일반논문

Historical Landscape of America's High-Tech Centers

Their Formation, Diffusion, Growth, and Diversity during 1950s-1980s

JUNG-HOON KI*

Since World War II, high-tech centers have appeared in United States' metropolitan areas. Computer related industries such as the computer, semiconductor, electronics, and software industries play a key role in high-tech centers. Geographically, initial high-tech centers spawn other following high-tech centers by two different ways: relocation diffusion, and contagious diffusion. By the relocation diffusion, initial high-tech centers in Route 128 or Boston Metro(MA) and Silicon Valley or San Jose Metro(CA) relocate their certain functions such as R&D laboratories and manufacturing operations to other states, and these moved functions work as an important initiative for the formation of new high-tech centers in Phoenix-Mesa(AZ), Dallas(TX), and Colorado Springs(CO). By the contagious diffusion, initial high-tech centers also expand into areas within the same states or adjacent states, and this expansion help build up new high-tech centers in Oakland(CA), Santa Cruz(CA), Ventura(CA), Orange County(CA), Dutchess County(NY), and Binghamton (NY). In both processes, Inherent industries and inborn entrepreneurs play a magnetic or agent role with university linkages, venture capital investment, a pool of educated workforce, active entrepreneurship, innovative business climates, and abundant foreign direct investment(FDI). Although there are general location factors, regional diversity among high-tech centers exists because of

* Department of Public Administration, Myongji University(johnki@mju.ac.kr)

their variations in initial funding, infrastructure, industrial structure, human capital capacity, and business culture.

Keywords: High-tech Center, Metropolitan Area, Spatial Diffusion, Regional Diversity

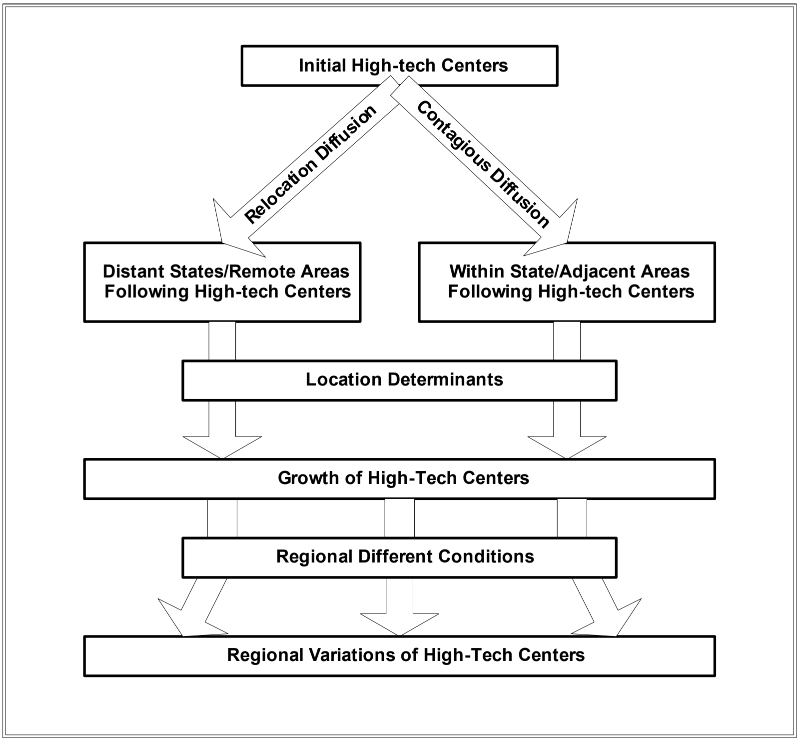
1. Introduction

The high-tech industry embraces a variety of features that are distinctive from traditional or non- high-tech industry. Those features include knowledge-intensity with high level of research and development(R&D) investment, highly value-added products, system-integrity and higher investment risk. Due to these characters, high-tech industries are identified by the very rapid growth rate compared to other industries. The employment rate of high-tech industries is much faster than that of traditional industry. There is a wide agreement that the high-tech industry has been a pivotal engine for economic growth in the U. S. for the last decade. DeVol(1999) claims that America's unprecedented economic growth is spurred by the high-tech industry; therefore, regions that fail to attract these industries could be left behind in the 21st century(DeVol, 1999). However, it is difficult to define 'high-tech industry' with only one factor. Thus, a variety of indicators are used in defining the high-tech industry. The most commonly used indicators are "R&D intensity, or the percentage of sales expended on R&D" and "technical workers(scientists, engineers, and technicians) as a percentage of the workforce" (Malecki, 1991: 174). McArthur's(1990) diffusion-based definition such as newly emerging and widely diffused technologies is also a very practical approach to define the high-tech industry(McArthur, 1990). These various parameters can converge in certain industrial sectors as the high-tech industry: electric office machines, information technology, software, semiconductors, biotechnology, biopharmaceuticals, and new material industries(e.g. ceramics, superconductor). Among these, computer related industries such as computer manufacturing, semiconductor, software, and electronics are vital elements of high-tech success and richness. Initial high-tech centers, which specialized in the computer related industries, are successful and sustain their prosperity in the example of Silicon Valley(San Jose metro) or Route 128(Boston metro) (Cortright and Mayer, 2000).

Geographically, the high-tech industry is apt to concentrate on metropolitan areas, mainly because of their highly dependence on R&D employees or educated workers who are likely to enjoy metropolitan lifestyle. There are several successful high-tech centers The Internet Website "Siliconia"(http://www.tbtf.com/siliconia.html) offers a comprehensive list of domestic and international high-tech centers that employ "Silicon" from the name of Silicon Valley. in the United States, which are widely known.

