

## Growing Global: Learning Locations in the Life Sciences

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### **Abstract:**

This research explores the role of place in corporate location strategy by following the global footsteps of pharmaceutical giant Eli Lilly and Company. Examining a life science company model whose acquisitions strongly affected industry strategy provides examples of place characteristics modifying high tech corporate strategy in four very different metropolitan areas: Indianapolis, Research Triangle, San Diego and Shanghai. Targeted interviews explore institutional, human, and place features. This case study illustrates why choosing the best learning location—where both structured and informal information exchange networks can nurture companies—is key to achieving competitive advantage through site selection.

### **Article:**

#### ***Introduction***

The uneven spatial distribution of economically vibrant cities and sectoral clusters continues to attract geographic examination. Some places succeed as attractive "magnets" binding corporate clusters, while businesses that prosper in certain locations fail to find a footing in other locales. The search for explanations of the role of place in economic success is particularly keen in the high technology industrial sector, given its lucrative impact on metropolitan areas able to sustain a critical mass (Kantor 1995, DeVol 1999). Location decision-makers face a choice of numerous global locations for expanding their business, and must evaluate place attributes with needs for particular assets in mind. The question addressed by this research concerns the fit of place characteristics with activities and outcomes. How do companies match locations with activities to be conducted—and what are some of the strategies both a business and a city can use to deal with the geography of place?

Numerous studies demonstrate that corporations utilizing similar inputs and serving similar markets clearly prefer to cluster in close proximity (Taylor 1985, Krugman 1991, Malmberg, et al. 1996). A major remaining question concerns the "fit" of both a successful industry and its nurturing region. Porter (2000) observes that the existence of "clusters suggest that a good deal of competitive advantage lies *outside* companies ... residing instead in the locations in which their business units are located" (p.16). Places are known therefore not only by the company(ies) they keep, but also by the type and stage of growth represented. Cooperation among companies and institutions in a shared place creates locational competitive advantage compared to similar companies in other places. Lilly looked to places where research was occurring on products or processes similar to its own niche interests, and sought to acquire the knowledge through obtaining the company. The extension of a branch plant to Shanghai followed a perceived need to be where other companies were going—in this case for a market rather than primarily a research foothold.

The configuration of space for the extraction of profit constitutes a key intersection of geographic and economic interest. In order to establish their location as a desirable node on a global chain, local leaders construct features they see as universally appealing to high tech companies. A copious literature illustrates structural aspects such as research universities with a corporate-matching specialty, generous financial institutions, and political

support (Glasmeier 1988, Lyons and Luker 1998, DeVol 1999). Others ascribe success to agency aspects more difficult to acquire, such as dynamic mediators and leaders driving interactions, e.g., no weavers, no web (Saxenian 1994, Kiplinger 1999). Mediating organizations are often created and enlisted in an attempt to focus efforts for nurturing businesses in a certain place, equipped with its own social rules and political-economic resources. Structurationist theory encompasses all of these structural, agency, and mediating institutional elements in its analytical stance (Giddens 1985), and furnishes the framework for this examination.

*Spatial division of labor.* The opening up of global sites for multinational corporations (MNCs) created a new spatial division of labor, reflecting the varied levels of training and pay scales prevalent in countries where divisions of companies were located (Dicken 1992, Peck 1989). Simply put, a human capital corollary to the product cycle model holds that places of high skill, high wage labor such as involved in research and development activities will attract businesses in the most developed countries, while lower paying and less skill-demanding jobs will cluster in less developed countries (Piore and Sabel 1984, Barff and Austen 1993). Mobility of labor also entices job seekers to migrate to other national or international regions able to offer jobs suitable for their skill sets (Dunning 1993, Angel 1989, Park 1992). Place-bound labor lends regions a key distinctive quality and is “the central factor among the possible influences on the location of economic activity” (Malecki 1997: 119), greatly influencing the type of work done in that locale.

Spatial divisions of labor considerations clearly play a role in the location of global biotechnology activity (Haug and Ness 1992). Research and development and manufacturing sites can be divided into core, semi-periphery, and periphery areas; the United States and China represent the first two categories, respectively, in this study of high tech activity. Research and development occurs in core regions, while process as well as product packaging innovations are focused in the semi-periphery due to differential levels of development. Routine versus non-routine work can also be used to characterize sites of spatially separate labor, often reflecting sites of former colonial versus colonizer relations (Piore and Sabel 1984, Malecki 1997). In biotech, where labor needs are tied to companies in particular areas (Indianapolis, San Diego), but produced at various locations on a national as well as global scale, tension arises from issues from employers trying to lure college grads tied to alma maters in Texas and Boston to visa problems for would-be immigrant workers in India and China (CONNECT interview, 1998). This spatial division of labor is stickier in some spots than the literature often acknowledges. Overall, locations benefit from a local spectrum of labor where the highest skilled through routine levels are available (Scott 1988, 1993). China, on the other hand, seeks to escape branch plant stereotyping, as its already highly educated workforce tries to find jobs that often utilize less than their packet of skills.

The form and function of a life science cluster are revealed by locational interactions taking place within that region, as corporate strategy plays out globally through a cycle of spatial extensions from headquarter location to far-flung branches. Similar companies congregate around the world in neo-Marshallian global nodes, or widely dispersed locations with recognized attributes for particular sorts of companies (Amin and Thrift 1992). Areas with low labor costs combined with high tech skills, good infrastructure for distribution, pro-business government permitting financial arrangements required, where enough companies gather that employees can change jobs without moving out, signifies a location with nodal status.

