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THE TENANT BASE FOR R&D SPACE: RESPONSES IN A CHANGING MARKET

BY

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THE TENANT BASE FOR R&D SPACE: RESPONSES IN A CHANGING MARKET

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ABSTRACT

This paper examines changes in the demand for industrial space in Santa Clara Valley by analyzing the tenant base of buildings built for "research and development" (R&D) tenants. Drawing from building inventories and leasing records kept by brokerage firms and from industrial directories, data sets identifying firm type and employee or lease size are developed. The data sets are used to explore the source of demand for R&D space and to determine how demand varies with location, type of space, and changing market conditions over time.

The study finds that high-technology manufacturing firms have been the dominant tenants of R&D space in Santa Clara Valley, but that the degree of dominance has declined dramatically in the past two years. A recession affecting computer equipment and electronic components and accessories firms has significantly changed the market base for R&D space in the Valley. Leasing has shifted first from manufacturing to nonmanufacturing high-tech activities and more recently away from high-tech related firms entirely.

Changing market conditions in high-tech sectors have also led to decreasing lease sizes and drops in rental rates in the past 24 months. Geographic variations in the market within Santa Clara Valley have been emphasized by some of these changes, with areas built to accommodate manufacturing activity showing the highest vacancy levels.

The research demonstrates the complexity of the market for R&D space. Aggregate analyses of manufacturing growth trends in the region cannot fully explain the changes that occur in the demand for space over time. An understanding of the industrial sectors and types of activities dominating the tenant base and of growth trends and location tendencies within these sectors is crucial to assessing future directions of industrial space absorption.

THE TENANT BASE FOR R&D SPACE: RESPONSES IN A CHANGING MARKET

Introduction

Speculative construction of nonresidential buildings boomed rapidly in the first half of the 1980s, in many cases creating heavily overbuilt markets. One of the most dramatic examples of a supply/demand gap can be seen in the Santa Clara Valley, in the southern part of the San Francisco Bay Area. In "Silicon Valley," despite the area's reputation as a rapidly growing core of activity in high-technology industrial sectors, speculative industrial space has experienced extremely high vacancy rates, reflecting the inability of demand to match the growing supply of space.

Such speculative periods are not unusual in the building industry. A substantial amount of research has already been devoted to the existence of long cycles in building activity, that lead to extended periods of oversupply.[1] These regular occurrences are explained at least in part by the durability of structures--it is simply not as easy to adjust building availability to unexpected fluctuations in demand as it may be to adjust less bulky and durable products.[2] Whatever the explanation, building owners at the end of a speculative boom are often left with the dilemma of trying to understand how they overshot the market; when, by whom, and at what price they may now be able to rent space; and when and under what conditions the market can be expected to turn around again.

An understanding of the tenant base of leased space is crucial in trying to provide this information. It is useful to

know what was the employment base upon which expectations of growth were built, when and why did that base begin growing more slowly than supply, and how is the base likely to respond in a period when the supply of space is plentiful.

This paper provides a detailed analysis of the tenant base of R&D industrial space in Silicon Valley during the 1980s. The tenant base is analyzed for a period from approximately 1980 through spring of 1986. The composition of R&D space is examined to determine its degree of dependence on high-tech manufacturing sectors. Changes in the composition of tenants are identified, to determine how changes in the industrial composition are reflected in the demand for space. For example, to what extent has the industrial mix of tenants changed over time? How has the amount of space rented changed?

What emerges from the research is a picture of a real estate market highly dependent on a few specific high-tech manufacturing sectors. During peak periods of employment growth, high-tech manufacturing tenants leased large amounts of space, and accounted for the vast majority of square footage under lease. In more recent periods, as a recession hit the primary employment sectors within high-tech manufacturing, the real estate market has been forced to adapt to a much more diverse market, but at the cost of smaller leases and ultimately lower rents. In a period of great uncertainty for the high-tech industry, the ability of a building owner to adapt space to other types of uses may be critical in determining how rapidly space is absorbed.

I. The Links Between Employment Growth and Building Occupancy

Clearly, employment growth plays a crucial role in the demand for industrial space. However, employment growth does not act alone in determining either the rate at which building occurs in any single year or the longer term cycles that appear over time. Thus, it is useful to discuss in more detail what is meant by building cycles and how employment growth may interact with other factors in determining the supply and demand for space.

A. Cycles in Building Activity--What Are They?

Researchers looking at building activity cycles are generally measuring either the square footage put in place or the level of financial investment over time. Measured in this way, there appear to be regularly occurring peaks and troughs of building activity. The cycles are also characterized by a predictable unevenness within each cycle in the fit between the supply of nonresidential space and apparent demand. At the early stages of a building cycle, the market is often heavily underserved and vacancies are very low. Builders who invest at this time may find that supply is leased up rapidly, often even before it is actually available for occupancy. The "hotness" of the market may then lead to a heavy increase in investment, far beyond immediate needs. This leads to a period of very high vacancies which may begin even before building activity slows.

Several explanations have been offered of the repetition of such cycles and the apparent delays within the market in responding to either very low or very high vacancy levels. Some theorists explain cycles of building activity by pointing to the uneven growth in demand that results from demographic changes

occurring on a generational basis or from lifecycle characteristics of industries using the space.3 Others attribute this uneven growth to the nature of buildings as a commodity, including the durability of land and structures and government regulation of land development; these factors lead building activity to respond in less flexible units than for a typical competitive commodity.[4]

B. Shorter Term Demand and Supply

On a more micro level, at any particular point in time, what factors are expected to influence the amount of new industrial space built and absorbed? Most research on the supply and demand of nonresidential space has addressed the office market.5 Similar factors are likely to affect the market for industrial space. A builder can be expected to add new space to a market based on perceptions of employment growth levels, current vacancy rates and current rental levels; more space will be built when builders perceive rent at a level where profits can be made and when absorption of new space can be expected to occur within a reasonable period (most real estate cost estimates until recently have assumed 95 percent occupancy within a year of completion of the building). Thus, a market where rents are rising and space is absorbed rapidly will appear to be highly attractive to builders and real estate investors.

The rate at which space is absorbed depends on similar factors. A firm will rent more space a) if it expects to grow rapidly, b) if prices are relatively low, and c) if space is readily available (measured by the amount of space vacant).

Expectations about expansion of the firm's industry may play an important role in the firm's growth prospects and thus in the amount of space leased. Square feet leased per employee, however, will be related to cost and availability of space. A firm's location choice within a geographic market area and the amount the firm is willing to pay for space depends as well on the perceived qualities of the particular building and its proximity to other firms and services.

C. Cycles in the Silicon Valley Market

Recent building activity in Silicon Valley to some degree reflects these macro and micro tendencies, although it is difficult to fully document trends with existing data. Little data is available on the preboom period of industrial building activity in Silicon Valley. By 1982, the first year for which detailed construction and vacancy data is available, industrial space in the Valley was already in the midst of a building boom. The total inventory of industrial space in the Valley increased by 15 percent during 1982 (adding 7.5 million square feet to a 50.8 million square foot base), and vacancy levels were already close to 20 percent by December of that year. Despite growing vacancies, the building boom accelerated through 1984, and vacancies climbed to over 30 percent. Construction levels began dropping off slightly in 1985 (to a level similar to 1982) but still exceeded net absorption in that year. Over the same 4-year period, when additions to supply were shooting up and then gradually slowing, the amount of net square footage absorbed each year (new leases written minus space emptied out) remained quite steady, at an average of 4.7 million square feet of industrial

space, 4 million of which was in R&D space.