The contemporary landscape of high-tech centers did not happen in a day. Historically speaking, it took several decades'creation and diffusion process of high-tech centers. The concentration of high-tech industry develops high-tech centers in several specific metropolitan areas in the U.S. There have been some factors in the concentration of high-tech industry and formation of high-tech centers. First, World War II transformed the fundamental U.S. R&D system. Since World War II, the huge amount of government money spent on university research, military contracts with research institutes, and procurement at companies, which enabled high-tech industry to grow rapidly with the birth and growth of numerous high-tech centers in the U.S. Although government spending played a critical role in the birth and continual growth of early high-tech centers, there are also many other factors

<FIGURE 1> Research Framework



that have contributed to the diffusion of high-tech centers. Some of these factors are spin-offs(Cooper, 1972; Saxenian, 1985; Stöhr, 1986), educated workforce (Stafford, 1980; Malecki, 1992; Florida, 2002), entrepreneurial culture(Saxenian, 1985; Goldstein and Malizia, 1985; Malecki, 1994; Saxenian, 1994), and foreign firm location and foreign investment(Gray, 1998).

Although high-tech centers can be created wherever these location factors are provided, there is a significant role of initial or precedent high-tech centers in formulating following or descendent high-tech centers. Thus, this paper inspects high-tech centers' spatial diffusion process in both relocation diffusion and contagious diffusion. And then it also deepens explanations for

<Table 1> High-tech Center's Initiation and Diffusion Functions

Function	Initiation	Functional Relocation Diffusion	Contagious Diffusion
Activity	New firm location	R&D Laboratories relocation Manufacturing relocation	Headquarter expansion Manufacturing branch
Motive	Government funding Univ-based research parks Educated labor pool	Production cost reduction, Affordable housing, Better transportation condition, Desirable quality of life, Cooperative local government attitudes, A large pool of unskilled laborers	More land availability, A need of professional workers

their location determinants and regional variations in subsequent chapters. I employ the computer and related industries in defining the high-tech center of the research because their significant role in initial high-tech centers. Details of these frameworks and their applications are offered afterward.

In this research, I argue the diffusion of high-tech centers that follows relocation diffusion or contagious diffusion among the U.S. metropolitan areas. Relocation diffusion catches the movement to other or remote states, while contagious diffusion grasps that within the same state or adjacent areas. Figure 1 and Table 1 below briefly summarize how these three mechanisms in diffusing the initial high-tech centers.

The rest of the paper is organized into five sections. Section 2 describes the research framework for spatial analysis of high-tech centers. The research framework consists of two subsections: definitions of high-tech industry and high-tech center, andthe spatial diffusion theory. This chapter defines America's high-tech centers using three four-digit North America Industry Classification System(NAICS) codes and their metropolitan location quotients (LQs) in employment and gross metro product statistics. In the spatial diffusion theory, I explain the relocation diffusion, contagious diffusion, and their mechanisms in diffusing high-tech centers. I also give the basic frames for explaining high-tech location determinants and regional variations. Section 3 describes the geographical birth and growth of initial high-tech centers. This section also describes the role of inherent industries and inborn entrepreneurs in the diffusion of high-tech centers. In section 4, the research investigates location determinants for the growth of high-tech centers. And section 5 presents primary rationales for variations among the existing high-tech centers. Finally, section 6 provides conclusion and policy implications. This research will offer valuable policy implications and guidelines for regional planners, government officials, and decision makers who wish to create high-tech industry, attract high-tech workers, and build a high-tech center in the regions they are planning or building up.

2. Research Framework

1) High-tech Industry and High-tech Centers

To define the computer-related industries, the research uses three four-digit NAICS(North America Industry Classification System) NAICS is very relevant to the past SIC(Standard Industry Code) data, thus it is possible to use NAICS data than SIC data. And NAICS is more available than SIC in recent database.NAICS 3341 is equivalent to SIC 3571, 3572, 3575, 3577, 3578; NAICS 3344 is equivalent to SIC 3671, 3672, 3674, 3675, 3677, 3678, 3679; and NAICS 5112 is equivalent to SIC 2711, 2721, 2731, 2741, 2771. codes as follows. These industries are most relevant to computer industry in respect to industrial relation, product operation, and system management.

NAICS 3341 Computer & Peripheral Equipment Manufacturing
NAICS 3344 Semiconductor & Other Electronic Component Manufacturing
NAICS 5112 Software Publishers

The research then uses the location quotient(LQ) in employment and gross metro product(GMP) to define the high-tech center that is based on the computer-related industries. "It is a measure of the relative significance of a phenomenon in a region compared with its significance in a larger region" (Hayter, 1997: 434), and is a way of measuring the relative contribution of one sector of an economy to the whole economy. The location quotient may provide an answer to the question: "How important is the high-tech industry in California compared to the rest of the United States?" For example, the location quotient for employment(or GMP) can be defined as follow

$$LQ_i = \frac{\frac{e_i^t}{e_T^t}}{\frac{E_i^t}{E_T^t}}$$

Where e_i^t = Regional employment (or GMP) in industry i in year t
e_T^t = Regional employment (or GMP) in industry total in year t
E_i^t = National employment (or GNP) in industry i in year t
E_T^t = National employment (or GNP) in industry total in year t

Industries with location quotients equal to 1.0 have a local employment share exactly equal to their national share. Regional production in these sectors is supposed to be just sufficient to meet with local demand, and theindustries are to have no basic employment. Industries with location quotients less than 1.0 have local employment shares smaller than their national shares, and they are insufficient to satisfy local demand, which requires products to be imported. Industries with location quotients greater than 1.0 have local employment shares bigger than their national shares. Local production is specialized in these industries relative to the nation, and their production surpasses local demand, which allows the surplus to be exported(Klosterman, 1990: 129).