A global hierarchy structures this network, from regions garnering the greatest profit closest to innovation sites, down to areas of routine, low-cost labor who at least are part of a high tech production chain. Castells and Hall (1994) apply the term “technopole” to global science park “planned developments” assisted by research institutes, land developers, and governments, a term that also applies to Chinese high-tech parks (Organization for Economic Co-operation and Development (OECD) 1987, Wang et al. 1998). In its hometown Lilly is a “technological oligarch” (Storper 1997), which dominates a location to the extent that all research and development activity is drawn to them. Second tier cities are most susceptible to this phenomenon (Markusen et al. 2000). Interview evidence rounds out several case studies following development of life science clusters involving Lilly. Detailed case studies of four clusters culminate in a summary conclusion regarding the “fit” of space attributes and economic activities contained within the specific locale.

## Theoretical Framework and Methodology

The primary focus of this research concerns the relationship between particular place characteristics and the success—or failure—of particular types of businesses located there. Beyond a behaviorist interest in factors involved in the location decision itself or an economic calculation of increasing returns from technology investments, the structurationist integration of human actions (agency), local cultural (structural) rules and embedded resources within capitalism and places, plus the mediating influence of bridging organizations, provides a useful integrating stance for examining cluster dynamics. While previous studies generated lists of necessary but insufficient features apparent in high technology cluster sites, this study focuses on the dynamics that are greater than the sum of each part. Given that networks for information exchange are crucial to success in high technology sectors needing cutting edge innovations, questions remain as to how the rules (ways of operating, e.g. secretive or open), resources (e.g., university specialties, financial institution lending practices), and agents (persons actively involved in advocating connections and network construction) function in a particular place to create success.

Four propositions are advanced to deal with dimensions of this situation. First, the specific attributes of a place lead to their capture and nurture of specific types of businesses in clustered locations. A company's competitive strength must fit with prevailing local business factors. Secondly, the driving dynamic in choosing a location is less cost minimization than learning maximization. Third, a governmental presence is always involved, directing a differential flow of support. Fourth, active networks must promote learning opportunities. Businesses and location agents can construct strategies to match a place with the activities conducted there.

The crucial aspect focusing this examination concerns network promoting activities that compress the learning curve, bestowing a key competitive advantage to connected companies. The case study of Lilly was chosen since its presence in major global sites throughout the United States and Europe is typical of the life science industry. On the other hand, its headquarter location in the Midwest, at a distinct distance from the typical Mid-Atlantic pharmaceutical concentration, led to its pioneering attempts to secure a geographic foothold in other areas of life science innovative activity, with mixed but instructive success.

TABLE 1. INTERVIEW AREAS AND RESPONSES

| Questions   | Indian-apolis  | RTP                | San Diego     | Shanghai         |
|---|----------------|--------------------|---------------|------------------|
| <b>1. Major reasons for present location:</b>             |                |                    |               |                  |
| Availability of needed employees                          |                | *(high skill)      | *(high skill) | *(many, low pay) |
| Prestigious address                                       |                | *                  | *             | *                |
| Other company close by                                    | *              |                    | *             | *                |
| Good real estate value                                    |                |                    | *             |                  |
| <b>2. What interactions occur due to local proximity:</b> |                |                    |               |                  |
| Employees (residence, food, recreation, organizations)    | *              | *                  | *             |                  |
| Information   | *              |                    | *             | *                |
| Other firms in area                                       | *              |                    | *             | *                |
| <b>3. Regional location factors:</b>                      |                |                    |               |                  |
| University (tech transfers employees, facilities)         | *(train)       | *(train, transfer) | *             | *(workers)       |
| Infrastructure good                                       | *(road)        |                    | *free-ways    |                  |
| Government incentives                                     |                | *                  |               | *                |
| City quality of life                                      | *affordable)   | *                  | *             | *                |
| <b>4. Networks</b>  |                |                    |               |                  |
| Effective organizations                                   |                | *                  | *             | *(Park)          |
| Dynamic individuals                                       |                |                    | *             |                  |
| Leading company(ies)                                      | *              |                    | *             |                  |
| <b>5. Adequacy of financing available</b>                 |                |                    |               |                  |
|   | *(deep pocket) |                    |               |                  |
| <b>6. Pro-business/risk-taking culture</b>                |                |                    |               |                  |
|   |                |                    | *             |                  |
| <b>TOTAL</b>  | <b>9</b>       | <b>8</b>           | <b>14</b>     | <b>9</b>         |

Appropriate methodology flows from both the problem under examination and the data needed and available to address it. Qualitative in-depth interviews permit construction of case study comparisons of the match between various company functions at different sites (Stake 1998). This applied geographic approach extracts meaning from reality as perceived by participants. Entrepreneurs and innovations, for example, clearly flourish better in some places than in others, producing the demonstrable unevenness of successful outcomes that motivates geographic curiosity and consequent inquiry. To understand the outcome, it is necessary to understand the context of action in each case study site by inquiring into the prevalent dynamics. A schematic of questions posed in each location is shown in Table 1, along with responses that are discussed further in another section. Categories under the first question reflect a mixture of likely responses suggested both by other studies (“availability of needed employees”) and previous survey results (“good real estate value”). The second question is echoed in the fourth question, as both deal with aspects of critical human networks, with the latter section identifying more specific components. The third question deals with “place” factors that are constructible by planning groups. The last two questions deal with issues prevalent in business literature, reflecting attitudes of respondents more than a measurable reality (e.g., how much financing is “adequate”?).