For the Silicon Valley case, neither the durability of buildings nor industry cycles appear to fully explain the high-growth-despite-high-vacancies phenomenon that characterized the R&D market during this time period. First, while R&D buildings are indeed durable, they are relatively fast to construct (unlike high rise office buildings); thus, a change in building permit valuation (reflecting intentions to build) shows up very quickly in a change in the actual amount of space added to an area. Second, as discussed below, employment continued to increase even as vacancies rose; the dip in the rate of job growth occurred too late to explain the degree to which the industry overbuilt the area.

Three additional factors may be involved in explaining the relatively long-lived building boom. The use of gross absorption (all new leases written) to measure market potential rather than net absorption--the difference between gross absorption and vacations of leased space--gave builders and lenders a high overestimate of market demand in the area. Available data indicates that of square footage absorbed through new leases written between 1982 and the end of 1985, more than half involved the transfer from other Silicon Valley space, rather than expansion from existing activity levels. Thus, despite heavy leasing activity, net absorption occurred at a rate far below construction activity. A second factor was the tendency to mask rent concessions by maintaining high nominal rents but encouraging new leases through such factors as generous tenant

improvements and free rents. This practice kept nominal rents growing even as rising vacancy rates and decreasing lease sizes indicated the market was not in balance. A further factor is the composition of employment growth. While high-tech jobs continued to expand through 1984, it is not clear that the high-tech jobs related to the tenant base behaved in the same way. Thus, growing vacancies indeed may in part reflect a weakening of the portion of the employment base upon which the market depended.

The gross absorption history is documented in much more detail in an earlier working paper6 while the question of nominal versus effective rents will be addressed in later work. This working paper explores in more detail the tenant base and its changes over time, to examine the degree to which detailed changes in tenant composition help to explain resulting overbuilding in a way that an aggregate review of overbuilding does not.

II. Employment Growth and the Silicon Valley R&D Space Problem

As demonstrated in earlier research, it is not the cyclical aspects of high-tech employment that appear linked to the real estate cycle so much as the tremendous rate at which new space was added to Silicon Valley.7 From early 1982 through the end of 1985, speculative industrial square footage (i.e. leased square footage) grew from 51 million to 94 million square feet in Santa Clara Valley (see Table 1). Three fourths of industrial square footage constructed during this period was in R&D buildings, which accounted for 64 million square feet of space by December 1985. Thus, industrial space overall increased by over 80

TABLE 1: COMPARATIVE GROWTH TRENDS IN SANTA CLARA COUNTY, 1981 - 1985

EMPLOYMENT IN SANTA CLARA COUNTY (Thousands)

	1981	1985	PERCENT CHANGE Total	Annual
Total	695.6	793.5	14.1%	3.3%
Manufacturing	254.7	291.0	14.3%	3.4%
High Tech Mfg.	181.4	226.0	24.6%	5.6%

SPECULATIVE INDUSTRIAL SQUARE FOOTAGE (millions)

TOTAL	December 1981	December 1985	PERCENT CHANGE Total	Annual
Industrial (All)	50.8	93.6	84.3%	16.5%
R&D	31.0	64.3	107.4%	20.0%

OCCUPIED	December 1982*	December 1985	PERCENT CHANGE Total	Annual
Industrial (All)	47.7	61.8	29.6%	9.0%
R&D	29.6	41.5	40.2%	11.9%

* Note change in year; data on occupied space not available for 1981.

Source: CREUE calculations from Grubb and Ellis and California Employment Development Department data.

percent (16.5 percent per year), while R&D space increased by more than 100 percent (20 percent per year) between December 1981 and December 1985.

For much of the first half of the 1980s, employment growth in high-tech industries was still quite strong, relative to growth in the rest of the state and nation. Nevertheless, the rate of growth was lower than in the previous decade, which in turn had been growing at far below the rate of increase in industrial space described above. Even before a 1985 recession, employment in high-tech manufacturing jobs grew at about 6.1 percent annually in Santa Clara Valley between 1981 and 1984, compared to 9.1 percent annually in the county in the latter half of the 1970s and to a 3.4 percent annual rate of growth for the industry nationwide in the 1980s. Manufacturing activity overall in Santa Clara County grew by 4.1 percent annually between 1981 and 1984. This period of moderate growth ended in 1985, with a very sharp slowdown in high-tech expansion and a net loss of manufacturing jobs to Santa Clara County. Between 1984 and 1985, average annual jobs in high-tech manufacturing increased by only 1 percent (there was a <u>job loss</u> in high-tech manufacturing by December of that year, compared to the previous December), while manufacturing jobs overall declined by 0.9 percent.

Occupied square footage grew more rapidly than might have been expected based on employment growth in the 1980s, but at a rate far less than building activity. Between December 1982 and December 1985, the longest period for which occupancy data is available, occupied industrial square footage grew by about 9 percent per year, while occupied R&D square footage grew by an

annual rate of 12 percent. Thus occupied square footage increased at about twice the rate of jobs, and there was some lag in the drop off of demand for space when job growth slowed.

There are several possible explanations of these differentials in rates of growth. First, in some markets, space fills up rapidly when a construction boom first begins as a result of pent up demand. This seems relatively unlikely for the Silicon Valley case, as there was already a substantial amount of space available in December 1982 (close to 11 million square feet of industrial space). A second explanation is that the demand for space is tied only to specific aspects of high-tech manufacturing growth, and thus would reflect different growth trends than those perceived in aggregate. For example, the newest, most rapidly growing manufacturing sectors might make heavier use of rental space than the more mature, established manufacturing firms. Alternatively, the more mature sectors could have been increasing the share of leased space in their total inventory of space during this period as a strategy for coping with an uncertain market in the future. For example, if mature manufacturing firms feared a slowdown in their rate of growth over time, they might choose to increase their share of leased as compared to owned space, to minimize capital investments in expansion.

A third possible explanation of the relatively fast rate of absorption compared to manufacturing job growth is that the tenant base is diversified and includes firms in more rapidly growing nonmanufacturing sectors. One further explanation of the

discrepancies in growth rates is that the response of building owners to an overbuilt market, through special price and lease condition incentives, encouraged firms to lease more space during this period than they would have chosen to do under conditions where the nominal price represented the true costs of space to the firm.

A detailed analysis of the tenant base can address the second and third explanations in this list. Information sources that can give a detailed picture of who uses R&D space and how the tenant mix has changed over time help to illustrate the degree to which the tenant base of R&D space is dependent on high-technology manufacturing, the rental behavior patterns of high tech manufacturing tenants over time, and differences (in terms of lease size and rental rates) among tenant types.

