organizational templates, but instead, organizational templates were created at Ministry level to ensure programmatic fairness across the nation. What is perhaps new is the fact that individual initiatives are increasingly anchored in external organizations, including brand new ones specifically created for that purpose.

Contrasting the institutionalized patterns

Previous chapters showed that there were seven new patterns of university-industry relationships which originated in the three universities and that became institutionalized beyond a single initiative. The degree of institutionalization between the seven is significantly different, however, in scale, scope of replication, locus of initiation, and degree to which organizational templates work. Some of them have indeed had external impact beyond the three universities as shown in Table 8-5. In the US, consortia-type multiple company relationships were replicated through the research center programs of the National Science Foundation. LFM-type programs were established in 12 or so other universities within the US in direct consultation with MIT. Strategic alliances have origins in other medical schools in the country; MIT's innovation in going beyond pharmaceutical companies is just being emulated in other universities also. For

Cambridge, embedded laboratories provide one example of institutionalization, notwithstanding their weakness in the sense of having high variability. The membership-based activities at the Institute of Manufacturing are the only other pattern of interaction that has been replicated – albeit within the confines of the Institute and limited to a handful of cases. In the case of Tokyo University, endowed chairs were established as a mechanism applicable to all national universities, and given that there were several other endowed chairs that were proposed by other national universities around the same time, the contribution of Tokyo University in its institution is not clear. Special Research Committees, on the other hand, were definitely a product of Tokyo University, though confined within the Institute of Industrial Science (IIS).

Table 8-5: New institutional patterns and degree of institutionalization

	Scale	Scope of replication	Locus of initiation	Organizational templates
Consortia, MIT	Large and becoming larger	MIT-wide Other universities	Individual-led	Loose, but becoming tighter in MIT Loose outside
Educational partnership, MIT	Large	Few in MIT Other universities	Administration-led	Loose in MIT Loose outside
Strategic alliances, MIT	Large	MIT-wide Other universities	Administration-led	Tight in MIT Loose outside
Embedded laboratories, Cambridge	Small becoming larger	Cambridge-wide	Individual-led Increasingly administration-led	Loose within Cambridge
Membership groups, Cambridge	Small	Few in number Institute of Manufacturing	Individual-led Increasingly administration-led	Tight
Endowed chairs	Small	UT-wide Other universities	Administration-led	Tight in UT and outside
Special research committees	Small	Institute of Industrial Science	Administration-led	Tight

Contrasting the initiatives

Another way of looking at the process of institutionalization is to examine the initiatives in terms of their longevity and replicability. When the experience of individual initiatives is reviewed, there appear to be three pathways: (a) local initiatives that die out (no institutionalization); (b) local initiatives that are sustained over time but remain isolated (local institutionalization over time); (c) local initiatives that become replicated elsewhere (institutionalization). These survival and replication patterns appear to be influenced by four factors that are mutually dependent: (a) the level of interest by the founding individuals in sustaining the initiative; (b) the ability of the founding individuals to define, articulate and enact the activity agenda of mutual interest to all participants; (c) the degree to which the founding individuals can obtain administrative and organizational support for the initiative; and (d) the degree to which the initiative becomes a template for others. This third point of "administrative and organizational support" refers principally to manpower and space; for instance, are there assistants who can help with the logistics? Can the founding individual have enough space to house these assistants in a way that is practical?

Personal commitment from the founding individuals appears critically important in order to sustain his/her participation in the initiative. The more their personal experience was in line with the content of the proposed initiatives, the more engaged they were, and the more they appear to be able to persuade others to join in. These same individuals had to make sure that their roles were consistent with those of their partners on the one hand, and with their colleagues and managers on the other. In addition, dialectic discourses appeared to play an important role in determining the level and kinds of support from various parties.

While there were remarkable similarities in the roles of individuals as seen in all cases from the three diverse settings, how they manifested themselves in the interviews was very different. For instance, whereas at MIT, individuals often simply articulated their personal commitment in an open way, at Cambridge, commitment was often communicated during the interviews with close peers rather than by the individuals themselves. In Tokyo, there was almost a generational difference between the older cohorts, who tended to be as reticent as those in Cambridge, and the younger cohorts, who were not shy to speak up, rather like their MIT peers. The older generation appeared reticent to such an extent that the shape of, and reasons for, their personal commitment only became apparent when several pieces of archival evidence were pieced togther - such as speeches and past interviews.

Concluding remarks

If these are the differences that characterize the three universities, what could possibly account for such differences? Chapter 9 will outline proposed explanations in terms of organizational boundaries, both internal and external, and Chapter 10 in terms of the role of individuals in story telling.

PART IV: WHAT WAS THE PROCESS OF CHANGE?

Chapter 9: Dynamics of University-Industry Partnerships: External and internal boundaries

In chapter 8, I contrasted the key differences among the three universities in the way their relationships with industry changed. In this chapter, I develop further the concepts of two types of boundary, external and internal, that were introduced in Chapters 5, 6, and 7, and argue that they influence and shape university-industry relationships. The external boundaries stand between the academic and industrial communities, and represent therefore the organizational boundaries of the universities. The internal boundaries stand between the different academic disciplinary communities, and between the academic and administrative communities within universities who need to work together to sustain the partnerships. Boundaries stand between different communities and represent differences in practices, values, and interests. And yet, it is these very differences that make collaborative work that crosses boundaries interesting. Differences make it possible to gain from a division of labor and are the reasons for complementarities and for working together. Differences also complicate joint work. In other words, differences represent both opportunities and risks.

There is nothing new in thinking about different cultural communities (Geertz 1973; Van Maanen and Barley 1984; Martin 1992; Schein 1992; Martin 2002) and recognizing how they require different initiation processes for new members (Van Maanen 1976; Van Maanen 1977); or in thinking that different "thought worlds" can create difficulties in collaborative work (Dougherty 1992). Some authors have noted the need for more work on boundaries to examine what happens at the boundaries and how boundaries are created (Abbott 1995; Martin 2002). To fill this gap, there is an emergent literature on cross-boundary activities which looks at: what kind of boundary objects can help in collaborative work (Carlile 1997; Carlile 2002); how different knowledge creation processes must be at work at boundaries (Carlile 2002); the salience of boundaries (Levina 2001); and how relative differences in knowledge can influence the learning of the participants (Black 2002). Current research contributes to this emergent literature by proposing the dimensions of these boundaries that may be relevant in determining the dynamics of interaction.

In this chapter, I describe the dynamics of university-industry relationships in terms of external and internal boundaries. For each type of boundary, I first describe the differences in values and interests of the two communities. I then describe what these boundaries look like in the three settings. Finally I describe how these specific configurations of the boundaries affect the nature of the university-industry partnerships.

Two different communities: academics and industrialists

It is clear that most university-industry relationships involve an academic community on the one hand and an industrial community on the other which are quite distinct in their values and interests. Table 9-1 summarizes the stylized differences as have been described by the scholars on science and technology and as confirmed by my discussions in the three settings (Merton 1968; Allen 1977; Dasgupta and David 1994). Several disclaimers should be made up front. These are stylized characteristics and therefore do not explain the many variations that emerge in practice, such as academic industrialists, or industrial academics. Academics in engineering, for instance, may behaviorally subscribe to a scientific community, but in value orientation may be closer to industrialists. Scientists at Bell Labs may have values and interests similar to those of academic scientists in universities.

Nonetheless, the framework provides suggestions as to why it is interesting for the two communities to work together, and why it is difficult for them to do so. For instance, the key differences between the two communities can be described in terms of goals: while academics aspire to create public knowledge to gain peer esteem, industrialists seek to develop competitive advantage usually through proprietary knowledge (Dasgupta and David 1994). The fact that they have different goals makes it easier for them to work together in the sense that they are not necessarily competing along the same lines. On the other hand, differences in goals make it essential that some coordination or compromise be made explicit so that they are not working towards inconsistent goals.

Table 9-1 Differences between academics and industrialists in interest and values

	Academics	**Industrialists**
Goals	Public knowledge and peer esteem as in publications	Value creation through private knowledge
Rewards	Priority of publications	Appropriateness
Problems	Autonomously-defined and generic	Directed by corporate interest and specific
Outputs	Papers	Products/artifacts Papers as by-products
Resources	Students, post docs, money generated externally	Professional researchers, money generated internally

While the academics are rewarded (eg in terms of recognition) for priority in knowledge creation, industrialists are rewarded for appropriability or ability to draw private gains from knowledge(Merton 1968; Dasgupta and David 1994). Problems in science are defined autonomously by scientists and tend to be generic and acknowledged by their peers, with papers as their primary outputs, while technologists work to solve specific problems as encoded in artifacts dictated by corporate interest (Allen 1977).

The differences in resources are hardly discussed in the literature, although strongly reported in the interviews. Several academics with industrial experience in all three country settings felt that critical differences in the production of knowledge were that they had untrained students as the primary workforce as opposed to trained professional researchers in industry, and that they had dependence on external monetary resources. On the one hand, the academics would find it difficult to compete against the industrialists if they were working on the same set of problems. On the other, the very fact that students are not trained and therefore not predisposed towards any solution, but are nevertheless highly motivated to solve problems, makes it more likely that the problems will be solved in unconventional ways.

While these differences appear to be relatively stable across the three country settings, there were several distinct constellations of relationships that had been established to deal with these differences. Philanthropic donations were found in all three places, in which industrialists essentially give up their interest and the research agenda was set by academics. Contracted and proprietary research was found in Cambridge, where some academics had given up their interest and rights to publish, and the research agenda was driven principally by industrial interest. Between these two extremes were collaborations in which the two parties worked jointly to set the agenda.

What do the organizational boundaries look like?

The preceding chapters have demonstrated that there are differences in the way the three universities define their organizational boundaries. These characteristics are summarized in Table 9-2. MIT's organizational boundaries are clearly defined in the sense that people know exactly where they are, and there are clear rules as to how they may be crossed. The organizational boundaries at MIT are therefore described as regulated. For Cambridge, by contrast, the location of organizational boundaries is often unclear, making the issue of boundary crossing ambiguous. Their boundaries are fuzzy and have few rules about crossing them. Tokyo also has clearly defined boundaries, where until recently, boundary crossing was not easy and so was rare. Tokyo has additional complications in the sense that some academics have traditionally managed to form informal boundaries that are different from the formal ones in establishing their relationships with industry (Odagiri 1999; Yoshihara and Tamai 1999). This issue will be discussed separately later in this chapter.

These organizational boundaries are further defined in terms of three distinct dimensions: people, knowledge and physical space. Individuals cross the boundaries based on rules and norms about organizational memberships. For instance, academics might be able to work as a consultant (or not), or be an executive director of a start-up company (or not), or be ready to leave the university to join industry. Industry employees can also cross the boundary by becoming an adjunct professor or even moving permanently through changing jobs.

Each of the three universities had different norms and rules about boundary crossing by people. MIT, for instance, has clear rules about external activities: academics can work up to one day a week for consulting and non-managerial positions outside. For MIT it is not only clear that these constitute "outside" activities, but there are also clear rules about exactly how far one is expected to go. Cambridge, on the other hand, provides no specialized rules about external work, which means that the academics can hold managerial positions in industry or consult without time limits, provided that they do not neglect their university duties. In Tokyo, consulting and representation in private

Table 9-2. Organizational Boundaries

	MIT	Cambridge	Tokyo
Type	Regulated Clear boundaries Clear rules on boundary crossing but negotiable	Fuzzy Unclear boundaries arising from multiple entities Unclear rules on boundary crossing	Impermeable formally, but permeable informally Clear boundaries Non-negotiable rules but boundary crossing increasingly permissible
Membership boundary			
Academics			
Part-time work	Consulting and non-managerial positions Up to one day a week	Consulting/board membership including for research sponsors	Consulting and board membership permitted since 1997
Dual positions	Not permitted	Can work as executive managers in industry	Not permitted
Quit U to join I	Sometimes	Sometimes – visible	Very rarely
Industrialists			
Part-time teaching	Adjunct professors Giving lectures Supervising theses	Part-time teachers Giving lectures Supervising theses	Visiting professors Giving lectures
Dual positions	Adjunct professors Board members Visiting committee members	College fellows	Visiting professors
Quit I to join U	Sometimes	Not often	Increasingly common
Knowledge boundary			
IPR ownership	University when significant use of facility	University or sponsors own if externally funded by contracts, but individual academics own otherwise	University and sponsors co-own when externally funded, but academics own when no external funding
IPR licensing	Can be negotiated including exclusivity	Can be negotiated including exclusivity	Can be exclusive, but not easy to negotiate
Confidentiality	Considered not right on campus	No rules	No rules
Publication	Delay up to 3 months	No rules	No rules
Physical boundary			
Department buildings	Can be rented provided no proprietary activity	Can be rented for commercial activity from university	Not available
Commercial buildings on campus	Not available	Available – owned by university/colleges	Not available
Commercial buildings near campus	Available	Available – owned by university/colleges or commercial bodies	Limited availability

companies were not permitted for the academics under the civil service code until 1997, when several categories of such activities became permissible. The norms and rules about employment define the membership boundary, which in turn can influence the overall level of inter-community understanding over time.

The knowledge boundary is also defined by the set of practices and rules about intellectual property rights, confidentiality, and publications; these represent the level of "knowledge sharing" that can go on between the two communities.

In MIT, all the knowledge generated on campus with significant use of MIT facilities belongs to MIT, and this has been a clear ruling since the 1930s. Sponsors, however, may retain the rights to license exclusively. Bringing proprietary knowledge into campus is considered undesirable, and confidentiality agreements are agreed only with reluctance and as an exception rather than a norm. The delay in publications to allow sponsors to review the content to make sure that all the needed patent processes are set in motion is acceptable only up to 3 months, though exceptional cases can be negotiated. There is a clear sense of to whom the knowledge belongs or where the boundaries are. There are also clear but negotiable rules about how far academics can go in accepting conditions on confidentiality or publication delays.

In Cambridge, by contrast, the ownership of knowledge generated on campus is negotiable. Companies may own it, if they bring substantive resources and expertise into the invention. These ownership conditions may also change over time, as companies' contributions change. Similarly, there is no single ruling against confidential information. While publications are the expected outputs, the use of confidential information as inputs is a matter of individual discretion.