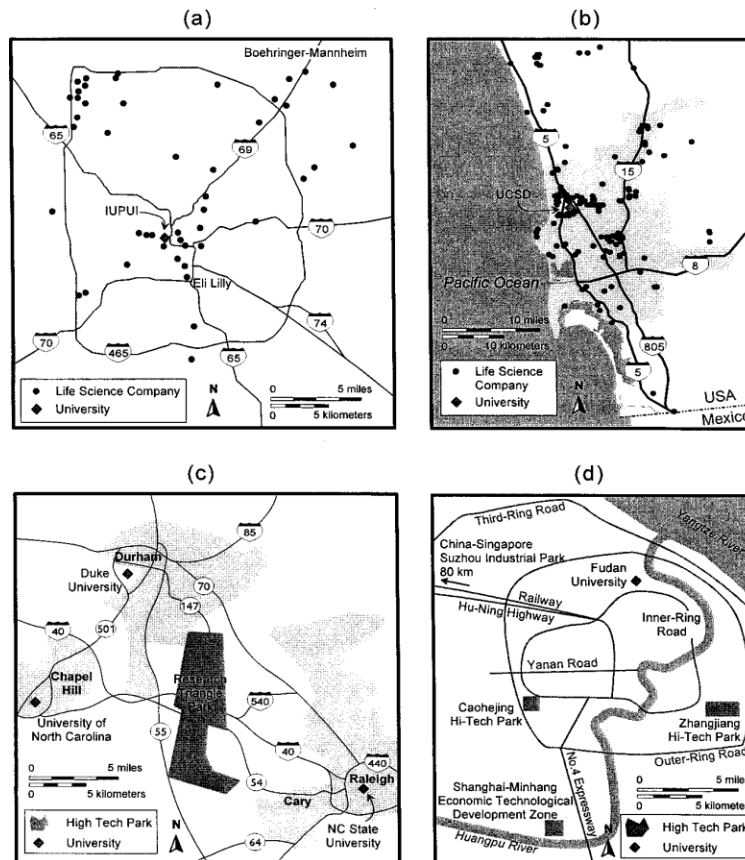
TABLE 2. INTERVIEW TARGETS BY TYPE OF COMPANY AND LOCATION

| CITY              | BIO-MED | MEDICAL DEVICE | R&D/LAB | OTHER COMPANY | DEVELOPMENT AGENCY | SERVICE AGENCY | TOTAL |
|-------------------|---------|----------------|---------|---------------|--------------------|----------------|-------|
| Indianapolis      | 4       | 7              | 7       | 2             | 19                 | 4              | 43    |
| Research Triangle | 3       | 1              | 1       | 1             | 5                  | 2              | 13    |
| San Diego         | 16      | 6              | 2       | 1             | 7                  | 3              | 35    |
| Shanghai          | 5       | 1              | 5       | 5             | 4                  | -              | 20    |
| TOTAL             | 28      | 15             | 15      | 9             | 35                 | 9              | 111   |

“Place” is richly nuanced, and corporations are creatures as well as creators of their context. Qualitative research is thus an indispensable element, involving numerous face-to-face on location interviews. Interviews and industry data in each case study site supply a preponderance of evidence. Given the critical importance of labor to the success of this type of business, getting at the nature of interaction between participants is indispensable to go beyond available secondary data (Schoenberger 1991, Fontana and Frey 1998). In no other way is it possible to understand technological dynamism.

Companies were targeted for interviews based on their representative and distributed location and sector (Table 2). Interviews in Indianapolis occurred primarily in 1994-5; San Diego was visited twice in 1998, and RTP in 1999. A research trip to Shanghai took place in the summer of 1999. Format varied from face-to-face conversations usually lasting an hour, to a smaller portion of telephone contacts, given the distances involved. Pharmaceutical, medical device, and research companies constitute major components of the life science industry. The other two categories represent support networks from accountants to development agencies. Since companies in the life science industry tend to be highly competitive and proprietary about access, it was often helpful and occasionally necessary to have a contact and reference name in order to obtain an interview in a practice known as “snowballing”. The job title of the person interviewed varied from president to human relations director, to designated spokesperson. Specific individuals recommended or listed as liaison with the local network organization were requested; the gatekeeper-receptionist then referred the researcher to whomever they considered available or most appropriate, given the nature of the information sought, and the availability of the person requested.

The following sections explore each of the four propositions in each of the four case study sites, beginning with the established pharmaceutical headquarters in the Midwest heartland, then chronologically through consideration of linked corporate affiliations in San Diego as a biotech model hot spot where Lilly invested heavily in an early innovator. Research Triangle Park (RTP) is the subsequent site of a currently more successful biotech breakthrough company acquisition. As the “dragon head” hope for Chinese modernization through attraction of advanced foreign company outposts, the Shanghai area hosts Lilly’s recent re-emergence in Asia. A “loose network” (Kantor 1999) of alliances underlies corporate clusters in each location. The type of business practiced in each place relates to the very nature of the local culture, since the sector and company were held constant. This research looks at the experiences of a particular pharmaceutical company in order to simplify and focus the examination on place considerations and specific practices.



**FIGURE 1. GLOBAL DISTRIBUTION, TOP 12 PHARMACEUTICAL COS. AND SUBSIDIARIES (SOURCE: FORTUNE GLOBAL 500, COMPANIES ON LINE 2000). a. Indianapolis, IN; (Source: High Tech Corporate Manufacturing Directory, 1995); b. Metropolitan San Diego, CA, (Source: American Business Directory, California 1998; CONNECT 1998); c. Research Triangle Area, NC, (Source: Research Triangle Park Foundation, 1999); d. Metropolitan Shanghai, PR China (Source: High-Tech Park Directories, 1999).**

### Place Attributes and Matching Business Practices

**Indiana Pharm home.** The importance of congruence of a business with the local context of both community and other corporations forms a key proposition of this research. From its beginnings on May 10, 1876, the pharmaceutical firm named for its founder Eli Lilly was at home in Indiana (Figure 1 A). Lilly's first big breakthrough came in the 1920s with the use of insulin to treat diabetes, first as a pancreatic extract and later as a recombinant DNA-based drug. A substantial portion of its profits currently comes from the pioneering anti-depressant medication Prozac. Since success in the pharmaceutical business depends on the next product in the pipeline stream, Lilly relies on in-house research and other companies operating in its niche in genetic engineering and computer-based three-dimensional molecular models. Far from the established cluster of life science industries on the Mid-Atlantic, Lilly's locational exceptionalism was sustained by cross-industry concentration within a health complex of companies in Lilly's proximity. Representatives from the geographic global Triad (Ohmae 1985) converged to continue relationships pursued together in other locations. Medical device giant Boehringer-Mannheim Corporation came to acquire an innovative test discovered by a Lilly employee, and brought some of its affiliates from Germany as cooperation with the pharmaceutical magnet expanded in their shared field of diabetes treatment. Hitachi and Mitsui from Japan expanded their automotive-based research in electronics to medical device applications, given the possibilities of high tech creations allied to the area's other predominant economic cluster.