III. Sources of Information on the R&D Tenant Base

Employment or firm data at the subcounty level is generally unavailable in published forms. While detailed firm data is available on computer tape from a couple of different sources (Dun and Bradstreet and Contacts Influential), the tapes are expensive and the coding does not allow for the separation of information by street address. To avoid these problems, this study draws data from several different published and unpublished sources to build a set of observations on the R&D tenant base.

The analysis relies on two different data sets, each of which was constructed using several resources. One data set is based on a building inventory provided by the San Jose office of Grubb and Ellis, a national commercial brokerage firm. The

building inventory was linked with information on firm type drawn from the hard copy reverse directory published by Contacts Influential for the South Bay, Penninsula, and East Bay. From these two sources, a set of observations was constructed that consists of tenants identified as being in R&D buildings (as defined by Grubb and Ellis) within Silicon Valley. This data set, referred to as the CI data set, includes 313 tenants and covers 228 buildings, 22 percent of the total sample of buildings with tenants.

The second data set is based on lease agreements recorded by Grubb and Ellis between 1979 and summer 1985 (with the bulk of leases dating from 1981 or later) and by Cushman & Wakefield in 1986. Both lists include all deals of which the companies were aware during the period covered (even if their brokers were not directly involved in the deal). The lists provide information on building location, the name of the firm, the square footage leased, the nominal rental rate, and the basic terms of the agreement (e.g. gross or triple net rent, free rent, cost of living bumps, etc.). Local and national industry directories were used to identify the firm's industry category. This data set (referred to in the discussion as GECW) includes over 600 tenants; the GECW portion of the list covers 26 percent of the firm's total building inventory (including both occupied and vacant buildings).

Clearly, neither data set is ideal in providing a random sample of tenants of R&D space. Biases appear both in an uneven geographic concentration of observations and through uneven representation among building size categories. The Contacts

Influential (CI) list covered between one fifth and one third of occupied buildings in most cities in Santa Clara Valley, but a few places were either highly overrepresented or highly underrepresented. For example, more than half of Palo Alto buildings were represented, and only 5 percent of buildings in Fremont were represented. This may in part reflect the problems of "unmeasured" vacancies in the area. A spot check of Fremont buildings identified as occupied or partially occupied from Grubb and Ellis's building availability list revealed that many of the buildings that had not been covered by the CI sample in fact had no occupants. This could have occurred in cases where free rent concessions involved a period of 6 months to as much as 2 years, so that a firm could afford to hold 2 leases at once. Palo Alto, where vacancies overall were much lower, may have had far less of this unidentified vacancy problem than other places.

In addition to uneven coverage by location, the CI data set also covers a relatively high share of small buildings (under 50,000 square feet) and a relatively low share of mid-sized buildings (50,000 to 100,000 square feet). This may bias the tenant base in terms of overall firm mix within Santa Clara Valley but is less likely to be a problem for comparisons of location choices within a single industrial sector or in analyzing firm size variations among industrial sectors.

Research in other locations comparing data from Contacts Influential with data compiled through a random survey has found the CI data base to resemble the random sample data base quite closely. A study of suburban office space tenants, for example,

found the CI data accurate in the information provided on firm type, size, and location, although somewhat less accurate in the details of a particular tenant (probably because of the delay between gathering the data and publishing the directory).8

The GECW sample derived from lease agreements appears to be more comprehensive (covering more buildings), although it, too, does not cover the full range of occupied buildings. Compared to the CI data set, the lease agreement sample is distributed more evenly by location. Only the Sunnyvale-Santa Clara-Cupertino area is significantly underrepresented by its total share in the sample, but there are still more than 100 buildings from those cities represented in the sample. The sample is also somewhat skewed towards midsized buildings and away from smaller buildings.

Because the lease information was gathered for other than research purposes, the sample may be affected by the interests of the brokerage firms. If the brokers were particularly interested in reaching high-tech tenants, or in leases in a specific size range or location, their coverage could be less complete for deals involving smaller tenants, outlying areas, or nonhigh-tech firms, for example.

Nevertheless, the GECW data set provides information on leases over a five year period, historical information that would be impossible to obtain through building surveys, and would be extremely time consuming to obtain through interviews with a broader sample of brokers or building owners. Analysis and interpretation of both data sets take into account the limitations described here.

IV. A Tenant Base Dependent on High Tech Activity

The two different data sources give somewhat different patterns of occupancy, but both show a tenant base highly dependent on high-technology manufacturing. In the CI data base, high-tech manufacturing firms account for 36 percent of all tenants in R&D space, while all high-tech firms (including wholesale and data processing as well as manufacturing) account for two thirds of the tenant base (see Table 2). Thus, one third of all tenants were not directly involved in high-tech production, sales or service activity. However, the nonhigh-tech firms tended to be much smaller in employment size than the high-tech firms. One third of nonhigh-tech basic firms (manufacturing, construction and distribution firms) had five employees or fewer, compared to only 9 percent of high-tech manufacturing firms. Almost half of the nonhigh-tech service firms had five employees or fewer, compared to 10 percent of high-tech service firms. All but three of the 64 firms identified with more than 100 employees are in high-tech employment sectors, with 70 percent of these large firms in high-tech manufacturing activities. This implies that absorption of space has been heavily dominated by high-tech firms, with a strong emphasis on manufacturing activity. A comparison of the size-of-firm profile in R&D space, as identified by the CI data base, with the size-of-firm profile for electronics firms in Santa Clara Valley shows the two, in aggregate, to be quite similar, while the high-tech portion of the data base has substantially larger firms than exist in the electronics

TABLE 2: TENANT INDUSTRIAL CHARACTERISTICS— PERCENT BY CATEGORY AND BY SIZE OF FIRM, CONTACTS INFLUENTIAL DATA

FIRM SIZE	TENANT INDUSTRIAL CATEGORY												ALL SANTA CLARA COUNTY FIRMS (COUNTY BUSINESS PATTERNS DATA)		
	NON-HIGH TECH BASIC		NON-HIGH TECH SERVICE		HIGH TECH MANUFACTURING		HIGH TECH SERVICES		HIGH TECH TRADE		ALL FIRMS				
	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Firm Size	Percent of All Firms	Percent of Electronics Firms
0-5	11	33.3%	35	47.9%	10	8.8%	6	10.2%	10	29.4%	72	23.0%	(0-4)	51.1%	24.1%
6-10	3	9.1%	12	16.4%	3	2.6%	11	18.6%	4	11.8%	33	10.5%	(5-9)	20.1%	10.7%
11-25	8	24.2%	14	19.2%	13	11.4%	10	16.9%	6	17.6%	51	16.3%	(10-19)	13.3%	13.0%
26-50	7	21.2%	4	5.5%	19	16.7%	10	16.9%	5	14.7%	45	14.4%	(20-49)	9.3%	19.7%
51-100	4	12.1%	5	6.8%	24	21.1%	11	18.6%	4	11.8%	48	15.3%	(50-99)	3.4%	12.7%
101-250		0.0%	2	2.7%	25	21.9%	7	11.9%	2	5.9%	36	11.5%	(100-249)	1.8%	9.9%
251-500		0.0%	1	1.4%	10	8.8%	2	3.4%	3	8.8%	16	5.1%	(250-499)	0.6%	3.4%
> 500		0.0%		0.0%	10	8.8%	2	3.4%		0.0%	12	3.8%	(500+)	0.4%	6.4%
TOTAL**	33	100.0%	73	100.0%	114	100.0%	59	100.0%	34	100.0%	313	100.0%		100.0%	100.0%
PERCENT BY CATEGORY	10.5%		23.3%		36.4%		18.8%		10.9%		100.0%				

* Basic firms include firms in manufacturing, construction, transportation and utilities.