The physical boundary is defined by rules about how external organizational units may be able to reside inside the university premises. For instance, in Cambridge, the university as well as the colleges can own land and buildings and be landlords both of academic buildings as well as of commercial ones. There is nothing that stops a company from renting space in the relevant academic department to undertake relevant research.

Boundaries as reflecting historically formed values

To the extent that these boundaries are accepted by organizational members, they must reflect and be consistent with the underlying shared values and assumptions of the organizations. Today's norms and rules reflect both the original views and values in the organization at its foundation as well as those that have been shaped subsequently.

For MIT faculty, for instance, working for external organizations was long an expected part of academic life, as described in Chapter 4. There is a strong value within the organization that consulting for industry to work with practical problems enriches one's understanding of the world, which can be helpful for developing educational curricula. Such a value was also reinforced by the fact that MIT faculty members were historically expected to find external funding for 50% of their salaries. In the 1960s, however, the upheavals of student movements led to a new understanding of the importance of drawing a line between public academic activities and private and individual activities. MIT rules were established, but in the spirit that protected faculty by establishing what is legitimate.

Similarly, there was a time when faculty members were involved in outside interests to a significant extent, especially in start up companies. Even though there was a ruling about limiting such involvement to one day a week, this ruling had not been strictly enforced. All this was to change in the 1960s, when external activities by faculty members, particularly in start-ups became an issue. Starting with a case of a mechanical engineering professor who was asked to choose between MIT and his company, time limits on external activities became more strictly enforced. The norm became established for academics either to take leave and concentrate on start-ups or to limit their external activities. The clarification of the boundary was at least in part a result of the prevalence of cross-boundary activities and the ensuing controversies. The community became less tolerant with fuzziness, as it provided no protection of legitimacy to organizational members.

In Cambridge, by contrast, the basic assumption is that every Cambridge academic has good enough judgment to be able to choose to do whatever is appropriate. The rules as well as the boundaries are fuzzy so as to permit maximum individual discretion. The continuing fuzziness of the boundary also reflects the fact that there has not (yet) been a sufficiently large number of problems raised for there to be a need for a firm policy. The arrival of Microsoft was arguably the first time in recent history that the university had to think hard about what is and what is not acceptable. The result was a strong sense of the need to articulate basic principles to be followed. While the boundary remains fuzzy today, the need for clarity with the possibly of rules is voiced by more than a small minority of people. The boundaries as they exist today may indeed be at odds with changing values. This tension is visible in the ongoing attempts to bring in a clearer set of rules, for instance, with respect to intellectual property rights and outside professional interests.

In Tokyo, the longstanding underlying value has been to ensure the autonomy of science from industrial capitalist interest. Academics as civil servants were not to consult for, nor play an active party in, industry. These employment boundaries may seem like a natural consequence of the fact that Tokyo University is a government body. However, Tokyo University itself had a very different relationship with industry until the end of the war, even with similar government legal structures. Faculty members helped industrial processes much more readily in the early days, either directly or through their students (Odagiri and Goto 1993; Odagiri 1999).

The duality of boundaries in Tokyo University reflects the unevenness of the values and interest among academics with respect to working with industry. Impermeable boundaries as reflected in the legal and regulatory structures are consistent with the post-war values about the importance of academic autonomy. To some academics, however, working with industry was obviously important, and they enacted informal boundaries, sometimes through developing their own memoranda of understanding about intellectual property rights and confidentiality, where closer relationships could develop, often based on personal trust. The recent changes in the laws have made it possible for national universities to rent space to companies at a discounted rate in order to attract them to the campus. It is interesting that one of the de-regulatory measures allows national universities to offer space to companies at a discount. This clearly demonstrates the nature of the cultural divide between the two communities. If the universities were an attractive enough place for industries to reside, why would space need to be offered at a discount?

Characterizing the process of interaction: engagement

What difference do these organizational boundaries make? I argue that they influence the level of engagement through which relationships may be developed. By engagement, I refer to the depth of interaction between the two communities. Two illustrative cases help illuminate the nature of engagement.

One example of engagement was observed during a company visit to a campus, where multiple industrial representatives met with academics to discuss the potential collaboration. In the course of the two-day visit, participants looked "engaged" on about 30 occasions. That is, they looked interested: they leaned forward and looked intently at each other. They physically exhibited interest and their verbal responses showed that they understood the content of the discussion and brought in new ideas or information related to the ideas being discussed.

There were two types of engagement that were particularly prevalent. One where the academics looked "engaged" in hearing comments from industrial representatives. Academics' interest was sometimes triggered by the mention of facilities or data available in the company that could help their agenda substantively, but was also triggered simply by good questions that appeared to capture their imaginations. Questions were "good" when they contained sufficient information explaining the reasons why the particular problem being raised was relevant, particularly from the company's perspective. The second type was when industrial representatives looked engaged, mostly when they came across research topics with potentially relevant applications. On some of these occasions, several industrial representatives were "engaged" among themselves, with a member of their own research staff, with their research theme manager and with their R&D director all discussing the implications for the company's interest.

These engagements appeared to be "genuine moments" when people were thinking hard about the same set of ideas. Though these are examples of momentary engagement, it is not inconceivable that these substantive dialogues, if continued over time, could have consequences for behavior. Academics, when engaged by those intriguing questions, might eventually be persuaded to try out new directions in their research. Company representatives, when engaged with each other, might be able to come up with a relevant link between the research agenda and their own work. Engagement might thus be postulated as being a mechanism through which the conflicts between autonomy loving academics and direction-oriented industrialists could be resolved: industrialists might "direct" academics in their agenda, through good questions that capture their imagination.

Another example of engagement is a deep commitment made by one company. In one university, a company decided to bring proprietary knowledge and technology onto the campus. This was not an easy decision for the company. The knowledge was not only proprietary, but it belonged to what the company considered to be its core technology. And yet, unless they could openly use the technology with outside research groups, the scientific potential for other applications could not be tested. The company took the risk – with assurances coming from the university collaborators to respect some confidentiality conditions. The technology was sufficiently novel and helpful for research that two academic research groups modified their research agenda and incorporated the company's agenda. Another group's research activities were guided by proprietary information related to device fabrication. When the company saw the returns to their risk, they decided to go further and bring in more people and technical expertise to the campus. The company was learning that unless they committed their technology and expertise in the collaboration, they could not gain from the research outcomes.

However, engagement does not necessarily mean an increased inflow of proprietary technology or information. In another company case, several industrial scientists who were on campus full time worked hard with their HQ staff to identify scientifically relevant questions. They considered it inappropriate to bring too much proprietary knowledge and information onto the campus, particularly that related to product problems. Instead, they invested their staff time in identifying the research agenda which would be of common interest. In this case, the key measure of engagement may be the time and information committed by the company to the collaboration.

Consequences of organizational boundaries

Different organizational boundaries appear to encourage different constellations of relationships. There are two processes through which the nature of relationships is influenced by the organizational boundaries. First, the permeable membership boundary in particular creates different levels of mutual understanding between the two communities. Several Tokyo University professors who have begun to consult or work as advisors to start-ups acknowledge that their worldviews have changed, and that they now have a much better understanding of the industry and where their interests are coming from. What this awakening indicates is the extent of misunderstanding that would have existed without such practices. If the two parties understand each other and their respective idiosyncrasies better, then the initial negotiation is likely to be different in nature.

The second mechanism is that different organizational boundaries allow – or require - different patterns of sustained interaction, which can influence the level of engagement. If it is possible to have industrial scientists on campus undertaking their own research, they can have daily interactions with the academic community and there are greater possibilities for engagement. In a steady state, one would expect there to be certain levels and types of engagement and a configuration of organizational boundaries which were at equilibrium. Table 9-4 summarizes the nature of engagement in the three universities.

Table 9-3: Organizational Boundaries and relationship characteristics

	MIT	Cambridge	Tokyo
Organizational boundaries	Regulated	Fuzzy	Impermeable
Relationship characteristics	Prevalent Close but bounded Narrow range Single and multiple Companies	Few Deep Wide range Single companies	Few Detached Wide range Multiple companies

For MIT, relationships through research contracts are close but bounded. Academics and industrialists can work with reasonable closeness, but without completely sharing the research agenda. As discussed in Chapter 8, there are more of these collaborative activities in MIT than there are in Cambridge or Tokyo. The collaborations tend to fall within a narrower range of engagement – mainly because there are clear rules and norms about what is acceptable. Confidential research is unacceptable in general at MIT. There is a strong resistance to getting too close. The close but bounded relationships also make it feasible for multiple companies to come together without having to worry too much about exposing themselves to competing firms who may also be around.

For Cambridge, relationships run deeper, with more information and personnel time commitment by industry. There is also greater diversity in engagement. Some collaborations are completely collegial with the key activities being weekly seminars in which industrialists and academics participate with no contractual obligations. Others are closer to being proprietary, with confidential information coming onto the campus. The fact that each collaboration tends to entail deeper engagement than at MIT also means that they tend to be with single companies; it is relatively rare to find multiple company collaborations. However, the collaborative activities are still sporadic rather than prevalent across departments.

For Tokyo, collaborative relationships are more detached, with multiple company relationships dominating single company relationships. In one interesting case, a single company partnership was forged with the active involvement of one senior academic administrator, but it ended up taking place outside Tokyo University through multiple consulting arrangements. The company explained that, given the IPR arrangement, it was not feasible for them to have formal relationships with Tokyo University. However, there are other informal ties in which professors work with industry without formal contracts. Rewards are often passed back to the professors in the form of scholarship grants, the form of money that has traditionally been least restrictive in its use.

While I certainly came across cases of this kind in Tokyo, I argue that there are unlikely to be many and that they are likely to decline in importance given that (a) more professors spoke about standard operations in which companies gave scholarship grants at the going rate, almost instead of name cards; (b) most Japanese industrialists whom I interviewed did not acknowledge there to be deep ties through such informal mechanisms; (c) both academics and industrialists spoke of the increasingly tight conditions in which formal agreements are becoming preferable; and (d) the overall level of scholarship grants has been declining in the 1990s, both nationally and for Tokyo University. Also, as the overall values within Tokyo University become more accepting of closer ties with industry, there are different avenues through which industry can more openly work with the academics, and the need to resort to informal trust-based relationships also diminishes.

Internal boundaries: disciplines, academics and administrators

Another set of important boundaries that emerged were those between different academic disciplines. While academics as a whole share many of the values and interests pertaining to the conduct of academic work, disciplinary spheres define specific topics and methods of inquiry differently. It was also apparent that the role of administrators was important in helping to bridge these internal boundaries. In Cambridge, there are informal and interdisciplinary communications among academics, especially through the structures of the colleges. However, these informal dialogues could not then be developed into organizationally supported interdepartmental activities, since there was little, if any, administrative support for them. If administrators, whose role could be to provide a bridge between different departments, were themselves isolated from the academics, they cannot play this role effectively.

Indeed, although often invisible to outsiders, there is a deep internal divide between academics and administrators in all three universities. They are almost two separate communities with their own respective practices, interests and values. The differences between the two communities, however, are much more divergent across the three country settings than are the differences between academics and industrialists, perhaps reflecting the fact that administrators and their culture are much more localized. Scientists contribute to international journals and attend international conferences and come to share some of their practices and values across international borders. Similarly industrialists readily cross international borders. In this study, I interviewed people from 22 companies, of which 7 out of 9 Japanese companies, 2 out of 8 American companies, and 1 out of 5 British companies were interviewed for their relationships abroad. By contrast, administrators are recruited locally, rarely go overseas or attend international conferences. Even with this caveat, the stylized role differences with their underlying values and interest can be summarized as in Table 9-4.

Table 9-4: Differences in values/interest between academics and administrators

	Academics	Administrators
Goal	Publications	Process coherence
Loyalty	Disciplinary	Organization
Rewards base	Priority of publication	Performance target
Value	Originality and diversity	Fairness and consistency
Roles	Production of outputs (papers, education)	Organization of inputs (students, money, space, library)

Table 9-5 summarizes the characteristics of internal boundaries at the three universities. Here, the interesting commonality is that there is one-way flow in boundary crossing: academics can become administrators, but administrators do not usually become academics, except some of the academic administrators who return to their original positions as academics after their service as administrators. Again, the extent of permeability was the largest at MIT, where there is tradition of senior academics taking senior academic administrator positions, such as deans and department heads, but also where there are researchers and post-docs who move into administrative jobs over time. There is boundary crossing from academia to administration at multiple levels at MIT. In Cambridge, in contrast, it is mainly at the level of department heads that academics become part-time administrators. Vice Chancellor is practically the only academic administrator position that is full-time. There is also a strong resistance on the part of academics to see themselves as administrators . In Tokyo, even this was not significant, since most academics held administrative positions for short tenure and continued with their academic work part-time.

Table 9-5: Internal boundaries between academics and administrators

	MIT	**Cambridge**	**Tokyo**
Boundary	One-way permeable Clear boundary Penetrated one way and at all levels	One-way fuzzy Unclear boundary Penetrated one way at high levels	Impermeable Clear boundary Limited penetration
Membership boundary	Academics become full-time academic administrators. Researchers become administrators Administrators do not become academics/researcher s	Senior academics are part-time administrators. Administrators do not become researchers Some administrators come with industrial experience	Academics become part-time senior administrators for short terms. Administrators do not become researchers Industrialists increasingly holding administrative roles

	Significant number of admin. with industrial experience		
Knowledge boundary	MIT owns all inventions based on significant use of MIT facilities	Cambridge owns when externally supported, and academics own when no external funding	Tokyo University own when externally supported and academics own when no external funding
Physical boundary	Shared	Central administration in a separate building Departments located all around the city	Central administration in a separate building Different campuses
Characteristics of administration	Diverse group with many tri-linguals (academic, industrial and administrative)	Home grown administrators with some bilinguals (academic, administrative)	Clearly separated monolingual administrators

Another significant difference is that at MIT, there are many administrators with industry experience working on relationships with industry, be they in the Technology Licensing Office, in the Industrial Liaison Program, or in the Corporate Relations Office. This has made the administration at MIT a diverse group comprising people with academic, industrial as well as administrative backgrounds. In Cambridge, in contrast, the majority of administrators are home-grown with little academic/research or industrial backgrounds, though more professionals with industrial backgrounds are beginning to be recruited. In Tokyo, none of the professional administrators had industrial experience, making them more "monolingual" than in Cambridge or MIT. There has, however, been a rise in "unofficial" cases where individuals with industry background came into the university either on secondment to affiliate bodies or as visiting professors to the university who then performed largely administrative functions.