<TABLE 2> Computer-And-Related-Industry-Based High-tech Centers (Metros)

Formation Period	Metro	State	(1) Population in Thousands (2003)	(2) Employment L.Q. (2004)	(3) Gross Metro Product L.Q. (2004)
1950s (3 metros)	San Jose	CA	1678.4	15.97	8.28
	Boston	MA-NH	6158.3	2.59	1.32
	Raleigh-Durham-Chapel Hill	NC	1294.7	4.03	2.42
1960s (5 metros)	Huntsville	AL	357.9	4.86	1.52
	Colorado Springs	CO	550.5	5.32	3.03
	Melbourne-Titusville-Palm Bay	FL	505.7	6.47	2.74
	Dallas	TX	3811.3	2.42	2.17
	Seattle-Bellevue-Everett	WA	2477.2	3.95	1.51
1970s (4 metros)	Phoenix-Mesa	AZ	3593.4	2.72	7.99
	Tucson	AZ	892.8	2.46	4.97
	Orange County	CA	2957.8	2.24	1.31
	Reading	PA	385.3	1.04	1.06
1980s (15 metros)	Oakland	CA	2462.2	2.21	1.25
	Ventura	CA	791.1	3.04	2.15
	Santa Cruz-Watsonville	CA	251.6	2.14	1.04
	Greeley	CO	211.3	1.91	1.79
	Fort Collins-Loveland	CO	266.6	5.79	2.17
	Boulder-Longmont	CO	278.2	11.13	3.89
	Boise City	ID	476.7	9.11	16.79
	Albuquerque	NM	748.1	2.76	17.19
	Binghamton	NY	940.4	5.68	2.25
	Dutchess County	NY	290.9	12.83	2.71
	Eugene-Springfield	OR	330.5	2.57	6.07
	Portland-Vancouver	OR-WA	2030.0	5.40	14.56
	Austin-San Marcos	TX	1377.6	6.00	6.34
	Houston	TX	4496.8	1.18	1.07
	Roanoke	VA	236.2	5.52	2.79
Total: 27 metros					

Sources: Malecki, 1991, Cortright and Mayer, 2000, Rogers, 1984, Rosegrant and Lampe, 1992, Lorek, 2000, Siliconia website, 2004, Markusen and Bloch, 1985, Dun and Bradstreet, 2004, Economy.com.

In this research, I argue that the high-tech centers are the metropolitan areas that satisfy the following three conditions Data sources include US Census and Economy.com.

(1) Populations are more than 200,000(2003) Generally, business activities such as new business formation or business movement are clearer in larger metropolitan areas than smaller ones.

(2) High-tech employment LQ is more than 1.0(2004);

(3) High-tech gross metro product(GMP) LQ is more than 1.0(2004).

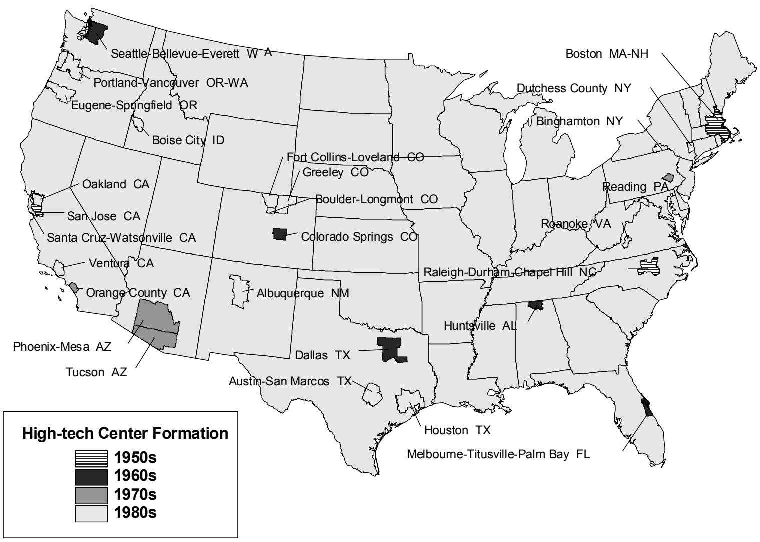
Selected twenty-seven high-tech centers are listed in table 2 and figure 1 below. In the table 2 and figure 2, the formation period of each high-tech center is when university-funded research parks or research centers are established in the metropolitan areas or newspapers or computer industry-related magazines acknowledge the activity of the high-tech center. I use the following references so as to determine the formation periods of America's high-tech centers: (Malecki, 1991; Cortright and Mayer, 2000; Roger, 1984; Rosegrant and Lampe, 1992; Lorek and et al., 2000; Siliconia website, 2004; Markesen and Bloch, 1985; Dun and Bradstreet company ownership data, 2004, Economy.com).

2) The Spatial Diffusion Theory

The key concept of spatial diffusion is a phenomenon(it is also called "birth" or "innovation" or merely "agent") and spread through geographic space(Morrill, Gaile, and Thrall, 1988). And the subject of spatial diffusion is dealt with in many areas such as the spread of disease, growth of urban area, diffusion of innovation, microcomputer purchase, franchise expansion, and ripple effects of natural disaster. Spatial diffusion of business or that of industry is also an interesting subject that many academic and professional researchers are studying. Researchers study on the spatial diffusion of retail stores, franchises, electric supply companies, management practice(Sugiura, 1978; Meyer and Brown, 1979; Jones, 1982; Aspbury, 1985; Sugiura, 1987; Graff and Ashton, 1994; Wojan, 1998). Their research frameworks vary depending on what kind of business or industry the authors focus on.