** Actual percentages may not add to 100 due to rounding.

Source: Compiled by the authors from data provided by Grubb and Ellis (raw building data file), combined with firm data collected from Contacts Influential directories for Summer 1985 and U.S. Bureau of the Census, County Business Patterns, 1982.

population overall.

The GECW data base shows an even stronger dominance of high-tech manufacturing. Almost two thirds of all leases tracked over the approximately 6-year period were to high-technology manufacturing tenants (see Table 3). Close to one fifth of the remaining firms were involved in high-tech related sales or services. Only 17 percent of firms were engaged in activities not directly related with high-tech sectors. Differentiation among firm types by size of lease was also apparent. Almost one fifth of nonhigh-tech basic firms were in leases of 10,000 square feet or smaller, compared to less than 5 percent of high-tech manufacturing firms. More than one fourth of nonhigh-tech service firms were in spaces 10,000 square feet or smaller, compared to only 8 percent of high-tech service firms and 20 percent of high-tech related trade firms.

Each data source may be somewhat skewed, compared to the full firm population. The CI data base's heavy concentration of firms with smaller leases and in smaller market areas, such as Palo Alto and Campbell, may overemphasize the importance of smaller, nonmanufacturing and nonhigh-tech firms. On the other hand, the methodology for identifying firm type for the GECW data base exaggerates the importance of high-tech manufacturing. This occurs because some compromises were necessary in identifying the tenant's industry type in the GECW data base. For this data base, firm type was identified by industry directory. Industry category information for the firm came from a listing that closely matched the building address in the sample in only 26

TABLE 3: TENANT INDUSTRIAL CATEGORY BY SIZE OF LEASE, GECW DATA BASE

LEASE SIZE (Square Feet)	TENANT INDUSTRIAL CATEGORY											
	NON-HIGH TECH BASIC*		NON-HIGH TECH SERVICE		HIGH TECH MANUFACTURING		HIGH TECH SERVICES		HIGH TECH TRADE		ALL FIRMS	
	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size	Total	Percent by Size
< 10,000	9	18.4%	6	27.3%	12	4.5%	3	8.1%	8	20.0%	38	9.2%
10-24,999	17	34.7%	10	45.5%	92	34.7%	16	43.2%	12	30.0%	147	35.6%
25-49,999	14	28.6%	2	9.1%	67	25.3%	11	29.7%	13	32.5%	107	25.9%
50-74,999	3	6.1%	2	9.1%	58	21.9%	4	10.8%	3	7.5%	70	16.9%
75-99,999	3	6.1%	0	0.0%	19	7.2%	2	5.4%	4	10.0%	28	6.8%
100-199,999	3	6.1%	2	9.1%	16	6.0%	1	2.7%	0	0.0%	22	5.3%
200,000+	0	0.0%	0	0.0%	1	0.4%	0	0.0%	0	0.0%	1	0.2%
TOTAL**	49	100.0%	22	100.0%	265	100.0%	37	100.0%	40	100.0%	413	100.0%
PERCENT BY CATEGORY	11.9%		5.3%		64.2%		9.0%		9.7%		100.0%	

* Basic firms include firms in manufacturing, construction, transportation and utilities.

** Actual percentages may not add to 100 due to rounding.

Source: Compiled by the authors from lease information provided by Grubb and Ellis and Cushman and Wakefield, combined with firm data collected from various industry directories.

percent of the cases. For other cases, the general firm SIC category would be applied to the particular case, if no further information were available on the actual activity at that location. Thus a building rented by Apple Computer for software operations or for warehousing may be listed in the sample as a computer manufacturing establishment, while a similar observation in the CI data base might list the firm by its actual (nonmanufacturing) activity on the site.

The two different data bases, then, can be seen as providing upper and lower boundaries of the degree of dependence on high-tech manufacturing and nonmanufacturing tenants. In either case, this appears to be quite high. The lack of diversification of the R&D market is further emphasized by the distribution of tenants within high-tech employment categories. Table 4 compares the high-tech portion of the tenant base, as measured in the CI and GECW data bases, with the actual distribution of high-tech employment among sectors within Santa Clara County. Clearly, only a limited subsegment of the high-tech industry is involved in the leasing of industrial space. Within manufacturing, computer and electronics firms dominate the leasing market, with instruments manufacturers playing a significant role as well. Aerospace, in contrast, involves a few large firms in owner-occupied space, and thus does not directly affect the tenant base of R&D space. Within high-tech service activities, data processing firms account for more than their share of square footage and tenant mix, but still account for a relatively small share of all space absorbed.

Information from the GECW sample on variations in lease size

TABLE 4: COMPARISON OF JOB DISTRIBUTION AND TENANT OCCUPANCY, SANTA CLARA VALLEY LEASES

HIGH-TECH EMPLOYMENT CATEGORY	HIGH-TECH EMPLOYMENT 1985	PERCENT OF ALL HIGH-TECH JOBS	PERCENT OF HIGH-TECH TENANTS (CI DATA)	PERCENT OF SQUARE FEET OCCUPIED BY HIGH-TECH TENANTS (GECW DATA)
MANUFACTURING				
Computers	55.3	18.4%	18.3%	35.7%
Communications	27.6	9.2%		
Electronics	85.7	28.5%	24.2%	36.5%
Aerospace	25.4	8.5%		
Instruments	32	10.6%	12.5%	10.2%
NONMANUFACTURING				
Data Processing	14	4.7%	26.0%	8.5%
Misc. Services	30.4	10.1%	2.4%	0.2%
Wholesale (Dur.)	30.1	10.0%	16.4%	8.9%
TOTAL*	300.5	100.0%	100.0%	100.0%

* Actual percentages may not add to 100 due to rounding.

Source: California Employment Development Department, Employment Data and Research, March 1985 Benchmark Figures, and authors' analysis using Grubb and Ellis, Contacts Influential, and Cushman and Wakefield data.

and rental rates give further evidence of the lack of diversification, overall, in the tenant base. In other locations, R&D space is often a masquerade for low end office space. As such, it may appeal to back office users, who prefer to pay at the low end of rental rates for office space, but become the high end lessors for R&D space. If this were occurring in Silicon Valley R&D space, we would expect to find that some of the largest tenants, paying relatively high rents, were in "back office" industry categories such as insurance, finance, or public utilities. However, lease data show that the nonhightech, nonmanufacturing users were both the smallest users of space and paid among the lowest rents (see Table 5). They are unlikely to be back office users based on this information, and in fact further break downs of these categories show a high concentration of tenants in retail and real estate related activities, rather than in the common back-office industrial categories.