It is possible to see the characteristics of the administration as cumulative results of governance structures. For instance, at MIT, the centralized and private governance structure appears to have led to professionalization of administration including academic administrators. In Cambridge, it seems plausible that both decentralized governance structures and the abundance of resources has meant that the central administration's work has been far less contentious, leaving the administrative tasks to be more isolated and less professionalized. In Tokyo, the supra-centralized governance dictated the loyalty of professional administrators to the Ministry. An alternative way to look at it is that internal boundaries over time defined specific sub-cultures of the administration.

These differences appear to lead to two significant consequences. First, at MIT, administrators appear far more capable of setting the rules, changing the rules and holding negotiations about them for special cases. The expectation that administration is there to serve the academic functions pervades the administration, and as such administrators behave with a good understanding of academic practices, interests and values. At Cambridge, administrators are far less legitimated to change the rules, and the recent attempts to bring in greater uniformity have been undertaken with extreme caution. In Tokyo, administrators can hardly negotiate or make judgments on any variable application of rules.

Second, administrators can undertake resource allocation favoring some projects and not others; they can create opportunities for some activities to scale up, and for others to dwindle or even disappear. This was most prevalent at MIT, where money worked well as a reasonable medium of exchange for research activities in purchasing manpower (students and post docs) and to a certain extent, space also. At Cambridge, to some extent, this takes place within each department, but there has been traditionally little adjustment of allocation across disciplines undertaken by the administration. In Tokyo, this takes place least, with the consequence that there are no clear mechanisms for scaling up activities.

Concluding remarks

I have argued that the three universities have differently defined organizational boundaries, both external and internal. Both external and internal boundaries can be examined by reference to three dimensions: people, knowledge and physical space. I have further argued that these boundaries have influenced the manner in which relationships have formed, and have led to different characteristics in the three universities.

Chapter 10: Emergence of new institutional patterns: The role of individuals in storytelling

In the preceding chapter, I argued that organizational boundaries shaped the patterns of evolving university-industry relationships. While organizational boundaries could explain some characteristics of change, they could not explain the dynamics of institutionalization, and more specifically, why some initiatives appeared more "powerful" than others in surviving longer, scaling up, or being replicated.

In this chapter, I use the concepts of "stories" and "compatibility" among them to describe the dynamics of emerging institutional patterns. I argue that when a new institutional pattern emerges, such as a new type of relationship, participating individuals create a cover story to justify the collective action, and create sub-stories that account for their individual roles. A new relationship is like a nested set of stories, comprising a cover story for the overall partnership and individual role sub-stories of the cover story. It is three different types of compatibility between stories that collectively determine the general strength of the new behavior pattern and ultimately its sustainability and replicability over time and across space.

Defining stories. A "story" is usually defined as a narrative that combines various events through a sequential plot in a way that explains the significance of an outcome that gives meanings to different events in light of the outcome[1]. In my analysis of emerging institutional patterns, I use the minimalist definition of a story as a narrative or an account that justifies and explains an action (Scott and Lyman 1968). Every institution, defined as a patterned behavior, must have some story or account associated with it, in order to be sustained. The stories might be explicit or implicit (Boje 1991); indeed their existence may not really matter until an opportunity arises to change the behavior (Dreyfus 1991; Piore 1995). Stories are critical instruments for social construction because they facilitate people's understanding (Bruner 1986; Polkinghorne 1988; Bruner 1990). "Stories" are products of sensemaking that may or may not be articulated in speech. They reside in people's mind as a way of understanding the past and as a way of projecting the future actions.

Defining compatibility. Another important point about an institution is that every individual involved in it may have different roles to play and therefore their individual sub-stories about what they do may be different. Institutionalized actions require different persons to perform different roles but in coordination. Compatibility among these role

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[1] Polkinghorne, D. E. (1988). <u>Narrative Knowing and the Human Sciences</u>. Albany, State University of New York Press. This is one of the minimalist definitions to be contrasted with more general definitions which typically include: temporal order; a beginning, a middle and an end; characters; plot; narratora and settings [something wrong with punctuation here] O'Connor, E. S. (1996). Telling Decisions: The role of narrative in organizational decision making. <u>Organizational decision making</u>. Z. Shapira. New York, Cambridge University Press.

stories means certain consistency or congruence, but can be defined principally as the absence of conflict. Compatibility is not a binary state of whether there is compatibility or not: compatibility can range on a continuum from weak to strong. Nor is compatibility something that can be attained in a static sense. It is only possible to define compatibility between behaviors that have already been enacted. Compatibility is strengthened by the existence of shared assumptions underlying individual stories. The more shared the underlying assumptions are the more compatible the stories are.

In the remainder of this chapter, key elements of the process theory of storytelling will be described drawing on real examples. I argue first that there are two types of stories that have different functions. (1) **a cover story** for joint action that is shared among all participants to explain why they act together; and (2) **individual role sub-stories** that are created by each participant that explain why he/she will take on a specific role within the joint action.

Then, I submit that there are three types of compatibility that are important in making the joint action sustainable over time: (1) **individual role compatibility** between the individual role sub-stories and stories that define his/her identity; (2) **partnership compatibility** between individual role sub-stories of people representing different organizations, such as academics and industrialists; and (3) **organizational compatibility** between individual role sub-stories of different organizational players, such as students, academics, and administrators in a university; or researchers, managers, and top executives in a company, which in turn can enable individual role sub-stories to develop into organizationally recognized roles.

Strong individual role compatibility pushes individuals to sustain action over time. With strong partnership compatibility, the coordinated pattern of behavior can be sustained over time. Similarly, organizational compatibility ensures sustainability of the new pattern of behavior across time and space within the organization, as stories become organizationally shared. Finally, I argue that **dialectics** is a critical process that provides opportunities for individuals to learn different types of compatibility needed for the participants to work together. It is a process through which differences are surfaced, giving opportunities to align them.

A cover story for joint action. Storytelling is usually initiated by an individual interacting with at least one other. The act of storytelling engages the storyteller and the listener/s in a way that they all agree on the need for joint action. For instance, an academic might be talking to an industrialist about a possible collaboration. Their interaction may result in a story of why they should work together – a cover story of joint action.

An illustrative example is the creation of the Media Lab, one of the most spectacular MIT success stories about engaging and winning industrial support. It all started from a proposal that Nicholas Negroponte, the Lab's founding director, wrote, which caught the attention of Jerome Wiesner, the then president of MIT, who needed to sign off on it. Negroponte was still young, in his early 40s, but with bold ideas. Negroponte recalls

"Rather than dismiss it as crazy, he offered to help...A great friendship began... Wiesner pressed for more sophisticated linguistics and deeper commitments to art. By 1979 we talked ourselves and the MIT Corporation into building the Media Lab (Negroponte 1995)." One senior academic at the Lab recalls:

> "In 1978, Nicholas and Jerry first drew what I call, what we call the Media Convergence Venn Diagram... This was a hypothesis that three industries were on a collision course: print and publishing, television and broadcasting, computing...And it was then that they said that by the year 2000, those three industries would... almost entirely... overlap. .. In my mind, that diagram was the origin of the Media Lab."

Wiesner, upon stepping down from the presidency in 1980, joined Negroponte in extensive overseas trips in search of industrial support. Enough funds were raised from corporate executives and high-powered friends of Wiesner to set up a building and the Media Lab was officially started in 1985. In the five years, Negroponte and Wiesner had traveled intensively "sometimes spending more nights with each other than with our families" (Negroponte 1995). They had clearly established a proposition about the Media Lab that was appealing to the corporate audience. Stewart Brand, the founder of the Whole Earth Catalog, who spent three months of 1986 on sabbatical in the Media Lab, summarized the message as follows:

> "Negroponte's vision: all communication technologies are suffering a joint metamorphosis which can only be understood properly if treated as a single subject and only advanced properly if treated as a single craft. The way to figure out what needs to be done is through exploring the human sensory and cognitive system and the ways that humans most naturally interact. Join this and you grasp the future" (Brand 1987).

"It worked," says Brand, and explains Media Lab's ability to persuade the corporate audience as follows.

> "How does a corporation get to the front of this risky business without spending a hell of a lot of money? How can you peer ten years along a technological trendline that might devour or starve your present cash cows? How can you explore the crossover technologies where entire new businesses are being born without becoming one of the stillborn? You read in the Wall Street Journal or the Boston Globe how former industrial backwater Massachusetts is booming, with unemployment down to 3.6 percent and a state budget surplus, and it's all being attributed to MIT. Then Negroponte shows up keynoting somewhere with video demos of MIT researchers test-piloting the information technologies at the edge of the possible, flying in formation around a pattern vague and shifting but emerging, hypnotic.... And you buy in" (Brand 1987).

The reality does not give simple counterfactuals, so it is not possible to know whether Negroponte, today a brilliant fundraiser, would have been as successful without Wiesner. The corroborating evidence is that it was Wiesner's phone calls that prompted the NEC chairman to respond in a day, and Negroponte himself recounts how much he gained from Wiesner's partnership. In his own words,

> "For me this opportunity to learn from Wiesner and to see the world through his eyes and those of his many brilliant and famous friends was an education. The Media Lab became global because Wiesner was global" (Negroponte 1995).

A statue of Wiesner's head still sits on the office table of the Media Lab Director as if someone still wanted him to participate in meetings even after his death.

Internalization: emergence of individual role sub-stories. What does a cover story do? A cover story helps individuals to make sense of the significance of joint action in light of a proposed goal/end. By the same token, the cover story provides a reason to sustain particular behaviors. What academics and industrialists would do at the negotiating table and indeed during the formative years of a partnership would be to develop their own sub-stories about their participation in the partnership. It has to be clear to their own internal audience how they would benefit and why it is important for them to join. In some cases, this will require different stakeholders within the industry, for instance, top executives, managers, and researchers, to develop multiple sub-stories about why they should participate in the partnership.

In one partnership case, the partnership decision was made first and foremost by the top executive. His vision was that a new type of knowledge alliance was needed to push the company forward. To his managers and researchers, who were much more operation-focused, the reasons for, and nature of, the partnership were not as clear. Some employees resented the initiative because it was top-down, and others failed to see benefits to the company. Some participated simply because they were told to do so by the top executive, rather than to explore the benefit that the top executive saw.

What is evident is that the establishment of a single partnership requires the involvement of multiple people, each with their own sub-stories about their roles in it: why and how they should participate. It is evident that one can have sub-stories that stem from ulterior motives, such as the subordinates participating simply to please the bosses. These sub-stories may still ensure some level of participation, but the nature of participation is likely to be weak and superficial. In other words, the compatibility between the main partnership story and individual role sub-stories can be strong or weak.

Sustaining participation: Individual role compatibility. In any partnership, a group of individuals must devote some energy to establishing and carrying on new partnership activities. Individual commitment or motivation can depend on whether the sub-story about participation is compatible with his/her personal values and ambitions. There has to be certain compatibility between the new role stories and identity narratives.

In a case in which an industrialist formed a company to help university technology transfer, the CEO expressed his motivation as being deep-rooted in the desire for self-actualization. He had worked as a professional in a position to advise young people about their career development, and had begun to question his own competitive advantage and career goals. He selected technical transfer as his field of expertise for three reasons: as an undergraduate, he had written a thesis on the topic. He already had working relationships both with universities and with industry, and he wanted to contribute to society through such expertise. He established contact with the world's best-known consultant in the field, worked hard to learn by working with him, and, five years later, became a CEO. In a case like this, it is not clear whether his personal motivation story was there to begin with, or was developed as he went along. Nonetheless it is clear that it is the story that he uses to explain his own commitment to the others, and probably to himself. When people are convinced that they are doing the right thing for the right reasons, they are more likely to devote more energy to it and be more mindful about it.

The personal ambition of the founding director is largely behind the establishment of another center with an intensive partnership arrangement with industry. He explains his personal motivation in three ways. He had joined academia, after a career in industry, with the idea of helping the university establish better linkages with industry. He was also interested in sharing with students the excitement of participating in technological revolutions, which he had been privileged enough to have lived through. Finally, he felt there was a critical need for academics in universities to learn to collaborate with each other. The design of the new center was based exactly on these principles: it squarely rests upon intense collaborations among faculty members; it attempts to ferment technological revolution by bringing in industrial partners that cover every part of the supply chain; and students have been central in the interdisciplinary technological developments.

Coordinating across external boundaries: partnership compatibility. Partnership requires multiple parties to take actions. Academics may need to recruit new post-docs with skills appropriate to new research themes, to find administrators to assist in the monitoring of finances, and to write reports and set up review meetings with industrialists. Some of these may not be "new" behaviors, while others may be totally new. Industrial researchers, on the other hand, may need to talk to the academics frequently, to visit them and to read their reports. Industrial managers may need to monitor progress to ensure company interest is protected, to respond to new requirements for equipment and other resources and to engage in patent reviews. Industrial executives may need to visit the campus every year to monitor progress and generally to ensure that the partnership remains viable for the company and is seen to be so by the rest of the company.

In other words, a new "institutional pattern" of partnership entails coordinated action among a range of participants. And yet, what governs individual action is not only the shared cover story about the partnership but also his/her own individual role sub-stories for participation. These individual role sub-stories are necessarily different across people and give meanings to different tasks/roles. And yet, in order for the individual actions to be "coordinated", these sub-stories must somehow be compatible with each other. There has to be some *partnership compatibility* among individual role sub-stories of participation for the various participants to behave in a coordinated way.

As the participants begin to enact the partnership and to respond to evolving circumstances, any inconsistencies between their sub-stories may have an adverse effect. In one partnership, where there was a weak understanding among industry employees as to why they were participating, the initial projects were selected without their serious engagement. As a result of not being compatible, some projects did not make sense;

many were not monitored in detail by the industry people, and the company did not gain much from the partnership.