There are three types of spatial diffusion: relocation diffusion, contagious diffusion, and hierarchical diffusion expansion. These three types are not separate phenomenon, but they can take place at the same time in one diffusion event. First, relocation diffusion means that the spreading phenomenon or

<FIGURE 2> America's High-tech Centers: Computer & Related Industries*



* Reference: Author has made the map by operational definition of high-tech center.

agent may have only changed spatial location, or as the trait is passed on to additional agents, it is lost in the original location(Morrill, Gaile, and Thrall, 1988). A common example of relocation diffusion is migration of people from rural to urban areas or poor to wealthy countries. However, there are cases when the spreading phenomenon just relocates its parts or functions instead of moving all things from the original location. I call it functional relocation or functional decentralization where the spreading phenomenon may maintain the original location. If a business relocates all its functions from one place to another, it is relocation diffusion. However, this is a rare case of business operation and location. If a business wants to expand, it usually relocate its functions such as manufacturing plants, R&D, and other service functions from headquarter to other location where the business find a maximum profit or operational efficiency. Second, contagious diffusion denotes that the phenomenon is passed on to the nearest or adjacent locations from the original location. The spread of an infectious disease, that requires direct contact between individuals for infection to occur, is a common example of this type of diffusion(Cliff, Haggett, Ord, and Versey, 1981). Contagious diffusion follows two assumptions: (1) all things have relationship, but things near have more relationship and (2) Movement(or diffusion) activity needs a cost or friction, and longer movement costs more than shorter one. In case of business or industry, it is easier for a company to move within same state or neighboring areas than remote ones because of lower transportation cost and fewer additional administration processes according to movement of business. Third, spatial diffusion of a phenomenon may take place according to an ordered sequence of places, classes, or sizes, and it may be called as hierarchical diffusion. There are two types of hierarchical diffusion: hierarchical diffusion and reverse hierarchical diffusion. If a diffusion process follows the order of hierarchy such as population size, it is a hierarchical diffusion or orderly hierarchical diffusion. Meanwhile, it is called a reverse hierarchical diffusion if a diffusion process follows the counter order of hierarchy. Examples of hierarchical diffusion are found in the spread of AIDS from large urban centers to smaller towns in the U.S.(Gould, Kabel, Gorr, and Golub, 1991) and spatial diffusion of electricity supply companies through a system of Japanese cities(Sugiura, 1987). An example of reverse hierarchical diffusion is in the spatial diffusion of Wal-Mart in the U.S. cities(Graff and Ashton, 1994).

3. Birth and Diffusion of High-Tech Centers in the United States

1) Birth of High-tech Centers

In the computer and related industries, initial high-tech centers appeared in three metropolitan areas during the 1950s: San Jose(CA), Boston(MA), and Raleigh-Durham-Chapel Hill(NC). These metropolitan areas benefited from increased government research funding opportunities, university-based research parks, and educated workforce at the funded institutions. These initial high-tech centers played a pivotal role in building the following high-tech centers in other metropolitan areas around the country.

In the United States, World War II marked the birth of early high-tech centers. Federal government began to spend a large amount of money on university research, federal laboratories, and procurement contracts with companies(Rosegrant and Lampe, 1992). In the beginning of World War II, the Boston region was stimulated as a high-tech center with a huge amount of support given to MIT by military contracts. Later, other regions such as Los Angeles Metro, San Jose Metro were added to the government's list.

The interaction among universities, the federal government, and industry was very fruitful. These three institutions were able to build unusual relationships that were important for the nation's successful mobilization, and that had the effect of igniting the formation of high-tech centers. Local R&D communities were established by these relationships. This, consequently, provided the means to train and employ even more scientists, technicians, and engineers in the critical areas of technology. In addition, government contracts allowed aspiring entrepreneurs to take their expertise to the market. By assisting a lot of leading-edge research, the government promoted R&D processes as well as pushing innovative ideas closer to the point of commercial viability(Rosegrant and Lampe, 1992: 75~76).

Government defense spending shifted to the west when the focus turned to the Pacific Front in World War II and the Korean War(Wells, 1987). Government spending in the west coast produced similar outcomes as the Boston high-tech area that experienced by in the east coast; high-tech centers were created in San Jose Metro and Los Angeles Metro. The Korean War (1950~1953) and the following Cold War period(1960s) fixed the federal spending trend in the previously invested regions, which fueled the development of high-tech centers producing important technologies, particularly microelectronics. Saxenian(1983) and Wilson and colleagues(1980) point out that the growth of Silicon Valley was to a large degree a result of large budgets for research and procurement of experimental electronic devices (Saxenian, 1983; Wilson, Ashton, and Egan, 1980). In Southern California, the aircraft/parts industry and electronics industry began to grow after the Second World War, driven by the extremely high levels of federal defense spending. Such industrial growth became a key factor in establishing one of the major high-tech industrial centers in the United States.

Federal spending, then, built the defense perimeter in the east(Boston metro) and west(San Jose metro) coasts from World War II through the Cold War period. Although a large amount of military spending was poured into the two coasts, sizable parts of military expenditure were allocated to the Southern states such as Texas and Florida. This became the basis for those regions developing high-tech centers. A new defense-based high-tech center in Texas appeared on the wide-open spaces of what was once called the Dallas-Fort Worth Metropolitan areas, or "Silicon Prairie"(Markusen and Bloch, 1985: 116). Defense companies also located in San Antonio and in Austin. Similar to Texas' high-tech prosperity, the growth of Florida's Melbourne-

Titusville-Palm Bay was sketched under the shadow of defense production. Even if these funding did not make computer industry based high-tech centers in Dallas and Melbourne-Titusville-Palm Bay, they played an important role in building infrastructure for further development of computer industry-based high-tech centers. High-tech centers are formed in these areas during the 1960s.