**San Diego: Bubbles of biotech on the beach.** San Diego's self-styled "Biotech Beach" is a product of local culture and unique individuals. The dynamic high risk-high reward environment of biotechnology supports firms who literally capitalize on opportunities to experiment and learn in a research and development rich

setting (Orsenigo 1993, Malmberg 1996). San Diego presents an interesting case study of an innovative milieu due both to its location outside the usual high tech regions in northern California and the northeast, and its proximity to larger and less successful biopharmaceutical rivals to the north, Orange County and Los Angeles. Transfer of talent and funds flowed fairly seamlessly from successful computer-related companies to bioscience as another high tech cluster. The prominence of University of California San Diego (UCSD) in biotechnology-related research is almost unsurpassed for cluster development (OECD 1984, interviews). The first successful local company founded from a laboratory idea came about by personal connections, however. Two medical product salesmen heard from a former boss that an acquaintance had a promising idea and now worked as a professor in the UCSD biology department. After securing permission from the university system to develop this research, the founders' next challenge lay in attracting a high skill labor base. Working to make money rather than advance scientific breakthroughs was such a heretical notion that the fledgling enterprise located close to the university so employees could disguise their corporate destination from disapproving neighbors (interviews).

TABLE 3. TECHNOLOGY TRANSFER MEASUREMENTS

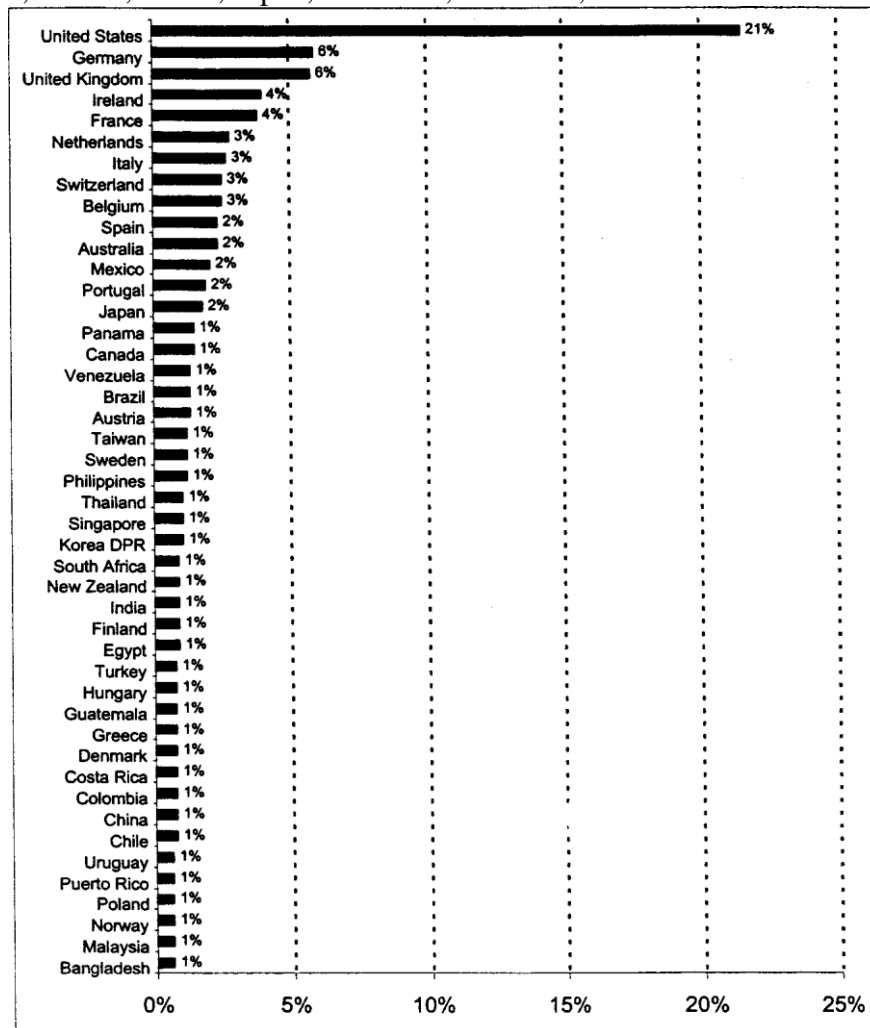
| College                  | Sponsored Research Expenditure FY97, US\$, | License Income Received | Active Licenses & Options | Patent Apps '97 | Start-Ups'97 |         |         |
|--------------------------|--|-------------------------|---------------------------|-----------------|--------------|---------|---------|
| UC System                | 1,586,533,000                              | 67,279,000              | 832                       | 500             | 13           |         |         |
| Stanford                 | 391,141,224                                | 51,762,090              | 1,044                     | 183             | 15           |         |         |
| CA Tech                  | 153,000,000                                | 4,056,829               | 121                       | 240             | 9            |         |         |
| CA TOTAL                 | 2,130,674,224                              | 123,097,919             | 1,997                     | 923             | 37           |         |         |
| Duke                     | 360,977,000                                | 1,520,000               | 180                       | 69              |              |         |         |
| NC State                 | 334,393,941                                | 3,164,795               | 455                       | 48              | 1            |         |         |
| UNC                      | 263,517,405                                | 1,684,093               | 257                       | 66              | 2            |         |         |
| NC TOTAL                 | 958,888,346                                | 6,368,888               | 892                       | 243             | 3            |         |         |
| TOTAL SPONSORED RESEARCH |  |                         |                           |                 |              |         |         |
|                          | 1997                                       | 1996                    | 1995                      | 1994            | 1993         | 1992    | 1991    |
| Stanford                 | 391,141                                    | 395,464                 | 373,000                   | 370,500         | 293,000      | 303,300 | 280,100 |
| UNC                      | 263,500                                    | 262,900                 | 240,300                   | 355,900         | 150,600      | 211,100 | 174,000 |
| Patent Apps Filed        |  |                         |                           |                 |              |         |         |
| CA Tech                  | 145  | 90                      | 60                        | 45              | 69           | 30      | 60      |
| UNC                      | 66   | 47                      | 113                       | 46              | 40           | 30      | 32      |
| Licenses Yielding \$     |  |                         |                           |                 |              |         |         |
| Stanford                 | 272  | 259                     | 220                       | 200             | 214          | 165     | 160     |
| UNC                      | 61   | 50                      | 49                        | 33              | 35           | 36      | 24      |