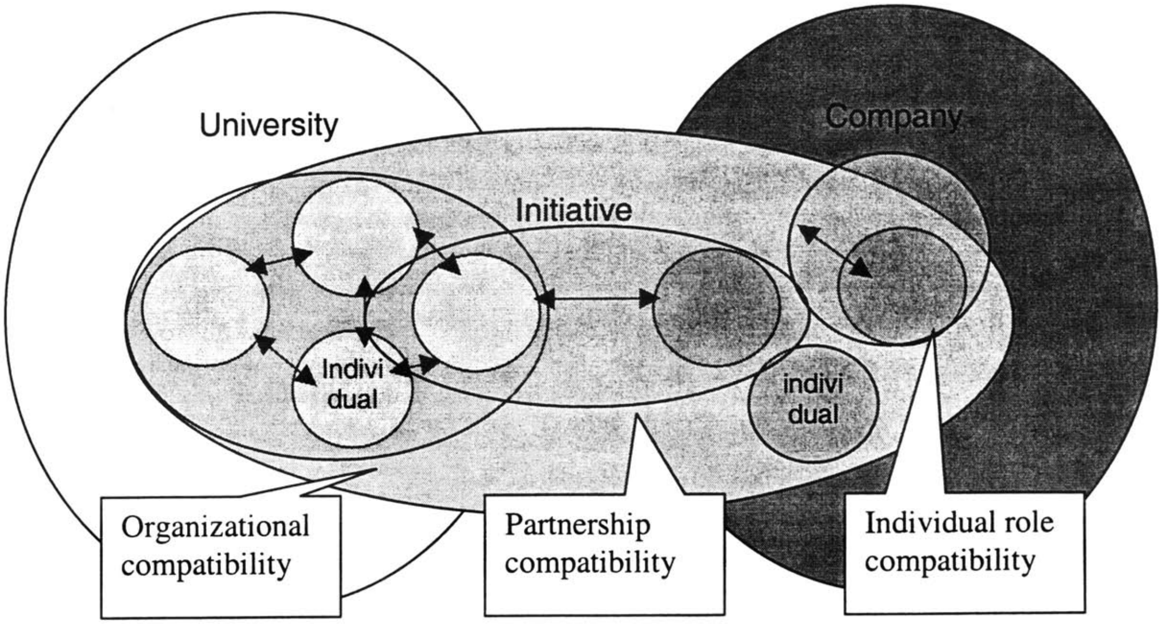
In a contrasting case, there was a strong commitment by the responsible managers to engage their researchers both in project selection as well as in their implementation. In another case, industrialists and academics developed compatible sub-stories. The academics did not have facilities and needed to have access to those in the industry. The industrialists wanted the scientific properties of their materials to be examined. The exchange of favors was therefore less problematic.

Coordinating across internal boundaries: organizational compatibility. Multiple actors in each of the two organizations need to enact the partnership in ways that are compatible with each other. For universities, these might include academics, students, and administrators. For industry, they might be researchers, managers, and top executives. On each side of the partnership, individual role sub-stories of different organizational players must be compatible with each other in order for their actions to be sustained over time. If a researcher, his manager, and the top executive all have compatible views about the partnership with the university and their role sub-stories are compatible with each other, the researcher will find his work for the partnership to be organizationally supported and easier to sustain over time. If the organizational compatibility is weak, then individual role stories remain specific to individuals. When the specific individuals move on to other tasks, the roles performed will not be inherited by other organizational members. It is only as organizational compatibility develops that individual role sub-stories become organizational role sub-stories.

In one partnership arrangement, the department head, administrators, and academics had developed compatible sub-stories about their participation. The department head saw his role as disinterested manager. He declined to take any funding directly for himself from the partnership, and focused on setting up the process to support faculty in his department, paying particular attention to those who needed start-up assistance. Administrators assisted in developing the contract to reflect most of the faculty concerns about ensuring academic autonomy. In other words, the sub-stories about their involvement, both of the department head as well as of faculty, were directly to do with supporting faculty research.

Industry interests also need to be represented with compatibility among executives, managers, and researchers. Any change in personnel could disrupt and destroy compatibility in their participation. In two partnership cases, a change in top management led to a sharp decline in interest in the partnership. In one case, new management combined with changing financials resulted in the non-renewal of the partnership. In another case, the change in management led to a serious re-examination of the partnership arrangement and activities.

Fig 10-1: Three types of compatibility



Building compatibility: dialectics and sustained contact. There appear to be two principal routes through which differences between individuals may be surfaced: dialectic debates among the participants; and sustained contact and observations. Open dialectics appeared to be the more frequent route, as interviewees often recounted instances of disagreements among participants. For instance, in several cases, academics had to lower their "prices" when confronted by industrialists who argued that they could not pay so much. In other cases, unwillingness on the part of industries to simply accept the proposed partnership as given, led to modification of the terms and conditions in much more elaborate ways. Similar states of "understanding each other" can be attained over time through sustained contact and observations. A junior researcher "gathered" what his reticent boss wanted in the partnership through observation over time. Several industrialists located on campus admitted that they have gone "native" in academia and understand academic interests far better than when they started. These remained notable exceptions, where participants had the luxury of having enough time to make sense of what they observed. More often, dialectics were the only viable route to surface and reconcile differences.

A question may prompt a need for an explanation and a story can develop incorporating different explanations for different parties. One center went through extended negotiations with multiple companies about the nature of their participation and inputs. The iterative process of negotiation was critical in establishing a central cover story, as well as compatible participant role sub-stories. The initial discussions between the center and partner industrialists led to an understanding that multiple strategic alliances needed to be put together in separate segments of the supply chain, but had to be structured in a way that each individual company could get exclusive access to intellectual property rights in some technological area. On the other hand, it also became clear that some technologies needed to be shared by them all. A new cover story to form both individual strategic alliances as well as a joint consortium had to be developed to reflect the concerns of industrialists.

Another example illustrates the importance of dialectic debate through its absence. In one consortium, the organizing academic said that neither the industrialists nor colleagues that surrounded him asked him many questions about how the consortium was to work. Most people merely voiced their respect for his proposal without critiquing it. As a result, it was not possible for him to identify inconsistencies or conflicting interests. The cover story of the consortium was accepted as proposed and did not take into account different interests of participants. On the other hand, to the extent that industrialists and other participants were willing to give the benefit of the doubt and participate in consortium sessions, there were opportunities for sustained contact and interaction through which differences could be surfaced and dealt with.

Concluding remarks

What is the role of individuals in institutional change? A new behavior can arise either by accident or through reflection, but in order for it to be sustained, there has to be an underlying story to explain and justify the importance of that behavior. A pattern of behavior emerges, when backed with a story that makes sense to an individual. A pattern becomes a shared one, if other people buy into the story. The role of the individual then is creating a new story of action, using it to persuade the others, and interpreting others' stories to develop one's story further. Sometimes, the new stories are created purposively. Other times, new stories get created accidentally. Individuals can and do play both a passive and active role in institutional change.

Chapter 11: Conclusions

In this dissertation, I argue that university-industry relationships are evolving rather differently in the three universities. At MIT, the main change has been the sheer rise in the volume, with an increasing number of companies as well as faculty members working with each other through proliferation of consortia in the 1980s and the emergence of strategic alliances in the 1990s. While there are a greater number of faculty members working with industry, it is not clear that the individual relationships are becoming any deeper than before. In Cambridge, on the other hand, the main change has been the development of a variety of single company partnerships, the so called embedded laboratories and their variations, which led to deep and sustained interactions between industrialists and academics, although the monetary scale of these relationships is smaller than that of MIT's strategic alliances. In Tokyo, there have been key administrative and organizational changes in support of university-industry relationships, and developments of multiple company relationships, largely outside the university.

I argue that these patterns of change can be explained in terms of two concepts: organizational boundaries that shape the nature of interactions, and the role of individuals in developing a pattern of interaction through story-telling. The objective of this chapter is to bring these two concepts to a coherent whole. To this end, the framework of organizational boundaries and storytelling is first presented at a fairly abstracted level. Second, the tales of the three universities are re-told through this lens. Third, I discuss my contributions to the understanding about the phenomenon and implications. In the final section, implications for future research are discussed.

Summarizing the framework: organizational boundaries and storytelling

So far, I have talked about organizational boundaries and story-telling separately, as though they were independent. Organizational boundaries represented a social structure that shapes action or stories as told by individuals; and story-telling represents the role of individuals in shaping new structures and boundaries. Individuals enact the organizational boundaries, which in turn influence future individual actions. The content of stories can be influenced by past interactions as structured by boundaries. New stories can in turn shape new boundaries, by clarifying the rationale for them.

Boundaries are what separate distinct communities or sub-communities, stand between organizational or professional sub-cultures, and represent divides between different interests and values. External boundaries exist between university and industrial communities. Internal boundaries stand between disciplinary communities or administrators and academics.

These boundaries are physically invisible, but powerfully at work, conditioning all interactions between the two groups. Specifically, there are three dimensions of boundaries that influence interactions: membership, knowledge, and physical space.

Membership and physical boundaries are parameters that condition the nature of interaction that can take place. Cumulative effects of membership and physical boundaries can be reflected in the level of mutual understanding among the two communities, at any given time. If the two communities understand each other at the outset, that understanding is likely to influence the nature of interaction, and the kind of stories that can be told. Storytelling in turn justifies new actions and behaviors, which can define new boundaries through new types of relationships. Consortia and strategic alliances created new types of "membership" for industrialists on campus, allowing them to have different types of claims in influencing university affairs. Embedded laboratories changed the meaning of industrial presence on campus by bringing industrial researchers to sit side by side and share space in an intimate way. Industrial research activities became physically part of university activities.

The knowledge boundary is different in that this dimension directly touches on the core difference in the interests between the two communities: academics and industrialists, on the one hand, academics and administrators on the other. In Chapter 9, I explained that both communities depend on and produce knowledge, but the meaning of "knowledge" could not be more different. For academics, knowledge is the output of their work and therefore something that one must exhibit to the world the moment it is produced. For industrialists, it is a critical input for production, and the more secretive they can be, the better. In other words, objectives, interests, and values of the two communities define the meaning of knowledge differently, and indeed in conflicting ways. How knowledge is dealt with at the boundary, therefore becomes significant in conditioning the interaction. Stories are created to justify maintenance or change in the knowledge boundary. For instance, it was not easy for MIT to insist on its ownership of all intellectual property rights when the size of industrial contribution became so large. Various accounts to justify MIT ownership were developed and can buttress MIT's position in future negotiations. Another example is that the MIT community learned that MIT ownership was different from company ownership, because inventors at MIT expect to retain certain rights and leverage in the subsequent licensing decisions, even though MIT owns the full rights legally. The tough negotiation experience that prompted such a debate became a story to explain what MIT ownership means and why it was different from company ownership, and will no doubt shape the way MIT will handle its intellectual property rights ownership.

I argue that storytelling takes place to explain and justify new actions and behaviors. At the boundaries, stories are particularly important as players from different communities are likely to see different meanings in the same sequence of events. Stories that are developed through active dialectics between different communities are more likely to convey similar meanings to both communities. Storytelling at the boundary is not only a mechanism for communicating the need for change, it is also a mechanism for translating and creating new shared meanings.

Stories have a critical function in institutionalizing behavior: providing a stable reason or a justifying account for a given behavior. Since institutions require "coordinated actions" where multiple individuals play the same or different roles, whether these individuals are operating on the basis of compatible narratives or not is the critical issue that determines the overall strength and robustness of joint action. If and when stories are understood and accepted by people, they are more likely to engage in the behavior pattern and sustain it over time. Once there are stories that are readily understandable for people, the chances of the behavior being replicated over time and across space increase.

The three types of compatibility show different fault lines of joint action. Individuals must create role stories that are compatible with their identity stories in order for them to keep up the new behavior over time. The role stories of academics must also be compatible with those of industrialists in order for the partnership to be sustained. The role stories must also be compatible within each partnering organization among various organizational players or across internal boundaries, in order for the partnership to obtain the necessary organizational support for living beyond individuals and being replicated elsewhere.

At the same time, it is not necessary that people remember and be aware of these underlying stories all the time. Indeed, as time passes, and as some patterns of behavior become "normal" there will be less and less reason to explicitly remember why they do things the way they do. It is probably the case that stories surface only when questions are raised, or when there is a need for change.

Exactly what degree of freedom does an individual have in telling stories? To what extent is storytelling a real instance of agency and not an act determined by a set of structures? Clearly the kind of stories individuals tell is heavily influenced by the individuals' past experience. Organizational boundaries can have a cumulative effect on the content of "typical stories" that arise from its members, because academics with consulting or work experience in industry are likely to develop different stories about how and why they would like to work with industry as compared with those without such an exposure to industry. However, many stories are created on the spur of the moment, almost as they are told. One industrialist I interviewed was amidst rationalizing about what benefit the company was getting from its relationship with the university. In my first interview with him, I got the impression that he knew what the answers were. It was only two interviews later that he admitted that he was thinking aloud, and that my questions were generating ideas to help him give an account of company action. Serendipity, dialectics, and improvising can influence story development.

The MIT Way Revisited: Organizational compatibility for amplifying stories

The most powerful way in which MIT differs from the other two universities is its ability to amplify and institutionalize activities. MIT more than the other two universities manages to amplify the ideas that come from individual faculty. An idea can grow from being a single faculty activity to a group activity, to a laboratory that comprises many researchers. Negroponte, the founder of the Media Lab asserted "Wiesner amplified the creativity of other people more than anybody before or since [Brand, 1987 #248]." Indeed the story of the Media Lab is one of the most rapid growth from a small group in the late 1970s, to a laboratory comprising about 30 academic staff, 80 other staff and 170 students today.

What is the secret of amplification? I argue that the key difference is the organizational compatibility within MIT. Administrators comprise both academic types and professionals and they are quick to understand and add to cover stories generated by the academics in comparison with those in the other two universities. They are a diverse group comprising different types of bilinguals, sometimes even trilinguals, who understand the motives and interests of different communities at work: academics, administrators, and even industrialists. As such, they are uniquely capable of understanding and translating stories in such a way that they make sense to different communities. Even though MIT academics are still likely to complain about the lack of resources and the need to fight for them, the fact is that administrators can allocate additional and critical resources such as seed money, space, and positions for principal investigators. What begins as a highly personal and individualized initiative can quickly become an organizational initiative as more organizational players subscribe to the cover story, and individual role stories can develop into organizational roles, thereby making it possible to be sustained over time and replicated across locales.