Based on San Jose and Boston's success stories, many other regions have attempted to re-create the dynamics of the high-tech centers(Miller and Cote, 1987). The Research Triangle in North Carolina is an outstanding example of the planned high-tech center. It was initiated in Raleigh-Durham-Chapel Hill metropolitan areas in late 1950s and grew in microelectronics, semiconductor, and software industries(Whittington, 1985). Diffusion activities of this high-tech center, however, were not as strong as the other two initial high-tech centers. This phenomenon is explained that Research Triangle had a relatively slow venture capital investment(Luger, 1984; Rogers, 1986), and consequent few spin-offs rooted in Raleigh-Durham-Chapel Hill(Malecki, 1986; Glasmeier, 1988).

2) Relocation Diffusion Processes

So moltenstones fly away to remote areas in a volcano eruption phenomenon, as relocating some functions of initial high-tech centers generated other high-tech centers where the relocated functions located. In the computer and related industries, the following metros are classified in this phenomenon: Phoenix-Mesa(AZ), Tucson(AZ), Dallas(TX), and Colorado Springs(CO). These metros provide a relatively better quality of life, and a pool of unskilled laborers.

High-tech center in Phoenix-Mesa(AZ) was founded on the basis of electronics production plants that were located in initial high-tech centers in San Jose or Boston. Many semiconductor companies in San Jose relocated their production units to Phoenix-Mesa and Tucson due to this area's affordable housing, desirable quality of life, cooperative local government attitudes, and a large pool of unskilled laborers. National Semiconductor and IBM established plants in Tucson along with many other high-tech electronics and aerospace firms. Consequently, Tucson's manufacturing labor force doubled between 1970 and 1979 from 9,000 to 18,000(Census Bureau, 1970~1980). Another identical phenomenon took place in Phoenix, Arizona, where Intel and Spectra Physics located their production units. As a result, because of new high-tech concentration, Arizona has been the fastest growing state in the nation over the past decade(Saxenian, 1981: 156). The functional relocation diffusion of the San Jose metro's high-tech industry played a major role in creating high-tech centers in Arizona.

Bostonmetro high-tech center has relocated some of its functions in a similar way. Faced with overloaded transportation, exhausted labor base and high operation costs, the largest regional companies have completed several out-of-state expansions. Their substitutes are located in Dallas-Fort Worth in Texas and Colorado Springs in Colorado as well as Phoenix in Arizona (Saxenian, 1985).

The table 3 below briefly summarizes a timeline in the relocation diffusion of initial high-tech centers.

3) Contagious Diffusion Processes

High-tech centers' contagious diffusion processes are comparable to the magma flow phenomenon in the volcano activity. High-tech firms and industries flow into surrounding areas from the volcanic initial high-tech centers

<TABLE 3> High-tech Centers' Relocation Diffusion

	Initial High-Tech Centers	Functional Relocation Diffusion	
Period	**1950s**	**1960s**	**1970s**
Location	San Jose (CA) (Silicon Valley)	Colorado Springs (CO)	Phoenix-Mesa (AZ) Tucson (AZ)
	Boston (MA) (Route 128)	Dallas (TX) Colorado Springs (CO)	Phoenix-Mesa (AZ)
	Raleigh-Durham-Chapel Hill (NC) (Research Triangle)	Internal Growth	Internal Growth

in San Jose, Boston, and other areas. High-tech firms searched for better locations for their plants and other functions, and they found them close areas that are adjacent to their original location or within state. Contagious diffusion costs less than relocation diffusion in terms of transportation and administrative process. Contagious diffusion of initial or following high-tech centers was found in California, Massachusetts, Colorado, and Texas.

In California, San Jose metro's high-tech center diffused into neighboring metros such as Oakland(CA), and Santa Cruz-Watsonville(CA) during 1980s. A part of the semiconductor industry moved from San Jose to Oakland to seek more space for manufacturing operation. In Southern California, aircraft industry played an important role in high-tech centers' contagious diffusion. Orange County(CA) is an exemplary high-tech center initiated by diffusion of a prosperous adjacent aircraft industry center, Los Angeles. There has been a growth in the military aircraft industry in Los Angeles metro. This growth marched into surrounding regions because land became scarce in Los Angeles metro. The spillover into Orange County began from the mid-1950s, with Anaheim and Fullertonen joying principal benefits(Markusen and Bloch, 1985). With the number of establishments and employment data of the aircrafts and parts industry(SIC 372), Scott and Mattingly(1989) argue that a very moderate acceleration of plant decentralization into Orange County is visible in the 1972 data(Scott and Mattingly, 1989). In the 1988 data, they say that

"Additionally, a large number of small subcontractors now occupy a very evident locational niche in the northern half of Orange County"(Scott and Mattingly, 1989: 55). These subcontractors are associated with the thriving computer industry-based high-tech center that grew swiftly in Orange County during 1970s.

Geographical diffusion of high-tech centers was also found in Boston metro. Large firms on Boston metro moved to adjacent regions looking for better living and transportation conditions for employees. The high-tech centers in New York account for such cases, which include Dutchess County (NY), Binghamton(NY), Albany(NY) and Long Island(NY). Geographical diffusion of Boston metro's high-tech center to New York areas was prompted by a need for professional workers rather than for available land(New York Times, 1980; Saxenian, 1985: 98).