The first lab idea in the U.C. system to go corporate (California Department of Commerce 1988), Hybritech's use of recombinant DNA technology and their product's potential application to diabetes' treatment attracted Indianapolis' "Fortune 500" pharmaceutical firm of Eli Lilly and Co. They acquired Hybritech in the late 1980s in order to capitalize on a promising cancer drug. The company founders made millions, attracting attention to biotech's possibilities as an investment gold mine. The technology ultimately did not live up to its promise—complicated by a conflict in ways of doing business.

The hierarchical "teamwork" model of large pharmaceutical corporate management proved fatal to the innovative venture. Lilly's Indiana-evolved large corporate culture of cooperative, consultative teamwork clashed with the California bio-entrepreneurial drive of rapid, individual-driven operations. A more ponderous management style drove founders and many employees to take their new millions and bail with "golden parachutes" into new start-ups. The place-related roots of Lilly's failed biotech venture in San Diego provide a clear illustration of place characteristics supporting a particular kind of milieu attractive to some corporate structures but antithetical to others. San Diego's culture and ready venture capital supported sprouting new companies that offered ready alternatives.

San Diego's worldly entrepreneurs clearly understand their place in the spatial division of labor. One noted that "manufacturing can be in Puerto Rico, Ireland, China; value is in the knowledge people here; cost reflects the value of information" (Duane Roth, 4/24/98). Another respondent noted that Lilly in particular considered that "manufacturing is a worldwide adventure, to spread the risk and for tax reasons: Kobe earthquake, Richmond [North Carolina] flood, in France for political reasons, Puerto Rico and Ireland for taxes" (personal

communication). A major biotech employer noted that 10 percent of his workforce came from UCSD, the rest from twenty-five states, France, China, Japan, Lithuania, Australia, and Hawaii.



**FIGURE 2. GLOBAL DISTRIBUTION, TOP 12 PHARMACEUTICAL COMPANIES AND SUBSIDIARIES. SOURCE: FORTUNE GLOBAL 500, COMPANIES ONLINE 2000.**

**Research Triangle Park: Lessons learned from a Sphinx.** North Carolina ranks seventh in the nation for biotech concentrations (Morrison and Giovannetti 1998). Even though compared to California universities, measures of technology transfer in North Carolina fall far short in a variety of categories measuring technological breakthroughs and commercialization (Table 3), the attraction for Lilly lay in Research Triangle Park's (RTP) general reputation as a location for active high tech transfers and specifically in the research underway at local biotech startup Sphinx Pharmaceutical. Lilly learned from its negative experience in San Diego, courting a different relationship with Sphinx that would provide deep pocket relief for a young innovative company struggling through the throes of the drug testing and approval process. This was balanced with promises of a hands-off approach to the existing corporate culture. The usual cash-out-and-bail route attracted a number of Sphinx employees, but enough stayed on to maintain the company. Now in Lilly-financed quarters befitting its RTP location—a considerable step up from the shopping center store front quickly leased to new first-stop-from-the-incubator tenants—Sphinx' innovative output feeds Lilly's product pipeline.

**Metropolitan Shanghai: Global footprints going back to the future.** China's approach to setting aside politics and opening to the world economy by dangling the potential of her large domestic market has been termed "neo-mercantilist" (Arnold 1993). Shanghai swirls in the noise and dust involved in constructing a critical mass of industry and activities sufficient to promote and sustain networks of high tech activities (Ning and Yan 1995). The goal is for the area's pool of China's highest skilled labor, improved infrastructure and service sector to produce economies of scale and agglomeration that will continually attract foreign investment

and multinational companies (Qu and Green 1997). The Shanghai metropolitan area and nearby towns sport a variety of Economic Technology Development Zones (ETDZs) and Hi-Tech Parks. Major metropolitan area parks include Caohejing (CHJ—started by then-mayor Jiang Zemin as a Silicon Valley hopeful), Zhangjiang (ZJ) in Shanghai's fast growing suburb of Pudong across the Huangpu River, and the satellite city of Minhang. These high tech parks essentially function as variant Chinese neo-Marshallian districts, drawing on localized labor cost and skill sets, production inputs and distribution networks of international origin, which has also been characterized as “offshore hub-and-spoke districts” (Amin and Thrift 1992, Markusen, et al. 2000). The location of the 12 largest pharmaceutical companies and their major subsidiaries (165 companies total) is highly concentrated and hierarchically stratified, heavily skewed in favor of the most advanced nations where research activities are conducted and affluent customers purchase highly profitable products (Figure 2). At the next level, in decreasing order of companies, are countries that combine relatively inexpensive labor with an adequate level of basic education and work ethic training suitable for manufacturing and marketing penetration by subsidiaries.