The Media Lab became a powerful story for joint action as it quickly gained support from the central administration and organizational compatibility was attained across key organizational roles. The support was initially given by Wiesner as MIT President, but that presidential support was inherited by Paul Gray. The individual role story developed by Wiesner for his own participation and support of the Media Lab led to justifications as to why and how the building of the Media Lab had to be supported by MIT. Wiesner's story became both compatible with the organizational strategy of MIT. Wiesner's individual role story subsequently became an organizational role to be played by other top administrators.

There were other idiosyncratic organizational norms and rules within the Media Lab that were developed and supported by administrators and the Lab's academics. For instance, the Media Lab developed unique rules about sharing intellectual property rights, where all the sponsors collectively get royalty-free commercialization rights, and academics and students get the name and publication rights but no royalty payments. Sponsors had to agree to the story that they would pay money, knowing that all that they would get would be collective rights shared with all the other sponsors. Central administrators had to agree to the story that intellectual property rights arrangements at the Media Lab were to be different from anywhere else on the campus. Academics in the Media Lab had to agree to the fact that in return for receiving all the material, spatial, and intellectual support from the Media Lab, they would give up their rights to receive financial returns on their inventions. This is an example of MIT coming up with a specific ruling for a given department, which is compatible with the organization-wide rules, but goes further in stipulating details for a specific department to suit its own need. This contrasts strongly with the experience of Cambridge in developing framework agreements, where there is explicit acknowledgement that the university cannot come up with an overriding ruling on the intellectual property rights arrangements even within a single department, since that would involve different academics ex ante.

If the Media Lab provides an institutionalization at a given locale, strategic alliances provide an example of institutionalization through replication. A kind of template was developed among academic and professional administrators in terms of how to develop one, what organizational structure could support them, and what to avoid, complete with a template legal agreement. Different types of administrators came together to develop a generalizable template that was later used for other strategic alliances. In the process, certain changes were introduced in organizational roles of administrators, to accommodate this new task of developing and supporting the strategic alliances.

How does this happen? As discussed in Chapter 9, administrators and academics share key values, by virtue of the permeable membership boundary where academics turn into administrators. It is not difficult then for the administrators to understand the stories of new activities as undertaken by individual academics. Any good stories would be picked up by multiple organizational members and amplified. To summarize the role of administration simply, it is that it provides the capacity to organize and sponsor new ideas. Laboratory heads, department heads, provosts – while they cannot provide "direction" in the classic sense, lest individual faculty autonomy be violated - can play a key role in making resources available, particularly at an early stage and selectively: a small start-up fund, space, and administrative support. The role of administration becomes particularly salient when contrasted with a place like the University of Tokyo, where the administration plays little role in resource allocation. As a result, all the academics have equal claim to space and resources with a consequence that nothing can grow bigger and nothing can disappear.

The Cambridge Phenomenon Revisited: Compatible stories through sustained dialectics

In contrast, Cambridge's initiatives are characterized by deep engagement that emerges through sustained contacts and interactions as permitted by the fuzzy boundaries. Academics and industrialists develop compatible individual role stories that make their partnership stronger and sustainable over time. What is interesting is the fact that partnerships that get formed appear to be intensely personal, and are unlikely to be sustained over time when specific individuals leave, or to be replicated across locales. Institutionalization is much harder to accomplish as organizational compatibility is harder to attain in Cambridge than in MIT. This may be because in contrast to MIT, there are few university administrators who can help turn these individual roles into organizational ones. The total number of administrators may be too low to cope with the kind of work load that is implied. The recruitment policy is such that it is rarely the case that academic researchers turn into administrators. There are relatively fewer "trilingual" players who understand academic values, administrative logic, and industrial interests.

One interesting example of the deep and personal relationships characteristic of Cambridge is the BP Institute, which, as explained in Chapter 6, was established with significant benefaction both to establish several chairs in the field of relevance to the company and to build a new building to house these research activities. During my first visit, the building had not been built yet, with a couple of academics on board. The representative from the company was struggling to explain how his company was going to reap the benefit from a relationship where they owned no intellectual property rights and no control over recruitment. He was speculating that the company should not dictate the content of research because that would distort the essence of science, which had to be curiosity-driven. He was proposing instead that the company was to "listen like mad" and engage in on-going science. He had learned through his sustained contact with Cambridge academics that engaging in the substance through discussions is the best way to work with academia. By my second visit, the institute had recruited about half of the total academic staff all housed in a brand new building. A series of meetings were being held with visitors from the company to discuss their operational problems. The academics seemed to know little about the specific details of technicalities involved in the operations, but through repeated meetings they learned enough. What is more, these dialogues were interesting both to the academics, who found operational problems as new intellectual challenges and were happy to ask all sorts of questions, and to the operators who discovered that the dialectics provided an opportunity for thinking out of the box. In the meantime, both academics and industrialists were learning about each other's idiosyncrasies, and learning to take those into account. By my third visit, the industrial representative was happy to report that some of these visits were bearing real results in terms of cost reduction.

Fuzzy boundaries between the university and industry give opportunities for academics and industrialists to explore a much wider set of working relationships through sustained interactions. There are greater opportunities to develop their individual role stories in ways that are compatible with each other, to attain a high level of partnership compatibility. It is also interesting that fuzzy boundaries are generating a new breed of bilinguals in large numbers. Microsoft employs over 50 researchers many of whom had been academics before, who understand in detail what it means to involve students and what makes them tick. Another company is expanding its research activities by simply recruiting post-docs both from Cambridge and other universities who then subsequently work on campus.

The Tokyo Story Revisited: Story tellers without powerful stories

The image of the Tokyo Story was that at least some academics were making honest efforts to change and live up to the new expectations to work with industry and to contribute directly to the society. Yet, it was difficult for them to get to where they wanted. What were the circumstances that stifled individual aspirations in Tokyo? The final version of the Tokyo Story is that storytelling took place without the benefit of dialectics. Academics lacked an audience that asked critical questions. There is a clear difference between an audience that would argue back and demand explanations, and an audience that would simply accept the story line as told. Stories develop in the directions in which there are actively questioning audiences – so that they make sense to that audience. The lack of questioning meant that both the cover story and individual role stories were not developed at the outset to ensure a certain level of compatibility.

Why does the Japanese audience not ask questions? One Japanese industrial researcher who had the experience of working in Tokyo and Cambridge explained the difference as follows. In Cambridge University, the academics actively debated what the collaborative research theme should be. They would not agree to collaborate unless there was a match of interest. In Tokyo University, on the other hand, the academics respected company's autonomy in setting the research agenda and did not engage in debate with the industrial researcher. Such reticence was also characteristic of his boss in the company, who was also Japanese. His boss gave only the broadest instructions and left everything else up to him to decide – and never asked questions. The researcher felt a great sense of respect for his boss, precisely because of his reticence and implicit trust. The boss was a man of deeds and not words. The researcher worked harder just because of that trust and responsibility. However, he had to develop the substance of what to do in the absence of any significant inputs from his boss. This story has a heavy cultural undertone of traditional crafts in which a master never speaks and an apprentice simply guesses what might be going through the master's mind. To ask questions or to be asked questions is uncouth – only through enacting over a sustained period you will learn.

There are other reasons why dialectics were prevented. Industry representatives are hard pressed to argue back to academics. Many of the Japanese company representatives interviewed echoed the view that they needed to treat Japanese professors as superior and that it is difficult therefore to engage in open discussions. One visiting professor at UT, with 35 years of corporate background, remarked that it is hard for companies to speak up against professors. Academic administrators also do not argue back to individual professors since they have traditionally had little decision-making authority. They have little reason or a basis for dialectics.

There are other internal boundaries. Junior faculty members generally would not engage in debate, partly because the career of junior academics until recently depended on the opinions held by senior professors. There is also a possible cultural undertone that it is simply inappropriate for youth to voice strong opinions. There were several instances where I explicitly heard senior professors making dismissive remarks about their younger colleagues on the basis of their youth. The remarks were not malicious – only, they were young. One "young" professor noted that in his field, a person must be over 50 to shed the title of being young. There is also little peer interaction among professors in general. Departments provide the most frequent encounters among professors – but there again, deep-rooted respect for professorial autonomy prevents any active debate about what they are doing.

The Tokyo Story is about the absence of powerful storytelling. But this does not mean individual desires for change were lacking. On the contrary, there were individuals who were passionate about their initiatives as described in Chapter 7. Their strong beliefs led to sustained actions against many odds. However, these powerfully motivated individuals were nonetheless not given opportunities to develop powerful stories – because storytelling takes both the teller and listeners.

There is one exception to the rule of silent audience. Administrative officers both within the university and in the Ministry do engage in debate. MOES bureaucrats argue back, because they are accountable for their budget requests to the MOF officials. Since they are the ones who will have to explain and defend the budget plan, they in turn demand from the academics "good reasons" why any expenditure is necessary. University administrators argue back, because they are accountable to MOES for the proper handling of finances. The laws about what is appropriate expenditure are quite complex and are particularly hard to grasp for rotating officials. The tendency then is for them to stick to the rules and precedents, so as to avoid trouble. Rotating administrative managers leave much to the judgment of lower level administrators, whose judgment tends towards conservatism. It is not that the lower level administrators want to be obstacles – some of them expressed joy in being able to provide discretionary help to professors to facilitate their work. They are, however, limited in their capability of providing such help.

The net result is that there is a pattern in the story development. The story gets developed in response to administrative officers' queries about how it fits within the broader contexts of law and government. But it is under-developed with respect to critical stakeholders, industrialists, and other academics.

Contributions

The present research contributes to our understanding of the phenomenon in three different ways. First, it adds to the past literature on university-industry relationships by emphasizing organizational level factors, rather than national or individual project level factors, and by bringing up front the role of individuals. The organizational perspective is important given that many universities are today struggling with the very issue of how best to develop relationships with industry.

Second, it provides a new way of conceptualizing organizational boundaries by clarifying three dimensions that influence and shape the subsequent interactions between the two communities. It adds to the past literature which had developed the key underpinnings to understand the nature of communities that created boundaries, such as organizational cultures or subcultures (Van Maanen and Barley 1984; Schein 1992) or communities of practice (Bourdieu 1977; Carlile 2002; Carlile 2002). [Organizational boundaries may be permeable or contested (Martin 2002), but the best way to examine the boundaries may be to look at the process of bounding (Abbott 1995) By proposing that organizational boundaries are defined by a set of norms, rules and practices, and by clarifying the three dimensions along which meaningful permeability can occur, the current research enables further understanding about the nature of organization-environmental relationships, and contributes to the emerging literature on cross-boundary collaborations (Levina 2001, Black 2002).

Third, it pushes the metaphor of storytelling in institutional change further to advance our understanding of the role of individuals. There is nothing new in claiming that stories may have something to do with institutions and the way organizations operate and change(Clark 1971; Boje 1991; O'Connor 1996) and indeed that stories may play a critical role in institutional change (Czarniawska 1997; Czarniawska 1998). Past discussions have been either highly abstract and theoretical in the way it was hard to relate to the observable phenomena, or exclusively focused on empirical analysis of narratives to the extent that underlying theories were not pushed further. Middle range theorizing to clarify what are the circumstances when "storytelling" leads to changes was missing. I use the minimalist definition of stories as accounts for justifying and explaining an action (Scott and Lyman 1968), and assume that stories may be explicit or implicit (Boje 1991) but that they are critical inputs and products of sensemaking. By proposing that stories form a nested set, comprising a cover story for the overall partnership, and individual role stories that constitute sub-stories of the cover story, and by introducing the notion of "compatibility" among the stories, the present research enables us to discuss the "strength" of institutions and plausibility of institutional change in a more concrete way. Furthermore, I argue that the opportunities to develop compatible stories arise principally through dialectic discourses that can help to surface differences between individuals in their values and interests.

Implications

Implications for universities. The principal implication for universities is that the way they relate to industry is strongly influenced by the way they define their organizational boundaries, which in turn have been defined through historical evolution, starting from the foundation and various historical events, both national and local. The governance structures, as well as norms and values stand as legacies of the past and strongly influence ventures that can arise within the organization. It is therefore not a simple task to start new types of relationships. The changes will take place slowly, through stories that are created by individuals to propose and explain new behaviors. To accelerate change, it may be important to create an enabling environment for individual initiatives, rather than to do so through programmatic initiatives. It is critically important to allow storytelling by passionate individuals – so that they can further persuade others to change.

Another significant implication has to do with the role of governance and administration or management. Universities have historically been defined as communities of scholars, and as such strong-handed governance structures that "manage" the academics and their activities tend to induce weary reactions from the academic community. Through the examination of organizational boundaries and their effect on academic-industry relationships, I have argued that the implications of the governance structure are multiple. The governance structure may indeed constitute key elements of the "membership boundary" as in the case of the Board of Trustees and visiting committees at MIT, or the collegiate system at Cambridge, which have no counterparts in Tokyo. The governance structures condition the role of administration and over time define its culture. The governance structures also provide mechanisms to define and refine internal and external boundaries, by clarifying rules, encouraging some initiatives to grow, and by bridging between increasingly isolated disciplinary communities. If left to academics, it may not be easy to allow some ventures to grow by allocating resources selectively, or to develop structures to work together across boundaries. More specifically, given the pace of life and given the strong allegiance of academics to their disciplinary communities, the role of administrators in providing the institutional glue within universities may be critical.

I argue that the role of administration was important in three respects: in formalizing the organizational boundaries over time; in bringing about sizable collaboration with industry; and in devising mechanisms to support inter-departmental activities. If the universities want to respond to the external environment, one prerequisite may be to have an appropriate administrative capacity to support that. The picture Clark once drew of universities changing constantly through changing subject matters even without organizational structures changing may still be true (Clark 1983). However, in today's world, when science is expected to be part of the economic institutions, the fragmented, discipline-oriented structure may not be sufficient. This implication is consistent with Clark's more recent study that demonstrates the need for a strong center (Clark 1998). And yet, a stronger administration can also have adverse implications. Most universities do not have internal mechanisms to coordinate between commitments made at the center and capacity and/or willingness to respond at the periphery. Strengthening the central administration could lead to over commitment or unmatched interests. Another possibility is that if administration becomes the organizational glue, it may in fact reduce the need for disciplinary communities to work together, thereby exacerbating the centrifugal tendencies of academic communities.