Contagious diffusion of high-tech centers was also identified among the following high-tech centers that are founded on the initial high-tech centers. For example, Colorado Springs metro's high-tech center diffused into Greeley (CO), Fort Collins-Loveland(CO), and Boulder-Longmont(CO). Dallas metro's high-tech center expanded into Austin-San Marcos(TX), and Houston(TX) within the same state.

The <table 4> below briefly summarizes a timeline in the contagious diffusion of initial or following high-tech centers.

4) Inherent Industry and Inborn Entrepreneur: A beginning of high-tech centers

What forces high-tech centers to start in a specific location? Although many forces influence the beginning of high-tech centers, Inherent industry

<TABLE 4> High-tech Centers' Contagious Diffusion

	Initial High-Tech Centers	Contagious Diffusion		
Period	1950s	1960s	1970s	1980s
Location	San Jose (CA) (Silicon Valley)	Internal Growth	Internal Growth	Oakland (CA) Santa Cruz-Watsonville (CA)
	Boston (MA) (Route 128)	Internal Growth	Internal Growth	Binghamton (NY) Dutchess County (NY)
	Raleigh-Durham-Chapel Hill (NC) (Research Triangle)	Internal Growth	Internal Growth	Internal Growth
	Relocation Diffusion from San Jose (CA) & Boston (MA)	Colorado Springs (CO)	Internal Growth	Boulder-Longmont (CO) Fort Collins-Loveland (CO)
	Relocation Diffusion from Boston (MA)	Dallas (TX)	Internal Growth	Austin-San Marcos (TX) Houston (TX)
	Aircraft Industry-based Los Angeles (CA)	Internal Growth	Orange County (CA)	Ventura (CA)

and inborn entrepreneur are two significant forces that work as a major agent for beginning high-tech centers in a specific location.

The inherent industries play an important in magnetizing and building high-tech industries. In the pre-World War II periods, electronics manufacturing in Southern California was mostly limited to a small radio industry that served the local market in Los Angeles. In spite of weak electronics, an aircraft industry in Los Angeles existed in the 1920s and 1930s, and they were growing during World War I and pre-World War II(Scott and Drayse, 1993). The aircraft industry and its parts industries attracted the fledgling missile industry, which developed over the 1940s. As a result, these industries became the "principal conduit" through which the modern electronics industry entered the Los Angeles area in the 1950s and 1960s. Today, the electronics industry is the dynamic component in the Los Angeles high-tech center(Scott and Drayse, 1993). The aircraft industry was the center around which other industries accumulated and allowed Los Angeles to grow into one of the largest high-tech centers in the United States.

Seattle metro also demonstrates the critical role of inherent industry and inborn entrepreneur in high-tech centers' diffusion process. The high-tech center in Seattle was created mainly from the national industrial expansion and the efforts of homegrown firms such as Microsoft Corporation and Boeing

(Haug, 1991). In addition, Boeing was active as the core of the aerospace industry, which was a pivotal factor in the development of Seattle's high-tech center(Gray, Golob, and Markusen, 1996). Washington natives, William Gates and Paul Allen, founded Microsoft in 1975, but they relocated to Washington State in 1979 because they wanted to remain in their home state (Gray, Golob, and Markusen, 1996: 880). Economic development programs and organizations in the State did not affect the location decision and initial success of Microsoft. Thus, the state benefited from the capabilities and success of Washington-based entrepreneurs who already resided in or knew the region and had no desire to relocate when establishing their firms. At last, some homegrown firms evolved over time into leading US software establishments with the rapid growth of the computer software industry.

4. High-Tech Centers' Location Determinants

There are several location determinants for the growth of high-tech centers, which usually work apart from and after high-tech centers' diffusion processes. High-tech centers' location determinants can be classified into three categories: business climate, quality of life, and overlapping determinant (Gotlieb, 1995). Each category includes several location determinants for high-tech centers. First, business climate(or business amenity) refers to important business conditions for attracting high-tech firms, which includes local patent, R&D subsidies/expenditures, available venture capital, local industry size, local market size, transportation linkages, office rents, and foreign investments(Scott and Drayse, 1993; Malecki, 1985; Timmons and Fast, 1987; Florida and Kennedy, 1988; Acs and Audretsch, 1988; Goss and Vozikis, 1994; Haug, 1995; Sivitanidou and Sivitanides, 1995; Lyons, 1995; Anselin, Varga, and Acs, 1997;

Audretsch and Stephan, 1996; Irwin and Klenow, 1996; Suarez-Villa, 1997; Gray, Golob, Markusen, and Park, 1998; Zucker, 1998; Sivitanidou, 1999; Varga, 1999; Alarcon, 1999; Cordes, Hertzfeld, and Vonortas, 1999). Second, quality of life determinant(or residential amenity) attracts and holds 'more footloose' technical and professional workers. This determinant embraces climate, cost of living, traffic congestion, crime, pollution, recreation, public education, public services, health care providers, and poverty rates(Malecki, 1992; Haug, 1991; Gotlieb, 1995; Malecki, 1985; Sivitanidou and Sivitanides, 1995; Herzog, Schlottmann, and Johnson, 1986). Third, overlapping determinant such as city size, population, and tax rates influences both business and residential amenities(Goss and Vozikis, 1994; Suarez-Villa, 1997; Sivitanidou, 1999). There is no one determinant that leads to the growth of high-tech centers, but various determinants are interwoven to contribute to the growth of high-tech centers.

Beyond these categories, regional scientists study the high-tech growth in the context of regional policy measures(e.g. tax); role of regional political leadership; efforts of local community; and unionization(Koepp, 2002; Doeringer, Terkla, and Topakian, 1987; Flynn, 1988; Cromie, and et al., 1993).