In contrast, high-tech manufacturing tenants are the largest users of space in the sample. High-tech service users pay the highest rents, by far. There is a large gap in rent level between these users and the next highest rent-paying category, high-tech manufacturing tenants. This rent gradient offers further evidence of the dependence of the market on high-tech activity.9

V. The Geographic Distribution of High Tech Tenants

As the high-tech industry has evolved in Santa Clara County, geographic variations have emerged, with differing location

TABLE 5: AVERAGE LEASE SIZE AND AVERAGE RENT OF GECW TENANTS

TENANT CATEGORY	AVERAGE LEASE SIZE		AVERAGE RENT	
	Square Feet	Number of Firms	$/ Sq.Ft.	Number of Firms
NON-HIGH TECH				
Basic*	34332	48	$0.84	33
Trade and Service	28275	22	$0.86	13
HIGH TECH				
Manufacturing	43349	264	$0.89	234
Service	32424	37	$0.97	31
Trade	31030	40	$0.89	34
ALL TENANTS	39306	411	$0.89	345
ANALYSIS OF VARIANCE				
F-Statistic	3.2432		1.2741	
Significance	0.0123		0.2798	

* Basic firms include firms in manufacturing, construction, transportation and utilities.

Source: Author's analysis, using GECW data base.

advantages offered by different places within Silicon Valley. These in turn can be expected to influence where firms making new location decisions choose to move, and thus should affect the geographic variations of tenant types within leased industrial space.

Sites for high-tech activity can be roughly classified into 6 different types of locations, each representing a different development period in the high-tech industry. These location types correspond approximately to geographically contiguous zones within the Valley (see Figure 1).

The area around Stanford University (Zone 1) has evolved from a place where high-tech manufacturing first emerged out of critical local innovations in electronics to a location with a heavy concentration of research, consultant, and other service activities of a technical nature. The Santa Clara-Sunnyvale-Cupertino area (Zone 2) was the first heavy concentration of high technology manufacturing firms. The area continues to be an important manufacturing center, but also plays a major role as a high-tech headquarters location, with associated R&D, software and data processing services. Some secondary, linked activities have emerged in cities that have less direct connections with high-tech manufacturing--Los Gatos and Campbell (Zone 3) have concentrations of small trade and service establishments that serve the surrounding economy.

As manufacturing activity expanded in the late 1970s and early 1980s, it spread far beyond the initial development sites in Silicon Valley. San Jose, Milpitas and Fremont became sites

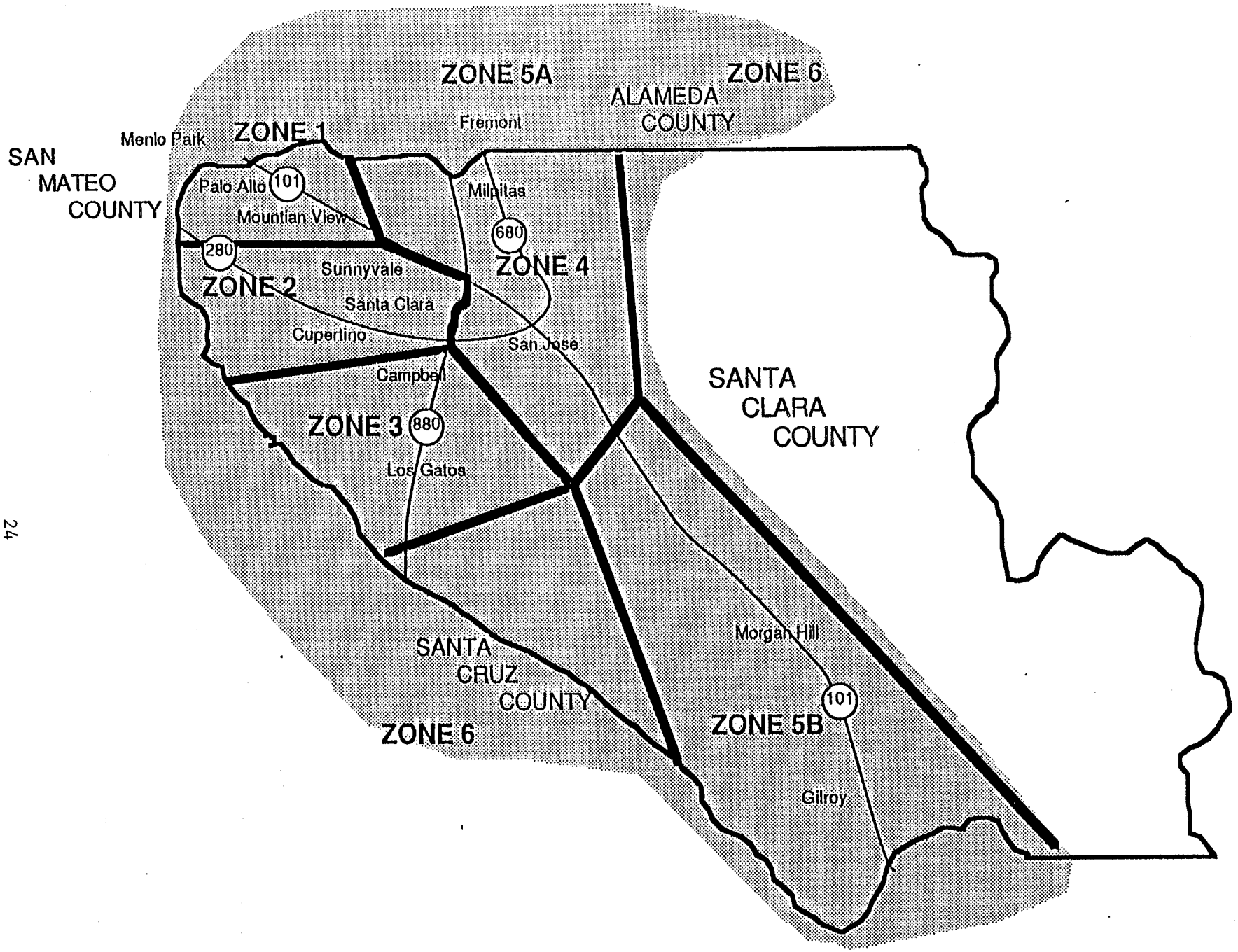

FIGURE 1: ZONES OF HIGH TECH ACTIVITY IN SANTA CLARA VALLEY

for branch plants and even some headquarters locations. Expansions appeared to occur in waves outward from the core of R&D and manufacturing activity, going first to San Jose and Milpitas (Zone 4), and then to more peripheral areas such as Fremont, Gilroy and Morgan Hill (Zones 5A and 5B). While these areas were designed particularly to accommodate expanding manufacturing activities, other sites well beyond Santa Clara County, such as Santa Cruz County cities, have fostered the development of smaller specialized research or production (Zone 6).10

Building activity has reflected some general expectations about the nature of tenants in different locations. The smallest and most expensive buildings (in terms of asking rents) are found where nonmanufacturing tenants can be expected to dominate the market, as in Zones 1 and 3 (see Table 6). Larger buildings are found in places oriented more towards manufacturing, as in Zones 2, 4 and 5. In addition, a gradient in asking rents can be observed among the manufacturing-dominated zones, with the highest asking rents found at the core of high-tech manufacturing activity (Zone 2) and the lowest rents at the areas furthest to the outskirts of the Valley.