Another practical implication has to do with the role of individuals and the strength of agency. If the proposed metaphor of storytelling and various kinds of compatibilitie among sub-stories has any validity, then the most powerful kind of institutional change will emerge out of individuals undertaking actions that make sense to them. If those individuals can then engage relatively freely in dialectics with other actors, to define their own actions, then the resulting behavior pattern is more likely to be robust against local disturbances or inertia against change. In order for the emerging pattern of behavior to become institutionalized over time and across settings, there has to be some flexibility on the part of the organization to allow organizational roles to be negotiated. This has an important implication for the way administration is defined: their essential function must be to support and enable individual actions, rather than to manage and control them.

Finally, there is one issue about the tradeoff between informality and formality. The contrast between MIT and Cambridge demonstrated that formality tended to bound the relationships while informality could co-exist with deep engagement. Informality can in turn lead to abuse, misunderstanding, or fear, because there will be little legitimacy for such behaviors. A lack of clarity about what is legitimate to do can also encourage individuals not to take any action. Concerns to avoid all conflicts and clearly establish legitimacy through rules, on the other hand, could lead to less engagement and consequently less emergent relationships. If formality is taken too far, as in the case of Tokyo where the rules are set in a way that is not compatible with the values of the place or individuals, it may simply drive individual activities to become invisible, as individuals would choose to undertake activities outside of formal rules or the formal organization.

Implications for industry. For industry, there are two implications. One, given that knowledge is clearly an axis where there is a conflict of values with university academics, is that it is important to have articulated strategies as to how and what the company wishes to gain from the collaboration. In doing so, it may be helpful to understand the characteristics of the university community and to capitalize on its strengths, rather than to force changes through conditions. In other words, the critical part of the absorptive capacity is to understand how academia works, so that the best outputs can be generated. Many industrialists who have worked for a long time with universities commented that partnership with universities should not be taken as equivalent to sub-contracting or out-sourcing. Particularly important to understand is the role of research students, who actually do the bulk of the work. They are untrained, but usually with deep personal commitment to their dissertations. They are unlikely to be motivated by simple straight jacket problems, and could end up anywhere in the world for their job. An important part of the relationship management would be to harness their energy and know what they do best. The discussion about engagement tells a powerful story about how industry can influence academia: by asking intriguing questions. This is particularly important given the powerful scientific ethos and values about academic autonomy, which puts an immediate strain on industry as it would like to have the power to direct the agenda. The key absorptive capacity for industry may be the ability to engage in a discourse with academics, sufficiently to influence their research agenda.

Second, it is important to have organizational compatibility about the what and how of the collaboration among the key organizational players. It is not enough that there are people at the boundary, doing the intermediary work, these functions must be understood and valued by management. Because it is easy to expect multiple things from an open-ended partnership, it is even more important that there is a larger framework of understanding about what is being accomplished within the organization.

Implications for the three universities. What are the lessons that each can draw from the other two? For MIT, the biggest lesson may be about faculty time to engage. When individual faculty members push for new initiatives, the time constraint of individuals becomes a natural limit to how many activities MIT would undertake. When the administration pushes independently for more initiatives, there may be even greater burdens placed on faculty time. The biggest concern might be the image of MIT professors who no longer can cope with all the incoming enquiries to such an extent that they only deal with the obvious contacts. The informal dialectics as a source of ideas is simply no longer there. The similar stifling of curiosity may be at work even at the organizational level. There is a strong sense that MIT is doing the right thing, and can lead and help the others. The question is should they also be learning? As Tokyo University professors remain curious how others do things, should MIT also be curious how others do it? The most interesting question may be not what Cambridge can learn from MIT, but what MIT can learn from Cambridge in restoring some sense of timelessness.

For Cambridge and Tokyo, the most important agenda continues to be the shape and structure of its governance to be able to cope with increasing contingencies that demand organizational attention. The issue would be how to centralize, while preserving individual autonomy. The most important lesson both universities can learn from MIT is the ethos of full-time academic administrators on the one hand, and professional administrators on the other, to serve the needs of the community. One important criterion in governance structures is that they provide room for dialectics, where reasoned arguments from individuals can have the potential to be heard.

Another important implication for Cambridge is that fuzziness does have its charm, one that is both a reflection of its members who seek certain independence as well as the broader national setting which tolerates differences among individuals. To tidy up rules of the game may be tempting, but there is a risk of destroying some of the most interesting characteristics of Cambridge– informality and deep dialectics – by becoming more straight-jacketed. The other issue is that the historical tradition of trusting individual members' instincts and permitting them to do what they like is at equilibrium with other practices, such as low salaries.

For Tokyo, the biggest implication is about how to create an environment that supports individual action. Clearly, one aspect of that has to do with configuring the governance structures, such that principled dialectics can take place, to support reasoned organizational actions. Professionalizing administrators and making them serve a supportive role would be one critical change that is urgently needed in this respect. Another issue is the creation of an environment where individual initiatives have an option of obtaining greater organizational support, at the cost of other initiatives.

Future research

The present research was designed to be inductive, to be based on grounded theorizing and to generate useful constructs. There are three general directions this research can be pushed further. First is to deal with the issue of generalizability. Second is to deal with theoretical clarification; and third is to look into the consequences of changing university-industry relationships.

Findings were based on empirical data from MIT, Cambridge and Tokyo University. The question is whether and to what extent they are generalizable to different types of universities, other countries and indeed other types of organizations? The three universities represent research universities of highest academic reputation. In less research oriented schools, conflict of interest in agenda setting (i.e. autonomy versus direction setting) between academics and industrialists is expected to be less. Similarly, the three universities cover a wide range of governance structures, even in light of other countries. However, it is also true that the three cases do not necessarily help distinguish the effect of being public/private and the level of centralization.

This said, the more abstract notion that differences between communities create boundaries, which in turn powerfully influence behavior, is likely to be generalizable to other organizational settings. This dissertation has already proposed that similar dimensions can be used to examine external as well as internal boundaries. The framework for conceptualizing boundaries is also compatible with the emerging literature on collaboration across internal boundaries within commercial organizations (Carlile 1997; Black 2002; Carlile 2002; Carlile 2002) or on collaboration across external boundaries between commercial organizations (Levina 2001).

There are several areas where further theoretical clarification would be of interest. First, the metaphor of storytelling and the idea of individuals enacting compatible role stories opens doors to a whole set of further theoretical and empirical analysis. Theoretically, it would be important to clarify the construct of compatibility further. How do individuals know if their actions are compatible? Or do they only know when they are incompatible, leading to unintended consequences? More rigorous empirical analysis could be conducted to re-examine the theorizing on storytelling through a more systematic collection of narratives in the field. For instance, it may be possible to undertake an in-depth longitudinal data collection from a small number of initiatives, where participants are asked the same questions about their roles and why they participate, while keeping track of the interaction that goes on among them. This may provide a way of analyzing the changing narratives about their roles. I have focused on boundaries that exist between communities. However, there is no reason why the same kind of theorizing cannot take place simply among individuals. By examining the role of storytelling among a small group of individuals engaged in collaborative work over time, it might be possible to further illuminate the nature of agency, and how agency leads to further structures.

Another way of extending the theoretical frontier is to look into the cumulative effect of organizational boundaries over time. Particularly interesting may be the effect of practices such as consulting. Tokyo University provides an interesting opportunity for further research in this respect. The other is the cumulative effect of spatial configurations, where the three universities offer stellar contrasts. MIT has the tradition of trying to connect all departments through corridors, Cambridge University is ubiquitous in the town and requires bicycles for transportation between departmental buildings. Tokyo University has three separate campuses requiring train or subway travel to move from one to another.

Third, it would be important to look into the consequences of changing university-industry relationships. The most obvious would be to consider the effect of these relationships on the content of science. For this, it may be interesting to conduct a structured comparison at individual, laboratory or departmental levels in terms of the nature of interaction and changes in research agenda over a period. Another would be to focus on a particular project and observe the evolution of the research agenda over a period.

It would be also both interesting and important to extend the analysis on university-industry relationships a step further by generalizing about university-environment relationships. University-industry relationships fall squarely into the resource dependence relationships, where it is in the narrow survival interest of universities and industry to work together. And yet, the need for autonomy was defined differently in the past – namely that universities needed to stand sufficiently outside of the structure in order to be able to be the independent voice and social conscience of the world. The question is whether it is possible for a university to be that, while being part of an increasingly complex web of inter-dependencies. This is ultimately a theoretical question about collective agency – can a university be designed to be a social conscience, and if so, how.

My dissertation examined the state of flux that universities find themselves in, the kind of flexibility that is demanded by the changing economic environment; and the range of responses universities were giving to this end. Because of the increasingly central role "economic considerations" play in most countries, to adapt to new economic circumstances seems both inevitable and good. One closing thought that I offer is a reminder that this is not at all obvious. What if the road of this marketization is leading to a place similar to where Tokyo University found itself at the end of WWII? What if the systematic search for commercializable science leads to systematic elimination of discoveries that could serve a greater public need? What if these "innovating individuals" are simply telling stories that are new and innovative in their locales, but ones that are in tune with the larger societal economic logic? They may be exercising "agency" in that local environment, but their existence may be part of a broader structuration of on-going "marketization". As the romantics in Tokyo University would tell us, it is not obvious that adapting to the requirements of powerful economic interests is the way to human happiness. From their perspective, to be conservative may indeed be the way to exercise their agency.

APPENDIX

Appendix: Social construction of a dissertation: The power of an audience

"Making up stories was his ruling passion.... In the old days, not all of his stories had turned out well... It was when Momo sat listening to him that his imagination blossomed like a meadow in springtime."
-- from "Momo" by Michael Ende

Dissertation writing is a process of social construction. The extent to which this is true, however, was something that I did not fully grasp until late in the process. In retrospect, four streams of social construction appear to have been at work simultaneously. The first stream has to do with my theorizing about story-telling – a process of which I was quite conscious. The second one has to do with theorizing about organizational boundaries, which took place in parallel, and of which I was far less conscious. The third stream was a process of social construction that was going at the societal level, through media reports and other debates, quite independently of my work, that nonetheless had a strong influence on my work. The fourth stream was a process of social construction that went on starting from my ideas, but over which I had no control. The four streams collectively show how powerful an audience can be for a dissertation and its writing process.

Storytelling

The beginning. Lotte was arguably the first person, as well as the first faculty member, to be intrigued by my dissertation. October 2000 was when she showed the first sign of active interest. I was presenting my first version of the Tokyo Story in a doctoral seminar organized by her, which I had attended every year of my 4.5 year student life. I was half way through my data collection and trying to make sense of it. My fellow doctoral students were as ruthless as usual. They gave me the hardest time on the comparability of my cases and why I selected them, why I framed my research question the way I did, and what did I mean really. Sarah was asking with her characteristic clarity – "you say you are worried about institutional change, but I don't see the change. Where is the change?" She was, of course, absolutely right[1]. It was not that I had not thought about the question. It was that I had all sorts of questions and answers jumbled up in my mind, and I could not present them in a coherent manner to an audience. In the end, they took mercy and I was allowed to move on. By this time, I had given up hope to get to the end. I proceeded to show some quotes – but I had no hope that any of them would make sense. I had already forgotten the story.

[1]I do not in fact know that this was the specific question she asked then. I have records to show that she articulated this question in April and then again in May 2001, by which time I knew that it was a recurrent question. If not this question, she would have asked some other characteristically incisive question.

It was something about the quotes that brought life back into me. These were real words– they really meant something – and even though I had lost the sense of where I was in the presentation, these words were so powerful in my memory that I began to explain what I thought about them. The audience became quiet. In one of the last slides, I was saying that the Tokyo Story was about the lack of powerful story telling and I heard Lotte inadvertently mumble "nice." These last slides contained many things that apparently appealed to the audience. They made positive noises – they physically looked engaged. Sarah was excited. "Improvisation is a risky act of illegality!" She was repeating my words. I understood that something was understood by this audience – though I did not know what. I received congratulatory emails from Lotte as well as Sean and Carlos, the two fellow doctoral students with whom I share institutional perspectives. This was the first time I felt that anything I had said in that room had somehow hit a chord. I began to wonder what on earth I did that got them to react that way. It was the first time I actively observed the power of an audience. They could wear you out when they are not with you. They can also energize you visibly when they are engaged.

Laura. October was a critical month. Around that time, Laura, a fellow doctoral student and a close friend, was going through a tough transition in developing her identity as a researcher. She was writing a beautiful article. She was applying the state of the art modeling, system dynamics, the method that she cherished as a practitioner and the reason for her coming to MIT mid-career, to one of the most sophisticated and fuzzy French social theories, using the data from the quintessential article that everyone in the field has read. When I asked her almost gasping how on earth she came up with such a great idea, she smiled with her unpretentious eyes and said, "well, I really wanted to show Paul the power of system dynamics." Paul is a junior faculty, who is heavily into social theories. She thought that he could be engaged if she used Bourdieu's theory – Paul's favorite, and she thought it would be neat to use Barley's data. Neat indeed! Something about her motivation touched me deeply – she really wanted to explain to Paul. There is something very creative about the need to explain something you care about to someone you care for.

Another day Laura was exhausted, and with her eyes gazing mid-distance, she mumbled – "I often wonder what made Rosa sit down that day on that bus." She was talking about Rosa Parks – a story as a foreigner with which I was not very familiar. Somehow, she was talking about Rosa's agency – the legendary story of one black civil right activist who ultimately started a social movement by her defiant act of sitting down in the section where the whites had priority for seats. In her telling me, I began to think about the meaning of agency. Laura was gathering courage – to walk the first step as an independent researcher and to do it the way she likes. There was a doubling of images – Laura and Rosa - and I came to regard agency as something fundamentally personal.

The Tokyo Story. With the energy that I gained from the approval in Lotte's class, I began to think about a broader theme of storytelling. The lack of powerful storytelling in Tokyo and the existence of very powerful storytelling in Cambridge served as a base for thinking about storytelling as a device for sharing and understanding ideas. Central in my puzzle was one professor at Tokyo University, Professor B, whom I had interviewed twice already and was going to meet for the third time, and who was fighting the system to set up a collaborative university-industry group – a kind of consortium. He complained that it was as though he was inside the "cage." Clearly the rules were against him and he was having to improvise quite imaginatively to be able to do what he wanted. The image of him was haunting to me because while I described the Tokyo Story in terms of the lack of powerful storytelling, he was definitely not a weak storyteller. He appeared to have all the passion and conviction about what he wanted to do, and he was evidently telling stories all the time. He was gaining "support" from many individuals with whom he came into contact through his storytelling – and yet, the whole group did not feel like a strong cohesive group.