Recently, researchers are paying a special attention to educated workforce as a major location determinant for high-tech centers. Although many researchers have already acknowledged educated work force as an important location determinant for high-tech centers, some reexamine the significance of educated and professional workforce in the formation and growth of high-tech centers(Florida, 2002; Kotkin, 2000; Kotkin and Siegel, 2000). For example, Carnegie Mellon University's regional economist Richard Florida defines educated workforce in the name of "Creative Class" that includes not only scientists and engineers but also managerial, legal, and healthcare occupations (Florida, 2002). The creative class substantially includes not just educated but also wealthy workforce and its contribution to America's high-tech centers.

With a comprehensive perspective for the high-tech development, Harvard Business School professor Michael Porter establishes the concept of cluster as a key determinant for innovation and technology development(Porter, 1998; 2000; 2002). He defines clusters as "Geographic concentrations of inter-connected companies, specialized suppliers, service providers, firms in related industries, and associated institutions(for example, universities, standard agencies, trade associations, and community organizations) in particular fields that compete but also co-operate(Porter, 1998).

5. Reasons for High-Tech Centers' Regional Variations

There are also several reasons for the variations of high-tech centers. That is to say, high-tech centers are not all created equally. History (or time) plays a pivotal role in creating variations of high-tech centers(Cortright and Mayer, 2000; Cortright, 2002). According to Cortright and Mayer(2000), history(or time) refines technological specialization, and enables successive generation of firms(Cortright and Mayer, 2000). A role of history is not limited to technological refinement, and successive generation of firms. Its substantial role is in the commercialization of research breakthrough, government policy and supports to specific regions, and industrial relocation. As industries and technologies change, firms and knowledge also transform in metropolitan areas. Cortright and Mayer say that "(high-tech) development processes seem to be cumulative and path dependent: a region's opportunities for development today are determined, partially, by the developmental patterns of the past" (Cortright and Mayer, 2000). Throughout these periods and processes, many location determinants make variations among high-tech centers. In the following, the research takes a deeper look at some reasons for the variations among high-tech centers.

First, federal government spending and military contracts contributed to the distinction among high-tech centers by being concentrated on the east and west coasts(the defense parameter) that cumulatively strengthens previous investments and the location decisions of military-industrial enterprises (Lovering, 1985; 1988). Subcontracting of components for complex systems has a tendency to prefer the same regions and fortify the concentration of multiplier effects(Malecki, 1984). Pre-existing government-built or government-owned facilities played a major role in attracting government spending, which leads to the military-industries' location. And biased spending tendency seems to have been affected by strategic consideration of the federal government(Markusen and Bloch, 1985: 114).

Second, physical conditions and infrastructure are other reasons that have generated the differences among high-tech centers. For example, high land availability in Los Angeles was a pivotal determinant in locating and concentrating aircraft/parts industries, which later provided a basis for the growth of high-tech centers in the area. Some aircraft firms relocated from the East Coast to Los Angeles to find an extensive space for construction, on-site experimentation and testing(Markusen and Bloch, 1985). Planned high-tech centers are strong in physical infrastructure, but they are usually weak in social and financial connections. Boston metro's Route 128's high-tech firms enjoy a well-developed investment network from the established local financiers, and investors. It is because banking and financial services are the national forte of this region. Meanwhile, high-tech firms in the Raleigh-Durham-Chapel Hill's Research Triangle Park lack venture capital to create spin-offs, even if it is a successful planned high-tech center in the United States.

Third, different industrial structure provides an explanation for the differences among high-tech centers. The traditional belief of the high-tech centers is that small firms' leadership produces strong spin-offs, networking, and regional prosperity(Saxenian, 1981; 1985; 1994; Birch and MacCracken, 1984; Brunco, 1986; Best, 1990; Phillips, 1991). However, some scholars suggest the opposite. In an empirical study, Davelaar and Nijkamp(1989) show that the linkages between large firms in metropolitan center and surrounding service clusters are stimulating spin-offs and innovation(Davelaar and Nijkamp, 1989). Researchers also argue that big firms' leadership, market share, and job generation are significant in Silicon Valley; and capability, rather than proximity, is the key determinant for linking firms to those big firms(Gray, Golob, Markusen, and Park, 1998; Park, 1999; Harrison, 1994). Nevertheless, small firms' role in the beginning stages of Silicon Valley and Route 128 cannot be ignored(Rosegrant and Lampe, 1992). The recently emerging high-tech center in Seattle has a different story. According to Gray and colleagues(1996), one or several core firms play a pivotal role in high-tech formation and location in the Seattle region(Gray, Golob, and Markusen, 1996). They are usually big firms, and they magnetize other firms into the region with few spin-offs. In the Silicon Valley, small and medium sized firms initiated the high-tech growth with support of military contracts. In Seattle, big firms started and attracted other firms into the region with the experience of previous success. Big firms' role was, especially important in Seattle under the condition of the lack of venture capital, remarkable research universities, and agglomeration economies. Seattle is trying to replicate the established high-tech centers with a different tool, which previous examples did not utilized. The continual success of the Seattle high-tech region may depend on obtaining stable investment sources such as government contract, venture capital, and foreign direct investment.