If builders' expectations are accurate, the geographic distribution of tenants in leased industrial space should tend to vary by industry type and the type of activity performed at the site. The true R&D based firms would seek the agglomeration advantages found in Zone 2 and to some extent in Zone 1, which has strong support services and Zone 4, with a share of headquarters activity. Business service firms not directly

TABLE 6: AVERAGE LEASE SIZE AND AVERAGE RENT, R&D SPECULATIVE SPACE, SANTA CLARA VALLEY CITIES AND ZONES

LOCATION	TOTAL AVERAGE SQUARE FEET	AVERAGE ASKING RENT PER SQUARE FOOT	AVERAGE ASKING RENT PER BUILDING
Zone 1	34827	$1.17	$1.16
Mountain View	35365	$1.07	$1.02
Menlo Park	36527	$1.23	$1.19
Palo Alto	23920	$1.45	$1.49
Zone 2	45231	$1.11	$1.09
Cupertino	43057	$1.39	$1.43
Sunnyvale	52841	$1.06	$1.07
Santa Clara	37811	$1.12	$1.05
Zone 3	33683	$1.19	$1.12
Campbell	37465	$1.29	$1.26
Los Gatos	26623	$0.86	$0.93
Zone 4	52388	$1.02	$0.99
San Jose	47825	$1.06	$1.02
South San Jose	54307	$0.82	$0.88
Milpitas	51403	$0.92	$0.92
Zone 5	45918	$0.82	$0.81
Fremont	45918	$0.82	$0.81
Zone 6	57052	$0.72	$0.71
Morgan Hill	92051	$0.70	$0.69
Gilroy	44732	$0.72	$0.72
Santa Clara Valley	47159	$1.00	$0.98

Source: Computed by authors from raw building data provided by Grubb & Ellis; data are for summer 1985.

related to high-tech activity may prefer the prestige of an address in Zone 1 cities (Palo Alto, Menlo Park and Sunnyvale). Routine manufacturing activity can be expected to seek less costly space, in areas accessible to a good labor force mix (Zones 4 and 5), while smaller secondary manufacturing, trade and service firms will try to fit into nearby, but less prestigious niches (as are found in Zone 3).

The CI and GECW data sets give somewhat contradictory information about tenant characteristics by location within Silicon Valley. Much of the difference can be explained by the data set limitations described earlier.

1) The CI Data Set and Location of Firms--

The CI data set, summarized in Table 7, indicates that there are distinct variations in the types of firms found by location, and that these variations closely follow the expectations as indicated by building activity. Zones 1 and 3, centered in Palo Alto and Campbell/Los Gatos, had relatively high shares of nonmanufacturing firms in their CI tenant base--37.5 percent of Zone 1 firms and 46.1 percent of Zone 3 firms were in nonhigh-tech sectors, as compared to one third in the overall CI sample. Zones 1 and 3 had relatively low shares of high-tech manufacturing activity, and Zone 1 showed a relatively high proportion of high-tech nonmanufacturing tenants (34.4 percent, compared to 29.7 percent overall). The share of high-tech manufacturing tenants in Zone 2, the oldest manufacturing core, was close to the average for the entire sample (37.1 percent), while this zone had a relatively high share of high-tech

TABLE 7: TENANT INDUSTRIAL CATEGORY BY ZONE, CONTACTS INFLUENTIAL DATA

ZONE	TENANT INDUSTRIAL CATEGORY: NON-HIGH TECH Total	NON-HIGH TECH Percent of Zone	HIGH-TECH MANUFACTURING Total	HIGH-TECH MANUFACTURING Percent of Zone	HIGH-TECH SERVICES/TRADE Total	HIGH-TECH SERVICES/TRADE Percent of Zone	TOTAL ALL TENANTS
I CORE SERVICE CENTER	24	37.5%	18	28.1%	22	34.4%	64
II CORE MANUFACTURING CENTER	41	28.7%	53	37.1%	49	34.3%	143
III MIXED SUPPORT AREA	35	46.1%	24	31.6%	17	22.4%	76
IV NEW MANUFACTURING CENTER	4	16.7%	16	66.7%	4	16.7%	24
V FUTURE MANUFACTURING AREA	2	33.3%	3	50.0%	1	16.7%	6
TOTAL REGION	106	33.9%	114	36.4%	93	29.7%	313

Source: Compiled by the authors from data provided by Grubb and Ellis (raw building data file), combined with firm data collected from Contacts Influential directories for Summer 1985.

nonmanufacturing tenants and a relatively low share of nonhigh-tech tenants. Buildings in Zones 4 and 5, the newer manufacturing areas, were much more heavily concentrated in high-tech manufacturing activity than the areas closer to Stanford. Half of the small sample of tenants in Zone 5 buildings and two thirds of the Zone 4 tenants were in high-tech manufacturing sectors.

2) Different Locational Patterns in the GECW Data Set--
In contrast to the CI data set, the GECW data set showed little variation in tenant type by location. Table 8 indicates that high-tech manufacturing activity dominated in all five zones. Most variations observed were not large enough to be statistically significant. This discrepancy is likely to be due to the same data problems mentioned earlier, particularly the way in which tenant type was identified.

3) Lease Agreement Variations by Location--

Data available from the GECW sample on variations in square footage size of leases and rental rates indicate most of the expected differences by location, as shown in Table 9. Zones 1 and 3 had the smallest average lease size, while the largest leases are found in Zone 4. Zone 5 cities, surprisingly, have among the smallest lease sizes, perhaps indicating the greater difficulties they have encountered in competing for high-tech firms (possibly due to the timing of leasing activity in that zone).

Results on variations in rental rates are stronger than results on lease size. A rental gradient appears to exist, with the highest rents found in Zone 1 and the lowest rents found in

TABLE 8: TENANT INDUSTRIAL CATEGORY BY ZONE, GECW DATA BASE

ZONE	TENANT INDUSTRIAL CATEGORY										TOTAL ALL TENANTS
	NON-HIGH TECH BASIC*		NON-HIGH TECH SERVICE		HIGH-TECH MANUFACTURING		HIGH-TECH SERVICES		HIGH-TECH TRADE		
	Total	Percent of Zone	Total	Percent of Zone	Total	Percent of Zone	Total	Percent of Zone	Total	Percent of Zone	
I CORE SERVICE CENTER	6	15.4%	1	2.6%	25	64.1%	6	15.4%	1	2.6%	39
II CORE MANUFACTURING CENTER	17	14.5%	6	5.1%	70	59.8%	14	12.0%	10	8.5%	117
III MIXED SUPPORT AREA	1	5.6%	1	5.6%	11	61.1%	2	11.1%	3	16.7%	18
IV NEW MANUFACTURING CENTER	17	9.6%	10	5.6%	121	68.4%	12	6.8%	17	9.6%	177
V FUTURE MANUFACTURING AREA	8	12.9%	4	6.5%	38	61.3%	3	4.8%	9	14.5%	62
TOTAL REGION	49	11.9%	22	5.3%	265	64.2%	37	9.0%	40	9.7%	413

* Basic firms include firms in manufacturing, construction, transportation and utilities.