Indeed he had asked me join his nascent consortia to which he was enticing individual as well as corporate members as loosely defined supporters. I was somewhat taken aback, but my thought process was roughly "I will have problems meeting his group in the future if I say no. I don't like the idea of becoming a sponsor, but on the other hand, the level of support he is asking for is so small that it is unlikely to create a conflict. It is more like a token membership." I agreed and paid up before I left the interview. However, something about the process left me with an uneasy feeling – I was subscribing to the activity for the wrong reason. I started to analyze my own behavior. At that time, I had not yet firmly grasped his research group's objectives and activities. Indeed, if I were completely honest, it seemed to me that their proposition was somewhat half-baked and not persuasive. They did not yet have a powerful story of collective action to convince me that what they were doing made sense.

There was another side to the storytelling, a kind of sub-story, in terms of my own participation. Even though I was not persuaded by their story, I felt obliged enough to pay and became a member. My sub-story to justify my participation was that I wanted to avoid confrontations with my interviewees. My joining was not driven by an interest in the substance of the group activities. Rather, I had ulterior motives - that I wanted to remain friendly to the key players. I realized that there were underlying stories associated both with their initial proposition and with my own participation, and that these stories seemed to play key roles in our subsequent behaviors.

Half baked stories on the part of organizers and half-baked participation on the participants' side - this sounded familiar in light of other consortia cases in Tokyo. I was hearing about companies joining only if the price was low enough – a procedural and obligatory membership. I began to create a framework of nested stories around the concept of "compatibility" between individual accounts for participation.

Laura again. I was so excited that I told Laura about my nascent theory of institutional change at once. She was a little tired that day – and she said "it is interesting" in a flat voice. As she was leaving, I could no longer hold back – I was excited by my idea and I simply could not accept Laura to be complacent, even if she was tired. In my heart, I was expecting her to show as much enthusiasm as I showed her on her Barley piece. I asked her directly, isn't this exciting? Her eyes rested momentarily at mid-distance as she put on her shoes. She said, "yes, it is interesting," in a very unconvincing way, and continued, "But I don't understand how you can tell when an agency is institutionalized, and when it is not." I must have physically jumped backwards. I waved my arms around in desperation as I tried to answer her question. I said something like "it is not visible to the others, but when Rosa sat down, it came from here" pointing to my stomach. I meant deep down from one's heart but I knew that I was not really answering her.

Chikako. That was the day when I began to think more seriously about the agency part of my theorizing. Fortunately, the first person I told the story in its full form was Chikako, who had finished her doctorate at Harvard and who was staying with me on a short visit. Chikako is an old-fashioned sociologist who believes in Weber and was rediscovering Adam Smith at that time. She had heard my early version of the Tokyo Story before and had already given approval that I was capturing and describing the Japanese setting in a right way. Her first reaction was one of sincere interest. The way she looked at me, I knew that she really meant it – something I said was making sense somewhere inside her. I described the concept of compatibility and how it describes the sense of institutional strength. In fact, all the key elements of nested stories were there in raw form, and she gave a nod to each. We then engaged in a discussion about each concept – applying it to other circumstances, back and forth. Her biggest contribution in that discussion was that she was someone that I respected – and she thought that I was on to something novel and interesting. I gained more energy to keep going. When you believe that you are discovering something important, you are not parsimonious with the level of effort you put in.

Lotte. When I had an outline of the Cambridge Phenomenon, I made an appointment with Lotte to show her what I had. When I entered the room, I told her that I wanted to tell her what I was finding in Cambridge; she looked so physically interested, she even pulled up her chair closer to mine so that she could see my power-point slides better. She also made the right noises in response. When I mentioned that something was puzzling, she too looked puzzled. When I was excited explaining something, she caught on the excitement and exclaimed "interesting." This is when Lotte became an indispensable audience for me. It was simply so rewarding and energizing to tell her my findings. By the end of the fall, it was clear that she simply had to join the committee to become its fourth member.

One day, when I gained enough courage, I told Lotte that I was thinking of a little grounded theorizing. When I began to tell her and as I got visibly excited, she stopped me with her hand and asked, "Sachi, do you have data for this?" I must have immediately looked uncertain. I said vaguely, "I think so." The next time I saw her, I was prepared with several vignettes. When I told her about two of them and as I was moving on to the third, she said "OK," and she needed no more. In a later meeting, when I expressed my own anxiety about not having written down anything about storytelling, she said with a certainty that only experience can give, "don't worry, it will keep coming. Even if you want to stop it, it will come." She somehow knew in her bones that it was so close to my heart that I could not escape articulating.

Wanda. One December day, I woke up thinking that I would love to tell Wanda about my storytelling theory – so it was almost a shock to my system when I ran into her at the Medical Center. Wanda is a professor whose course on organizations is legendary among doctoral students. "Awesome" – is the way one student described her course. The main reason why so many of us found that course "awesome" was that she talked to us about underlying assumptions in social science in a way others did not. Wanda cared deeply about agency. As a result, she was one of the first people that I thought to talk to. As I caught a glimpse of her in a waiting room of the MIT Medical Center, I almost attacked her and told her about my little theory on storytelling. She listened attentively and gracefully said that it was promising. Something about the way she responded, however, made me realize that I had not really explained it well. Perhaps, she did not even understand fully what I was saying. Somehow, I came away wondering about the power of my examples. I figured Rosa Parks was better than the Tokyo Story, but perhaps it did not work on her as a foreigner.

It was only about a year later, in Fall 2001, that I felt ready to explain it to her in a full form. Wanda was probably completely oblivious of the fact that she had become one of my target audiences. When I explained my theorizing on storytelling, she was rewardingly attentive and abruptly asked "what do you mean by compatibility?" I jerked and tried to explain, but found that I was utterly speechless. She looked up in her dictionary and thought aloud – only to make it clearer that I needed to clarify the concept better. It became another piece of homework for me to do. Later that year, when I finally decided that I had a partial answer to her question, I organized a small informal presentation to talk about my theorizing on storytelling. As she was leaving the room, I asked her what she thought. She replied almost hesitantly – "it is nice, but I wonder if compatibility is more like a process - something that you practice?" I must have looked terribly uncertain, she kindly added "it may not be relevant, and you may not need to go there, but you might think about it." More homework. By this time, I knew that the role of the audience was to demand and create more work. The key constructs as well as the general storyline of the thesis developed as I engaged in more and more conversations, and the more I took seriously what they said.

Sarah. The next thing I did was to write up about storytelling in a three page note to show to Mike. Mike is an advisor who always had a very clear idea as to what my goals were, but was often delinquent as far as timely reading of my half-baked products were concerned. It had to be short – it had to be simple. I wrote up a piece based on Rosa Parks. Before I sent it, I wanted to make sure that it read OK. I phoned Sarah, a fellow doctoral student and a close friend, to ask her if she would read it quickly. She interrupted her task of the day - reading Foucault – and called back an hour later to give me comments and suggestions. Her overall comment was that it was a nice piece, but I did not explain why Rosa sat down that day and not before or after. "What do you mean," I asked, a little irritated. She proceeded ruthlessly, "you know, why did it happen then? Was there no one else who sat down before? If yes, why did it not work then? Why just work this particular time?" Sarah was asking a classic social movement question – without herself knowing it. I was a little annoyed because I thought the elements to answer her question were in place and yet when I pointed it out, she did not buy it. I gave up delivering my half baked answers and thanked her courteously. For now, it was enough to know that it was good enough to be sent to Mike. However, for the first time, I understood that this was a pattern to be reckoned with – my fellow doctoral students were going to ask the most awkward and intuitive questions, that were out of context - because none of us yet had a context. Sarah was also a little agitated about the use of Rosa Parks. There was something weird about a Japanese woman writing about the race issues – and if it was to go to a more public arena, she would need to look at it with more critical eyes to make sure that I would not raise eyebrows. The theory itself – it was nice but secondary to these other concerns. Of course that is not what she said. But with friends you know what they are really thinking no matter what they say. Laura had similar reactions. Her reading of it was such a non-event, I don't even remember what she said. I decided that I would never write about agency using Rosa Parks again – even though I thought it was very elegant.

Mike. Mike was evidently excited to read the piece. I say "evidently" because I never really got his reaction. He called me to say that he liked it, and that I should call him over the weekend at his Cape home. For some reason that escapes me now, I never managed to call him back, and by the time he saw me, the excitement had long worn off. Instead, he asked if I had data for this. I told him why and how I came to think about storytelling based on the consortium case in Tokyo and other corroborating pieces from the field. Interestingly, some of these had to do with the way I related to the interviewees.

My relationships with the field: importance of questions

I noticed that Professor B was visibly intrigued by my questions the third time I interviewed him. He remarked that nobody had previously asked him such questions. This was puzzling indeed because my questions (about the benefits to different categories of industrial members) seemed very obvious ones. He explained,

> "when people see these diagrams, they are struck in awe. They say, 'wow, this is great.' In that sense, there are rarely questions that cut into the issues. They see this and say "wow, how do you manage to develop such ideas all by yourself?" …. They rarely ask what this means exactly or what I am really intending to do."

And yet, he was clearly interested in having such questions asked, so that he could develop good answers.

I wondered if he was so isolated that he lacked critical colleagues and industrialists who would dare to ask such simple questions. The picture of his isolation was very consistent with the general picture I was developing about Japanese industrialists who were a little weary of interacting with Japanese professors. They regarded the academics as being too pedantic to engage in serious technical discussions but nevertheless as important sources of students. It was also consistent with the image of junior academics that I was developing. They had clear, justifiable, and sometimes even devastating criticisms about some of the activities of senior professors in which they had participated, and yet had not voiced such criticisms directly to them.

I soon noticed that I made my own judgments about whether stories about partnerships made sense or not. Some partnership stories sounded convincing, others sounded half-baked. Some seemingly half-baked ideas began to make more sense as I understood more about the local contexts. Others remained half-baked even at the end. I extrapolated that industrialists who are approached by academics might also have similar reactions, finding some stories convincing and others not. For industrialists to be persuaded to participate, and make a significant resource commitment, the story had to be powerful.

One entrepreneurial professor in Cambridge had told me that in order to get financial support one must have a story about why it is important and why it makes sense. His laboratory was a kind of incubation space for start-ups. One research staff explained later that most of the things they do cannot be understood unless there are stories, however wacky, to give images of how these new technologies might come into use.

I also encountered many interviewees who thanked me for asking good questions. One went as far as to ask for the interview tape and another explicitly thanked me for engaging in discussions that evidently helped him think through the role of the partnership. Another thanked me in my third visit for providing him with opportunities to think through things. It was interesting to me that what they appeared to enjoy was not so much my advice or conclusions, but their own words and reflections about what they were doing. My interviews evidently provided good opportunities for them to think in a way that was structured and yet not threatening. In other words, they needed to tell a story so that they understood themselves, and my questioning provided an occasion to construct such stories.

Back to convincing Mike. I told Mike about some of these field tales – perhaps in less polished forms – as well as case examples such as the Media Lab, for which two powerful "agents" got together to weave a central story. By the end of that conversation, Mike was ready. "You have it!" he said. Then we talked about how I might present the case. I wanted to present various cases and then end the thesis with this theorizing about storytelling. Mike thought that was too ambitious and that once I started thinking that way, it was very difficult not to tell the cases that way. I proceeded – somewhat misunderstanding our conversation to mean that I should not foreshadow anything about storytelling until the final conclusion chapter – only to get into trouble later.

Keiko. Keiko is a close friend, who had become something like a little sister to me over the dissertation years and who had just finished her doctoral dissertation in SUNY. We talked frequently on the phone about life and about our dissertations. She was always curious and unfailing enthusiastic. She would habitually ask what I was up to in my analysis or theorizing in minute detail. She was one of the first to understand the practical implications of my nascent theory of storytelling: the importance of dialectics for story development. One day, I was saying "I am fuzzy about this bit" and she wanted to know what was fuzzy and why I thought it was fuzzy with her usual enthusiasm. As I answered her questions, she and I simultaneously saw that I could articulate it much more clearly than I had feared. It was as though I just needed to be asked, and I just needed to articulate it in front of an audience with whom I felt comfortable. Without saying a word, we both knew that we both understood this new ritual – of her asking questions so that I could clarify my thinking. Thereafter, she was always attentive and unfailingly enthusiastic – she became MOMO for my dissertation.

Eleanor. I had no trouble writing the first draft of the chapter describing storytelling – it was one of the easiest chapters to write. I had conviction about what I was saying and clarity of the concepts, based on a year of thinking it through. Though I had not spent much time explaining my theorizing to Eleanor, my committee chair, I was not at all worried, because she was very familiar with circumstances in Tokyo and in one earlier discussion when I explained Tokyo in terms of the lack of powerful storytelling, she nodded in the way that made me think that she liked it. She looked reflective and I was convinced that something that I said made sense with some of the other things that she knew about Japan. Because she has in-depth knowledge of Japan and Japanese culture, when she appeared to buy what I was saying about Tokyo, arguably the most difficult of the three universities, I felt very reassured.

In November 2002, Eleanor read the first draft and came back with a rude surprise. "I don't like it," she said definitively, "it sounds as though you have solved the puzzle of institutional change. This is the best thing that has ever happened and you know it all. And yet, it is not as if to say you heard them articulate all the stories as they went about life – you have no data on the actual stories as told." This was roughly her objection. I tried to tell her – but it did not work. Her advice was to diminish its importance – call it the emergence of institutional patterns – not institutional change, call it a process theory, not a meta-theory. Even with all these changes, I had the sense that she accepted it grudgingly.

The real problem was that Eleanor was right. I honestly did believe that I had discovered the theory of institutional change and all by myself. I took in her comments slowly but seriously – and made all the changes as suggested. However, it was not until much later that I understood why these were important changes. How difficult it is for us doctoral students to accept and appreciate advisors who command us to diminish our claims! It is usually much later that one realizes how little one is actually adding and how much has already been discovered by our predecessors.