Fourth, it is an important topic to search the role of human capital factor and cultural distinction among high-tech regions. In comparing San Jose metro(Silicon Valley) and Boston metro(Route 128), Saxenian(1994) introduces "cultural duality" as a factor that influences different regional advantages (Saxenian, 1994). Her idea is that the eastern technological culture derived from the hierarchical and authoritarian ethics of Puritanism was profoundly conservative, centered identity and social relations on family, focused on risk avoidance, secrecy, and integrity. Meanwhile, western culture is based on pioneers who emphasize experimentation, entrepreneurship, and elaborate lateral connections among professionals, a rough democracy of in-migrants. Saxenian (1994) and Korea Industry and Information Technology Institute(KINITI) (1995) suggest that non-market networks and networked social relationships among engineers and entrepreneurs are more active in San Jose metro(Silicon Valley) than are in Boston metro(Route 128)(KINITI, 1995; Saxenian, 1994). Both point out that the cultural and competitive factors contribute to the different growth rate between the two high-tech centers. The cultural factor produces the different industrial structures among the two regions: Route 128 shows big business leadership, vertically integrated, and less sensitive to market demands; but Silicon Valley is functionally decentralized, more sensitive to market demands/technological change with networked cooperation(KINITI, 1995: 25). However, critics argue that the cultural factor is a notoriously slippery and vague concept, and network approach has few mechanical models (Stoper, 1995; Scranton, 1995). Cultural and network approaches leave room for more studies with the role of community and business leaders as a guide for new firms located in the high-tech centers. Certain community and business leaders are informed about current practices and are willing to help newcomers in the commercialization and improvement of crafts, skills, and industries in the local economy(Cromie, and et al., 1993).

6. Conclusion

Each region has its own characteristics. There is no guarantee that successful development in one region will gain the same result in another region. One region's medicine can be another region's poison. Regional or local communities who desire to build a high-tech center in their area need to pay attention to this proverb. From the historical and geographical perspective, there is no standard rule that guide a region into a successful high-tech center in a short period of time. However, we have a previous experience that how an anonymous region transforms into a high-tech center that helps other regions conceive and build another high-tech center. From the successful stories of the San Jose and Boston metros, we learn that it requires a huge amount of research funding, science and technology infrastructure, knowledge workers, and educated human capital so as to launch a victorious high-tech center. When a high-tech center is established, its diffusion effects can take place in both remote areas as well as adjacent areas. Industrial diffusion from initial high-tech centers plays a pivotal role in conceiving new high-tech centers. We also realize that existent businesses, homegrown firms, inherent industries, and even inborn entrepreneurs are critical elements for attracting high-tech firms and grow as a successful high-tech center.

From the research results, I make four suggestions for the local governments, planners, and developers who desire regional prosperity by the high-tech industry and its economic contributions to the regions. First, local universities, businesses, and governments should build up extensive and long-term R&D investment. R&D investment has a positive correlation with technological innovation, especially when there is a long-term commitment of R&D investment to knowledge-based industries that need workers who have college degrees or higher. Second, so as to build a high-tech center, it is very important for local regions to construct education infrastructure such as research universities and research institutions. Strong education infrastructure nurtures inborn and homegrown entrepreneurs, or it can buy educated workers, which contain a higher percentage of entrepreneurs, from other regions. Third, it is also a good strategy to conceive a high-tech center to foster innate business sectors and locally located enterprises more competitive, particularly by identifying their connections to new technology and innovation. To accomplish the strategy, local communities may need a new local consortium or organization that includes local scholars, businessmen, government officials, and local media members. These members study the regional industries, discover a desirable future direction, and reflect it to local and regional economic policy. Fourth, with these efforts, if they look around to receive spillover effects of the growing high-tech centers and increasing high-tech sectors, economic prosperity of their region will be expedited.

초록

미국 첨단산업지역의 역사적인 공간적 구조에 관한 연구:
1950년대부터 1980년대까지의 형성, 확산, 성장 및 분화과정 연구

기정훈

2차 세계대전 이후로 미국의 첨단산업은 대도시를 중심으로 공간적 집적이 이루어진다. 컴퓨터, 반도체, 전자 소프트웨어 산업 등의 컴퓨터 관련 산업이 이러한 첨단산업 지역형성에 핵심적인 역할을 하게 된다. 공간적 측면에서 보았을 때, 초기의 첨단산업지역은 두 가지 방법에 의해서 확장해나간 것을 볼 수 있다. 그 하나는 재입지를 통한 공간적 확산이며 다른 하나는 주변지역으로의 확장이라고 할 수 있다.

재입지를 통한 공간적 확산을 통해 초기의 첨단산업 집적지역인 보스턴과 Route128지역, 실리콘밸리 지역의 첨단산업체들은 그들의 연구개발이나 제조업 기능의 일부를 다른 지역으로 이전시켰고 이러한 과정에서 애리조나의 피닉스, 텍사스의 댈러스, 콜로라도의 콜로라도 스프링스와 같은 지역에 첨단산업 집적이 시작된다.

반면에 주변지역으로의 확장 또는 접촉적 확장을 통해서는 초기의 첨단산업 집적지역이 같은 주의 주변지역으로 확장되어 가는데 이러한 과정에서는 캘리포니아 주의 오클랜드, 산타크루즈, 벤츠라, 오렌지카운티, 뉴욕 주의 더체스 카운티나 빙햄턴 카운티에 첨단산업이 집적하게 된다.

그 지역의 전통적인 산업들이나 지역 출신의 기업가들은 이러한 첨단산업의 공간적 확산과정에서 주도적이고 핵심적인 역할을 했다. 대도시지역에 입지한 첨단산업 지역의 성장에는 대학교와의 연계, 벤처자본투자, 고급노동력, 기업가정신과 혁신적인 사업환경, 그리고 활발한 해외투자 등이 중요한 역할을 했다는 연구들이 많이 있다. 그러나 첨단산업지역은 지역적인 차별성(또는 분화)을 나타내기도 하는데, 여기에는 초기투

자의 규모, 지역의 인프라, 산업구조, 인적자본규모, 그리고 기업문화 등이 중요하다.

주요어: 첨단산업지역, 대도시권, 공간적 확산, 지역적 차별성(분화)

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