Source: Compiled by the authors from lease agreement data provided by Grubb and Ellis and Cushman and Wakefield, combined with industrial category information derived from various industrial directories.

TABLE 9: AVERAGE LEASE SIZE AND AVERAGE RENT BY ZONE

ZONE	AVERAGE LEASE SIZE Sq.Ft.	# Firms	AVERAGE RENT $/Sq.Ft.	# Firms
I	30524	60	$1.07	51
II	34100	179	$0.96	137
III	30336	19	$0.94	14
IV	37200	263	$0.86	207
VA	28795	100	$0.75	75
VB	32425	4	$0.83	4
All Leases	34087	625	$0.89	488
ANALYSIS OF VARIANCE				
F-Statistic	1.4854		17.9761	
Significance	0.193		0.000	

Source: Authors' analysis using GECW data base.

Zone 5. Zone 2 rents, which are 12 percent higher than Zone 4 rents and 28 percent higher than Zone 5 rents, indicate the value of agglomeration in the most centralized high-tech locations.

VI. A Changing Tenant Base Over Time

In a market so heavily dependent on the high-tech sector, the response of the market in a period of restructuring (or even cyclical downswings) in high-tech activity becomes very important. Examination of changes in the tenant base, size of leases, and rental rates over time show clear variations in leasing activity as the industry responds to economic conditions.

First, the share of leases held by high-tech manufacturing firms reached a peak in 1982, at 83 percent, and has dropped steadily since then (see Table 10). By 1985, only 57 percent of all leases were for high-tech manufacturing tenants. The biggest increase in share over the same time period was in high-tech services, which grew from 5 percent of the leases written in 1982 to 15 percent of leases written in 1985. If the Cushman and Wakefield 1986 data is assumed to differ from previous years because of the changing tenant composition over time (rather than because of differences in the initial customer base being tracked), then by 1986 the tenant composition was shifting significantly away from high-tech activities entirely. Nonhigh-tech firms accounted for over one-third of all leases written in the first half of 1986, as compared to only 5 percent in 1982.

The types of leases agreements reached show changes over time in terms of the amount of space leased and rental rates, as summarized in Table 11. Average lease size fluctuated in the

TABLE 10: TENANT INDUSTRIAL CATEGORY BY YEAR OF LEASE (GECW DATA BASE)

YEAR	TENANT INDUSTRIAL CATEGORY										TOTAL ALL TENANTS
	NON-HIGH TECH BASIC*		NON-HIGH TECH SERVICE		HIGH-TECH MANUFACTURING		HIGH-TECH SERVICES		HIGH-TECH TRADE		
	Total	Row Percent**	Total	Row Percent**	Total	Row Percent**	Total	Row Percent**	Total	Row Percent**	
1979	1	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1
1980	1	25.0%	0	0.0%	2	50.0%	1	25.0%	0	0.0%	4
1981	6	14.6%	0	0.0%	29	70.7%	3	7.3%	3	7.3%	41
1982	2	4.8%	0	0.0%	35	83.3%	2	4.8%	3	7.1%	42
1983	3	5.7%	2	3.8%	39	73.6%	3	5.7%	6	11.3%	53
1984	6	7.1%	5	5.9%	60	70.6%	7	8.2%	7	8.2%	85
1985	7	7.9%	4	4.5%	51	57.3%	13	14.6%	14	15.7%	89
1986	23	24.7%	11	11.8%	45	48.4%	7	7.5%	7	7.5%	93
TOTAL	49		22		261		36		40		408

* Basic firms include firms in manufacturing, construction, transportation and utilities.

** Percent of all tenants in a single year.

Source: Compiled by the authors from lease agreement data provided by Grubb and Ellis and Cushman and Wakefield, combined with industrial category information derived from various industrial directories.

TABLE 11: AVERAGE LEASE SIZE AND AVERAGE RENT BY YEAR OF LEASE

YEAR OF LEASE	AVERAGE LEASE SIZE		AVERAGE RENT	
	Square Feet	Number of Firms	$/ Sq.Ft.	Number of Firms
1979	45300	2	$0.51	2
1980	39935	4	$0.83	4
1981	47756	53	$0.75	50
1982	38842	48	$0.87	44
1983	44659	59	$0.90	56
1984	41341	117	$0.95	113
1985	32373	146	$0.99	140
1986	21856	190	$0.77	73
ALL LEASES	33920	619	$0.90	482
ANALYSIS OF VARIANCE				
F-Statistic	9.6190		12.7094	
Significance	0.0000		0.0000	

Source: Authors' analysis using GECW data base.

early 1980s, but stayed between 39,000 and 48,000 square feet. From a level of approximately 45,000 in 1983, average lease size dropped by one third by 1985, to approximately 30,000 square feet. The 1986 data indicate that average lease size has dropped further still, to less than half its peak size. A disaggregation of lease size over time by major tenant category indicates that this shift in lease size is at least in part related to changing overall tenant composition, but also indicates reductions within some sectors (e.g. high-tech manufacturing) in the size of leases over time.

Nominal rental rates (in current dollars) peaked in 1985. Average rents dropped in 1986 within every tenant category for which significant numbers of cases were available for analysis. Later analysis adjusting for changing price indices and factors such as free rent is likely to indicate even greater rent markdowns over time.

These results are certainly not surprising, in that they reflect the behavior expected from firms in the real estate market as conditions change. However, they are important as an illustration of the dependency of this market on the production side of high tech and of the consequences to the market as production activity weakens in Santa Clara County.

VI. The Tenant Base, Job Growth, and Absorption of Space

An examination of the detailed growth patterns of the industrial sectors of tenants in R&D space helps to explain the shift in absorption patterns over time. Table 12 indicates that all but one of the major high-tech tenant categories grew faster

TABLE 12: EMPLOYMENT GROWTH IN DOMINANT R&D TENANT SECTORS

INDUSTRIAL SECTOR	EMPLOYMENT LEVEL 1980	1984	1985	June 1986	ANNUAL RATE OF GROWTH 1980-84	1984-85	June 85-June 86
MANUFACTURING							
Office & Computing Equipment	43.8	57.1	55.3	52.4	6.9%	-3.2%	-5.4%
Electronic Components	66.6	86.7	85.7	80.2	6.8%	-1.2%	-6.7%
Instruments	25.5	30.5	32.0	31.8	4.6%	4.9%	-1.5%
All High-Tech Manufacturing	176.2	223.7	226.0	NA	6.1%	1.0%	NA
NONMANUFACTURING							
Data Processing	9.1	13.9	14.0	13.4	11.2%	0.7%	-3.6%
Durable Wholesale	21.9	28.9	30.1	31.7	7.2%	4.2%	5.7%

NA Not Available

Source: California Employment Development Department, Employment Data and Research, and CREUE.

than high-tech manufacturing overall between 1980 and 1984, in the earlier boom years of R&D growth. This may help to explain the relatively rapid absorption of space during the early 1980s. By 1985, however, the two largest sectors, computer equipment and electronic components, which accounted for 60 percent of all leases during the 1979-86 period studied, were losing employees, although high-tech manufacturing as a whole still showed a slight gain. Substantial job losses occurred in all of the major high-tech tenant sectors except durable wholesale in the first half of 1986.