Although Pudong in particular represents a significant commitment by the government to attracting foreign business residence and jobs, surrounding areas also compete for the economic boost represented (Yusuf and Wu 1997). The China Singapore-Suzhou Industrial Park (CSSIP) is an effort by the Chinese government to forge a partnership with another ethnic Chinese government respected for its demonstrated record running a successful capitalist economy. The CSSIP (Figure 1D) lies on the outskirts of Suzhou, a mid-size ancient scenic city some 50 kilometers west of Shanghai. This region includes numerous universities and research institutes, and a manufacturing labor base. Current occupants of CSSIP include electronics, pharmaceutical and medical device manufacturers, as well as traditional silk and textile enterprises ([www.cs-sip.com](http://www.cs-sip.com) 1999). Another unique feature is the grouping of same sector companies as neighbors, inspiring new global pairings of cooperating competitors. Government-forced localization of personnel supports the notion of “multidomestic” transnational companies (Forteza and Neilson 1999) whereby regional heads of large foreign-headquartered corporations seek to become part of the local culture and employ local nationals as much as possible.

Lilly's presence in the high tech park renews its place in 1928 as the first American pharmaceutical company in Shanghai (Bayne 1999). While its foothold on the Mainland slipped with the advent of Japanese Occupation and departure of the Nationalists, it was eager to join the current crowd of global pharmaceuticals branching out from research sites in Europe and Japan to essentially manufacturing and marketing locations in South America and China. Typical of many foreign companies anticipating future expansion, it currently occupies only a portion of its acreage. Johnson & Johnson has expanded five times. Near neighbors include Becton-Dickson and Burroughs-Wellcome, with a one billion (U.S. \$) facility.

The first pharmaceutical to catch the opening door of Deng's China was Squibb, whose decision to locate in Shanghai inspired the creation of an ETDZ around it in Minhang. The company later opened an administrative office in central Shanghai, while continuing manufacturing in suburban Minhang. Minhang is the oldest but not the largest ETDZ, in terms of acreage, employment, and companies. CSSIP acquired the most land, and the highest percentage of foreign-connected companies.

### **Learning Locations**

Both structural and informal factors compress the learning curve for Lilly in its hometown. The company's status as a big fish in a small pond amplifies its ability to attract support and shape its milieu. A corporate policy encouraging employee voluntaristic involvement in civic life furthers construction of informal local networks. Ironically, absence of nearby eating facilities downtown and the early Lilly innovation of a company cafeteria (an American industry “first”) concentrate mealtime interaction and visibility of potentially cooperative players during the work day.

Large pharmaceutical companies excel at linking discovery, manufacture, marketing, delivery and sales of their products (Grabowski and Vernon 1994; Gambardella 1995). Although much research is done in-house, particularly at Lilly, it is never enough to provide the constant supply of new products needed in the “pipeline”. As patent protection expires, generic substitutes quickly siphon off a large part of the market by their



competitive pricing, unencumbered by heavy research, testing, and development costs. The excitement of commercially promising new discoveries coming from university laboratories attracted Lilly to look at a small new company—the first university-approved technology transfer from the University of California at San Diego—whose innovation indicated possible application to Lilly’s main diabetes product line.

Factors compressing the learning curve and conveying a competitive advantage to San Diego feature an ease of communication between company heads and employees, university and research center scientists, and students (personal communications). Many interview subjects credited a “western” mode of openness, similar to the Silicon Valley versus Boston divide cited in another high tech study (Saxenian 1994). Structural attributes of the “biotech best practice” picture were educational institutions, agents were Hybritech founders and other corporate networkers, and place dynamics are found in San Diego convivial human and physical climate. Companies concentrate around a circumferential UCSD roadway, and in industrial parks within ten minutes of each other. Rapid access to allied university laboratories and contracted scientists focuses location.

North Carolina ranks seventh in the nation for biotech concentrations (Morrison and Giovannetti, 1998). Technology transfer at its major research institutions falls far short of the national leader, California universities (Table 3). A national data set reflecting funded research and development, derived income from inventions, patents as measures of innovation, and commodification of knowledge into commercial business ventures, provides multiple ways of assessing the “innovative milieu” character of a location. Two charts provide both a cross-sectional snapshot and a longitudinal look over seven years from consistently reporting institutions. The attraction for Lilly lay in RTP’s general reputation as a location for active high tech transfers and specifically in the research underway at local biotech startup Sphinx Pharmaceutical. Learning from its negative experience in San Diego, Lilly courted a relationship with Sphinx that would provide deep pocket relief for a young innovative company struggling through the throes of the drug testing and approval process. This was balanced with promises of a hands-off approach to the existing corporate culture. The usual cash-out-and-bail route attracted a number of Sphinx employees, but enough stayed on to maintain the company. Now in Lilly-financed quarters befitting its RTP location—a considerable step up from the shopping center store front quickly leased to new first-stop-from-the-incubator tenants—Sphinx’ innovative output feeds Lilly’s future product pipeline.