John. It was the latest draft, which satisfied even Eleanor, that met another uncompromising critic, John. John was another advisor who was known as a guru of qualitative methods. Though he never raised many questions, when he did, they were intriguing questions that were qualitatively different from those raised by others. It was as though he entered the worlds that I was describing through my texts and identified aspects that did not somehow fit. I often described to friends, "John reads my papers as if he was licking them." There was almost a physical texture to the way he related to a text. When he said "this is convincing" having read these texts, it was very reassuring. He was always gentle in posing questions, so I never felt threatened, and sometimes even wondered if he took me seriously. Having read the first draft once through, he asked to read the second draft in small doses as chapters became ready, and I had sent him draft chapters 9, 10, and 11. He liked chapter 9 – "I really like this table" he said, pointing to the table that listed characteristics of organizational boundaries. His smile turned into a hateful expression as he turned to chapter 10 on storytelling. "I really don't like this" he said. I could see how much he hated it. He looked as though he was about to spit on it. It was painful and devastating to watch and hear him – and all this for my favorite part of the thesis too!

Institutionalists. Around the same time, two fellow doctoral students who were also studying institutional change were reading the same chapters: Carlos and Kate. Carlos, who was doing the initial rounds of data collection, was independently getting interested in the role of narratives in institutional change. When he read Chapter 10, he said "You've got it!" and was very excited. Kate, who practically revamped my last three chapters through her matter-of-fact comments, was most excited about Chapter 10 and the way I tied in identity with institutional change. They both said "it makes so much sense." Another institutional doctoral student, Sean, had given me a green light on an earlier version by saying that it was "cool." All of us were interested in tying the concepts of individual identity with institutional change. It wasn't just students who liked it – Susan, a sociologist faculty whose recent research was based on narratives also liked the ideas I presented. I had a difficult time understanding why John was so unhappy.

All the apricots ripen at the same time. My initial reaction was to respond subversively: divide and conquer. I discussed John's objections extensively with Lotte – but not with Eleanor who had concerns similar to John's. I was afraid that if the two of them got together, they might amplify each other and come up with stronger objections. I used the fact that Eleanor was very busy at the time and only reported cursorily to her about his comments and what I was doing about them. All this was probably not essential, because by the time I saw John for the next couple of chapters, he was less forceful in his objections. In the grand scheme of the dissertation as a whole, John was probably willing to drop his charges at least somewhat.

In the mean time, I also worked hard to understand the nature of John's objections. He said "this came out of nowhere! You have no data for this! And you are there alone!" His suggestions were two-fold, drastically cut back on the chapter, and relate it to the literature. He thought that it was futile to try to relate it to my data, since I didn't have the data for it. I disagreed with his last comment.

As I engaged in reading the literature to cope with one of his demands, a new awareness was beginning to dawn on me. "Storytelling" was in the air! It was in the air because of the way in which intellectual discourses had developed across several disciplines, and because of the rise of post-modernism, where positivist ideas were giving way. Although I came up with it "all by myself," I clearly did so because of the environment within which I was thinking. This was an instance of "agency" that was institutionalized. Carlos, Kate, Sean, and I were like apricots ripening at the same time, as the Turks would say.

The second puzzle was the contrast between the two conclusion chapters. How come John liked Chapter 9 on boundaries but not Chapter 10 on storytelling? As far as I was concerned, they were both equally grounded and essential for explaining the phenomenon. So why did he like the one but not the other? I slowly realized that the social construction of "organizational boundaries" took place in quite a different way from the one on storytelling. It was only when I reflected on the whole process, and then recollected the way John reads texts, that I understood the nature of his objection.

Boundaries

My twin conclusion chapter on boundaries was based on a different kind of social construction process. For one thing, there was far less dialectics with external audiences during its formation, except with Eleanor, who provided key conceptual underpinnings for it. The first time I articulated that the three universities appeared to define their organizational boundaries in different ways was in the doctoral seminar at the Industrial Performance Center (IPC) in May 2001. The IPC had provided me with a fellowship earlier that year and so I had been part of the graduate student group involved in regular seminar presentations. This was the second time I presented on my dissertation, and in many ways a critical one, as three of my advisors, Eleanor, Lotte and Mike and one of my shadow advisors, Richard engaged actively in its discussions. Sarah and Laura were there of course, representing my fellow doctoral wisdom.

It is interesting the way these seminars usually have two types of outcomes: one on issues that people are actively unhappy about – in my case these often pertained to methodological issues around case selection; and the other on issues that people were intrigued by. On the former, I worked systematically. Sometimes it was on the issue of presentation, at other times, I had to re-think my approach. The second type of issues was often generative and I drew more energy from people's expressions of intrigue. The notion of differently defined organizational boundaries was the hit in that session. Richard liked the idea that Cambridge seemed to have a very different type of boundaries. Mike also thought that what Cambridge showed was a kind of tolerance or confidence about not needing to police its boundaries.

Eleanor again. Eleanor was the one who pushed me to try to characterize these boundaries more clearly. Eleanor had a very interesting ability to be generative on the spur of the moment, and when I least expected it. For instance, the notion of boundaries being permeable or fuzzy was something that Eleanor had suggested very early.

One evening over a drink, she was suggesting that I think more about the difference between permeable and fuzzy boundaries. I asked "what do you mean?" As we had run out of time, she was picking up her bags to get to the airport, she speculated aloud, "oh, maybe with permeable boundaries you are at least clear about where the boundaries are, whereas fuzzy boundaries - you don't even know where they are." Whenever she would make these seemingly off-the-cuff comments, she would always add, to get rid of my defensiveness, "you don't have to use these specific ideas, but just think about it."

How many of these ideas actually later served as cornerstones for my theorizing! Eleanor was the one who wondered aloud if external as well as internal boundaries were at work. I remember vividly that moment and my first reaction, "more work!?" It was in the conversation with her that the notion of top-down and bottom-up initiatives or early ideas about informal and formal boundaries in Tokyo arose. More work to refine the concepts and yet more re-writing! She kept on pushing until the day I wrote all the case chapters and a summary chapter on boundaries.

Three days before my defense – she was still pushing – though with a smile to help me not to get defensive. I also discovered in the process that what had seemed "off-the-cuff" remarks were actually based on years of thinking about these issues.

Writing the cases. The key elements of boundaries and how they work emerged much later in the process and as I wrote up the chapter cases. As such, there was one critical difference between the chapter on boundaries and the one on storytelling: the former was developed as I wrote the actual case chapters that became the key part of my dissertation, while the latter was already in place by the time I started writing the case chapters. My committee members observed the development of boundaries both in discussions and in writing, while there was less need to "write aloud" to work out the storytelling concepts. For John, who loved to see the case stories ground up, the story-telling chapter suddenly appeared without having the case chapters lined up with the content. He had also been away during the previous year and had missed out on most of the early case studies as well as conversations about them, which were more directly geared towards storytelling. He was absolutely right: in my first draft, not enough was documented to make a case for the storytelling chapter.

Jean Jacques. A week before my defense, even after I submitted my draft to the committee, I was still worried about whether Eleanor and John would buy the story-telling aspect of the thesis – which in my view was a central piece in my dissertation. In my daily conversations with fellow dissertation writers, this particular concern was discussed quite extensively, but it was Jean Jacques who ultimately put it to sleep. Having listened attentively to my latest concerns and my mumblings about John's reactions, he said with an uncharacteristic firmness: "you know, Sachi, if you believe in what you are saying, there is only one thing you can do. Defend it. At the end of the day, not everyone will agree with what you find – but then your role is to defend your perspective as best you can." Such words, delivered with a gentle French accent, were enough to shake me out of my anxiety and take me to a new level of dissertation writing.

Power of the phenomenon

There was another level of social construction that had little to do with my own work but that had a powerful influence. University-industry relationships were topical among policy makers and practitioners in a way that made it "topical" for the day. MIT was clearly a model that many countries and universities looked up to. MIT had a partnership with Cambridge – both sets of academics were learning about each other. Tokyo professors were visiting MIT to learn about how it worked. There was an emerging story about university-industry relationships and how different universities dealt with it differently through which many faculty around me were actually living. The phenomenon became a powerful story in its own right, with or without my dissertation. I observed that power in the level of interest people expressed about my research.

Until January 2000, my dissertation was framed as organization-environment relationships, with universities as organizations, in which I was examining how universities changed in response to environmental changes. I could not help noticing that some themes had a greater appeal to people than others. For instance, university-government relationship was the topic of my second year paper, where I compared the experience of the UK and Japan. I usually had to explain in great depth why this was an important topic to examine, and how it could be interesting to a broader audience than the practitioners in those countries. The audience would generally give me the benefit of the doubt, and listen suppressing the yawn. I needed a captive audience to get reactions. When I said that I might look into university-industry relationships using MIT as a case study, it was a whole new game.

Richard. Richard was one of the first to show signs of interest. He was a rare member of faculty who had independent research interests on the changing role of research universities. He was also British. He was one of the most policy-oriented faculty I knew. Even then, a comparative analysis of higher education reforms in Japan and the UK was a hard sell for him. One day, when I mentioned the possibility of looking into MIT's own experience in working with industry, particularly the strategic alliances, his face lit up. Since then, he has been a supportive faculty and a shadow committee member, who was always willing to engage in discussions about my research.

Others. By fall 2000, I discovered that more people showed signs of interest in what I was doing. One faculty commented in one seminar, "Sachi, your phenomenon is interesting enough. You don't need to justify it so much – you sound defensive." His message was: just get on with it and tell us what the story is. The most amazing incident was when I told Michael about my thesis topic. Michael was a faculty member who had originally been assigned to me as an advisor, but none of my research interests, universities as organizations or higher education reforms, made sense to him. He was also a business historian with a keen sense of what is current. He wrote about Japan at the height of the Japanese miracle, he was writing about Microsoft as the company made a meteoric rise, and he published a book on Netscape just as the Microsoft-Netscape war took off. In our early discussions, he used to try to sound and look patient, but invariably ended up asking "why is that interesting?" This time, he did not even need an explanation. Instead, he looked up and said, "that's interesting." This time, I sensed that it was not really the way I was telling the story about my dissertation or framing, but that it was the subject matter of my thesis that was somehow interesting in its own right.

There can be certain face validity to the phenomenon you examine. It was as though your dissertation could piggy back on the power of the phenomenon itself. That power was there or not there depending on the kind of social construction that had gone on about that phenomenon. The point of your dissertation then was to ride on it.

The power of the concepts

Quentin. Quentin, my partner in life and work, was usually one of the first readers for every version of my chapters. He is an education consultant, who undertakes a range of strategic consulting tasks for governments and educational institutions including universities, some of which are more appropriately termed "advisory". He is a practitioner with little patience for obscure terms that do not make sense to him, who likes me to get to the point. And yet, he was also one of the most ardent and earliest supporters of the idea of storytelling. One day, he told me that he had an exciting conversation with one of his clients, a chairman of a university, with whom he happened to meet at the train station and walked together to the meeting they were both attending. Quentin had evidently used that 15 minute opportunity to explain about my dissertation. "And he thought it was very interesting," he concluded. I asked somewhat doubtfully, for I was not yet sure what my dissertation was about at that stage, "so what did you tell him?" Quentin was very robust in his answer "oh, about how there are these boundaries and how you need to tell stories to cross them." I was surprised – because of all the things in my thesis, these concepts were what I expected practitioners to have least interest in. I tried to quiz him about exactly what he said and exactly why the Chairman was intrigued. Quentin explained – but I did not really understand. This was one of the first moments when I understood that I will not always understand what my audience carries away from my thesis. Even when I know the person as well as I do Quentin.

The power of the faceless audience

The final phase of dissertation writing was all to do with negotiating with the existing literature. Lotte pointed out that I should be contributing not to the literature, but to the understanding about the phenomenon. I disagreed. Academic writing is targeted to academic audiences and tailored to the particular manner in which academics "understand" – through the literature. What is understood by people in their respective locales but not written in academic writing is not yet "understood" by academics. So, it is not enough for me to add to general understanding, I had to add to academic understanding too. This was the toughest audience – faceless and silent, and yet demanding. I simply read and read and read - through the first draft, and then the second draft, and then the final draft, and through the defense. Ultimately, it is to the process of social construction through academic literature that this dissertation must add.

To the finish line

My defense was a glorious event, well attended both by faculty and by students with diverse backgrounds, and complete with a Champagne celebration afterwards. I was particularly pleased that several Management of Technology professors attended the session, given that I had put in a semester of real effort to get to know that community and their literature. My committee said that they were proud and happy with both what I had done and how I presented – or at least that is what I heard on the day.

A couple of days later, Lotte was saying a lot of work was still needed. I did not understand. Yes, there was a lot of editorial details to correct, but these were procedural and required little energy from me. What struck me was the fact that she truly looked anxious when I said that I was turning in a final draft in two weeks. Mike was saying that I had better work really hard to get it into shape.

If these were the demands coming from the side of the committee that I thought was more supportive of my thesis, I dreaded to think what Eleanor and John might demand. Indeed, I avoided asking them in case that triggered further thoughts. The most upsetting was Mike's comments. He had said that "You have done more than I could do with the amount of data" which I took to be a compliment. And yet he was ruthless in saying that he had a lot of problems about the way I talked about storytelling. My first emotional response was simply "what do you mean?" I felt betrayed by his comments. "You too?" was my reaction. As I deciphered his comments in the margins of the text, which were universally negative, I was ready to throw the entire thesis into the air. I was devastated.

When I gave up the idea of feeling good about my thesis, I noticed an irritating fact. The irritating fact was that both Mike and Lotte were actually asking very interesting questions. As I drifted further into their questions, I realized that these were questions that they could not have asked before. It was because I had clarified things from the final version that these questions could now be asked. My clarity was my vulnerability – the clearer I was in explaining my ideas, the greater the degree of understanding on the part of readers, and hence the better the questions they ask. This was the first time I realized that I was working with a moving target, and with an audience who will never be satisfied but will always encourage you to go on the next step. Dissertations are never finished and everything one writes is a half-told story.

Another discovery I made during this final stage, particularly through writing this appendix, was the extent to which emotions influenced the way I interpreted the comments that I was given. In retrospect, I could have taken everything that my advisors or friends said as comments, and dealt with them professionally. Somehow, that was not how things happened. I was always on the edge, feeling the need to defend, and afraid that I may not be right. Dissertation writing has been a process through which I found my own voice and confidence to make assertions before a powerful collection of multiple audiences. And I feel much better for having gained that confidence through this process.

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