Factors shortening RTP corporate learning curves are less potent than location in a spatially designated high tech park might imply. As part of the effort to maintain a park-like setting, companies are required to set aside 80 percent of their land as undeveloped. A wall of greenery thus separates individual companies, isolating them on their campus. Although fast food and other time-reduced food settings are easily available in commercial areas outside RTP, there is no central mixing area for socializing, eating, and observing interactions. Drive-through lines are busier than sit-down facilities inside, emphasizing the isolation. Long-term profitable but time-consuming sociability is sacrificed for short-term time efficiency. As an informal network example, the fourth rectangular leg of the “research triangle” is formed by a booming suburb named Cary, known by its telling acronym: “Containment Area for Relocated Yankees”. Cary particularly attracts young families, who make connections around the soccer fields and other local events. Network exchanges here happen after-hours. The “Research Rectangle” functions as a typical neo-Marshallian node, in but not of the South, frequented by international transients on yet another corporate global posting.

### **Government Presence**

Life science companies in all four locations are well-connected politically, which is not surprising given the desirability of their presence as “clean”, well-compensated occupations. The origin of this connection varies, however. In Indianapolis, a public-private partnership with many interwoven interests binds the economic oligarch with pro-business political machinery. San Diego’s ties are bottom-up, instigated by individuals connected with life science companies to promote interests such as better schools (for better workers), better transportation connections, and more awareness on the part of politicians of the life science industry’s substantial economic impact. Both RTP and Shanghai ETDZs exist due to a top-down political decision creating them, and supporting sustaining interests such as transportation connections.

A local metropolitan and state socio-political niche nurturing industry-specific and mutually beneficial growth added a critical component to Lilly's Indianapolis mix. The personality of founder Lilly and his namesake grandson knit webs of civic relationships that stood both company and city in good stead. When other industries left Rust Belt cities such as Indianapolis in the 1960's, Lilly stuck by the city of its birth. Expanded operations took place on land cleared and infrastructure improved by city money. In turn, a public-private partnership involving individuals tied to the private Lilly Foundation reconstructed Indianapolis' downtown to attract an amenity-conscious labor base needed by this life science giant on an urban campus (Haddix et al. 1989, Walcott 1998).

While city-level government decisions greatly assisted Lilly's success, and San Diego's booming cluster positions itself for both metro and statewide issues but little direct government-industry involvement, the next two Parks owe their existence directly to state (Research Triangle) and national (CSSIP) initiatives. Formal designation and construction of a technology park takes the form of a "property initiative", changing the ownership and use of a particular piece of land for a special purpose (Massey et al. 1992, Massey and Wield 1992). Parks usually specialize in administrative offices, research and development functions, providing learning networks for companies somewhere between the incubator and global headquarters stage (Staudt et al. 1994; Westhead and Batstone 1998). Establishment of Research Triangle Park (RTP) was an effort to add a new, innovative element to North Carolina's low-wage agricultural and basic manufacturing mix (Whittington 1985). The land and human support came from the non-profit Research Triangle Committee's government, university and business leaders (Burritt 1999, [www.rtp.org](http://www.rtp.org) 1999). RTP's slow growth from underutilized scrub pine land between major college towns (Figure 1B) accelerated in 1965 with the addition of IBM and the National Institute of Environmental Health Sciences. These provided weighty private and public anchors, as the fledgling area lacked venture capital, a local successful giant like Lilly, or preceding high tech-high profit computer companies as in Southern California. Burroughs Wellcome joined the Park three years later as its first major foreign direct investment.

San Diego and Shanghai illustrate opposite ends of the spectrum for government involvement. Although the metro government encourages growth of the local biomedical presence, Shanghai directs companies to particular Parks, handles particular requests, and designates the type of companies specifically encouraged to locate in certain Parks. The meteoric development of Shanghai area sites for attracting foreign and domestic high tech companies has led to great adjustments that are still in progress. Examples include construction of apartment blocks for workers in the development zone so they can reach their jobs by bicycle instead of long bus commutes, a subway line, international airport, luxury housing and state-supported stores in China's biggest shopping center in Pudong.

### **Active Advocacy Networks**

CONNECT, the high tech mediating organization founded at the behest of the business community by UCSD, is steered by a local dynamic entrepreneur known as "a bulldog for biotech". The number of successful Hybritech spinouts attests to the talent of the founders and the climate of a region that could sustain so many innovative companies. Life science anchors in Indianapolis and San Diego enjoy close physical proximity promoting frequent and easy interaction. Certain eateries and activities draw participants in the same line of work for informal but not unrelated conversation. The physical setting of companies on large lots with mandated majority set-aside as undeveloped separates companies otherwise connected by roadways in RTP. Workers are divided among four surrounding communities. No central gathering place draws informal contacts, aside from directed purpose (lecture, class, and mixer) activities at the mediating organization. The situation in Shanghai is even more varied. Such partnering as occurs takes place with companies in immediate proximity (personal communications).

Indianapolis lacks a formal mediating organization, but Lilly is omnipresent. San Diego's CONNECT and BIOCUM function in tandem, the former as a bridge to university, financial, and corporate interests (especially for startups) and the latter as an essentially political lobby group. Similarly, the mission of RTP's Council for Entrepreneurial Development is to stimulate "the creation and growth of high impact companies in the greater

Research Triangle area” by offering a wide range of services. Some of these include exposing new companies to financiers at quarterly public “showcase” forums, sponsoring mentor relationships and access to networks of advisers and other entrepreneurs, conferences, roundtables, training programs, international CEO and contract research organizations. The State of North Carolina also maintains a Biotechnology Center whose organization (NCBIO) represents the interests of the life science industry in particular (as does BIOCUM). The RTP Foundation primarily functions as a land development agency for the Park, resembling more closely Shanghai’s Development Corporations. RTP struggles with its success, dealing with mounting traffic congestion and growing pains of a rapidly developing suburban spread (Burritt 1999).

Organizations connecting similar sectors (such as pharmaceuticals) are just beginning in the Shanghai region. Expatriate groups allied by nationality draw individuals closest to the central Shanghai downtown area. It is recognized that in a large country, the larger the voice (of an interest group) the better in order to be heard above many competing interests. The Development Corporations are designed as one-stop integrated bridges for corporations between various government bodies and local needs. Their effectiveness also varies. CSSIP relies on a Singaporean model and the ability of its Overseas Chinese intermediaries to handle the Chinese bureaucracy. The deliberate grouping of sectorally related companies next to each other provides an innovative and quite locationally interesting step. Zhangjiang is as newly opened as CSSIP, with a visionary and well-connected former head of a large state utility company appointed to his current position by city powers. Success in luring companies here stalled until the Asian financial crisis abated and subway and airport connections were completed to integrate the area better with Shanghai. The planners’ vision of a well-to-do American suburb includes providing international schooling, a private golf course, and preserving local waterways. Only occupants are lacking. As in more centrally located Caohejing Hi-Tech Park, Chinese companies take up the slack somewhat by being located to learn around the large foreign companies.

## **Conclusion**

Examination of each case study site along the lines of the four propositions reveals distinct differences and sustaining similarities explaining why certain places are more suitable for different functions. First, the method used in this research of studying a company’s adaptations to place characteristics of production and local network construction provides clear examples of the need to match company goals with place appropriate characteristics. Integration of each area with its local culture divides the cities into two camps. Clusters in Indianapolis and San Diego sprang from local companies, so best reflect an embedded local way of “doing business.” Large Lilly can be characterized as a conservative, midwestern company stressing team players, while San Diego’s biotechs thrive in a more improvisational frontier setting. RTP clearly is in but not of the South, a global node station whose affluence assists the state coffers but exists more as an island than an example of Carolina dynamism. A paucity of local financiers speaks to this situation of a difficult transition from tobacco to high tech in the local mindset.

Shanghai’s role clearly fits in the conceptual context of an international spatial division of labor. Shanghai area foreign companies function as a way station between established SAR Hong Kong and politically correct but less business-oriented Beijing, between developed world corporate headquarters and developing world local surroundings, somewhere between the formers’ research and development function and basically assembly work in the latter. China seeks to mandate its way out of this situation by requiring localization of employees at all levels and the presence of some R&D functions in foreign plants, but the degree of compliance clearly varies. As observed, most such activity occurs to modify an existing product for local market conditions.

Second, companies seek to place themselves where they can learn by location, profiting by proximity to potential or established partners and competitors in settings supportive of high frequency interactions exchanging high quality information. In particular, high tech companies in the life sciences whose lifeblood flows from access to the latest innovations in order to keep their cutting edge competitiveness must include place-based characteristics into a locational choice model. Being where innovations happen—that happy mix of applied research, technology transfer-savvy institutions, financial capital, and organizations and individuals dedicated to making all the connections work— means companies must locate or acquire some access to others

in such a place. Lilly's location in the Midwest, rather than the Mid-Atlantic coast where most pharmaceuticals are in the U.S., made it even more imperative to establish a presence in innovative regions. "Rules of the Game" require that business be done according to not only corporate capitalist procedures, but follow the "Rules of Rome", or local norms, which must not deviate too greatly from the preceding. Structurationism refers to these as the embedded rules and resources. Lilly experienced trouble with this in San Diego, but learned to keep a looser rein in Research Triangle. It followed the global stampede to Asia by locating carefully within an international park next to other life science players.

The third section concerning the importance of an external government presence touched on various scales as well as degrees of involvement. Lilly benefits principally from its municipal "big fish" position, along with state considerations in industry-specific matters. San Diego's cluster seeks appreciation and involvement in city and state policies that impact labor and land issues, but is more autonomous to politics than to its research institutions ties. Research Triangle sprang from a state economic development initiative, and now suffers from lack of regionalism. Economic ventures in China depend heavily on national policy in a still highly centralized political economy.

In the final category of advocacy networks, agency impacts begin with the founding impulse behind each life science cluster, varying by location and historic circumstance. Lilly forms the center of Indianapolis' high tech attraction due to the characteristics of the family, the elimination of other industries via economic restructuring, and the company's success in weaving political webs throughout the state and city. San Diego's bioscience boom came from a combination of cutting edge research at its university and local institutes, and entrepreneurial individuals building bridges in the business community. Research Triangle Park originated as a state land and labor base shift. As such, it remains an anomaly in the region less well integrated with its locale than the preceding two. In a sense, its success comes from transcending its local-regional context to acceptance as a global nodal location, which attracted Lilly's deep-pocket support for biotech Sphinx. Finally, the CSSIP is a joint venture of two national governments, succeeding by its proximity to Shanghai. CSSIP is the best integrated development zone within its boundaries and the most distant from its locational magnet. Lilly's latest China venture seeks to compress its learning curve through connection with an experienced Singaporean mediating organization, and personal touches creating a friendlier environment for Chinese workers.

These four locational case studies demonstrate the validity of the four propositions suggested earlier. The sectoral types of life science companies clustered as mapped in each location reflect the particular attributes of that setting. The opportunity of learning by being there supersedes any other costs connected with that location, on the other side of the continent or the world. Microeconomic considerations such as corporate funding needs also reflect whether the business must be self-sufficient (Indianapolis), able to attract venture capital (San Diego) or in need of large corporate sponsorship (RTP). Governmental support remains a presence in each case, though on different scales.

More investigations of national and global multi-located corporate variations are called for in order to draw attention to the need to investigate and operate within local contexts of place geography. For example, a look at how Johnson & Johnson maximizes its historic headquarters location in New Brunswick, New Jersey—with transformative consequences on that aging college town similar to Lilly's effect on Indianapolis. While capitalism's global growth dictates a far-flung web of allied corporate relationships, successful sites of neo-Marshallian nodes need well-constructed learning networks.

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