The composition of nonhigh-tech tenants over time shows the limited directions in which diversification of the tenant base has occurred (see Table 13). Nonhigh-tech tenants were an insignificant component of the tenant base in 1982, while they account for a significant share in 1985 and 1986. However, the direction of diversification has been quite limited. R&D space appears to be drawing nonhigh-tech tenants primarily from the alternative industrial markets (light industry and warehousing) rather than from office space markets. The largest nonhigh-tech tenant group is in construction activity, while manufacturing, retail and real estate related activities also have a significant number of leases. Thus, more than half of the nonhigh-tech component of the tenant base is directly generated by the Valley's overall growth activity. This will limit the extent to which continued growth of these components may occur in the absence of expansion of the Valley's major employers.

Current employment trends among major high-tech tenants and

TABLE 13: DETAILED DESCRIPTION OF NONHIGH-TECH R&D SPACE TENANTS

INDUSTRIAL SECTOR	NUMBER OF R&D LEASES 1982	1985	1986	SHARE OF R&D LEASES 1982	1985	1986
Construction	1	5	14	2.4%	5.6%	15.1%
Nonhigh-Tech Manufacturing	1	2	8	2.4%	2.2%	8.6%
Transportation	0	0	1	0.0%	0.0%	1.1%
Nonhigh-Tech Wholesale	0	0	1	0.0%	0.0%	1.1%
Retail	0	1	6	0.0%	1.1%	6.5%
Real Estate and Related	0	3	4	0.0%	3.4%	4.3%
All Nonhigh-Tech	2	11	34	4.8%	12.4%	36.6%

Source: Compiled by the authors from lease agreement data provided by Grubb and Ellis and Cushman and Wakefield, combined with industrial category information derived from various industrial directories.

the concentration of growth-dependent sectors within the nonhigh-tech tenants indicates that the immediate prospects for absorption of R&D space are not bright. Even should the loss of jobs level off, or job growth begin again, it is likely that firms currently are leasing an excess of space, and that they will be quite cautious in committing themselves to expansion activity in the near future.

Growth prospects for the longer term are of course quite uncertain. Several trends in the high-tech industry could influence how industrial growth, and thus the demand for industrial space, proceeds in the Santa Clara Valley. First, many of the major tenants of R&D space, especially those in the office and computing equipment and electronic components sectors, are in a mature phase of production, when competition from other firms will play an important role in location decisions. For these firms, the cost of space and of labor are likely to take precedence over agglomeration economies and advanced skills of the workforce in their location decisions. Thus, much of the new manufacturing activity of these firms is likely to move out of Silicon Valley.

Two types of manufacturing activity would continue to find a Silicon Valley location advantageous. One is customized manufacturing of complex components, which can benefit both from proximity to a strong research base and from proximity to the diverse and specialized customer and supplier base of Silicon Valley. A second type of manufacturing activity that will continue to locate in Silicon Valley is the production activity of firms in the initial stages of marketing a new product.

Customized manufacturing activity is likely to be highly dependent on agglomeration advantages of particular sites, and may well prefer the core historic manufacturing areas (Zone 2 and to some extent Zone 4) over other areas. Start-up products, on the other hand, while they benefit from a Silicon Valley location, may also be highly cost conscious (depending on the degree of capitalization). These firms may seek the lower costs of more peripheral Santa Clara Valley sites (Zones 4, 5 and even Zone 6).

Even with growth of the non-routine manufacturing activity described above, high-tech manufacturing activity overall is likely to play a smaller role in the absorption of R&D space in the future than it did in the early 1980s. Diversification into nonmanufacturing tenants could come from two different directions. High-tech related financial and administrative services have strong prospects for growth in Silicon Valley even if manufacturing activity continues to do rather poorly. The major reason for this is that Silicon Valley has exceeded a threshold size for support business activity in terms of total population size and the size of the high-tech component of the economy. The region has become large enough to support a number of services that were previously provided by firms located in San Francisco, Los Angeles, or even New York. The headquarters of many high-tech companies are likely to remain in Silicon Valley, and even with more difficult economic conditions, these firms are likely to rely heavily on management and financial service support from outside the company. Slackening of growth in

manufacturing activity in the Valley may in fact give a boost to the high-tech support service firms, by increasing the availability of labor and related items such as housing.

Growth of high-tech support services is likely to impact only a small share of the R&D market, however. Most of these firms will be interested only in the most centrally located, high quality spaces. Thus, at least over the next few years, these firms are likely to concentrate in Zones 1 and 2. The size of the City of San Jose suggests that these firms may also find parts of Zone 4 of interest, but the wide availability of office space close to downtown San Jose and to other major business centers in the city make it unlikely that tenants will seek R&D space.

A second type of nonmanufacturing tenant that may expand in Santa Clara Valley is the back office user, unrelated to high-tech activity. This type of user may try to benefit from low cost space and a broadening labor supply, particularly in the more peripheral zones identified in this paper. However, at least over the next five years, this component of the tenant base is quite uncertain. The degree to which nonhigh-tech back office activities expand close to Santa Clara Valley will depend on the extent to which the San Francisco Bay Area economy as a whole can grow apart from high-tech activity and on the cost and availability of alternative office space in other parts of the region.

In conclusion, even in the longer term, the expansion of manufacturing activity within Silicon Valley will play a determining role in the rate and level of absorption of

industrial space in the region. If this space is successfully absorbed, however, the tenant base over the next five to ten years is likely to differ from the present tenant base in both the types of manufacturing activity occurring in leased industrial space and in the nonmanufacturing component of that space.

The research described here also carries broader implications for the type of market analysis that may be needed in the future to predict demand in rapidly industrial changing markets. Aggregate analysis of economic trends is likely to mask important trends affecting both the level of growth overall within the local area and the distribution of growth among different development sites within a region. There tend to be both primary and secondary elements of demand within the market, and growth within each of these elements will not necessarily occur at parallel rates to the growth of each other segment of demand. Growth trends in fact may vary inversely from one market segment to the next in some instances. For example, in the case studied here, a slow down in high-tech growth could encourage the expansion of certain nonhigh-tech, nonmanufacturing activities. Thus, a good understanding of future absorption rates must rely on a detailed understanding of the strengths and weaknesses of the major subelements of the market and the ways in which these different activities may interact. Market analysis may also require an understanding of the <u>type</u> of activities within a particular sector that are likely to be located in leased, as opposed to owner occupied, space. It may turn out to be the case

that in some industries, the best markets for rental space occur during periods of uncertainty and fluctuation in the industry, when firms need the ability to expand or contract quickly. Similarly, industrial firms may locate the activities that are most subject to fluctuation in rental space, again giving them more flexibility in adjusting to changing space needs over time.

Footnotes

1. See, for example, Homer Hoyt, One Hundred Years of Land Values in Chicago. The Relationship of the Growth of Chicago to the Rise in its Land Values, 1830-1933, University of Chicago Press, Chicago, 1933, and Manuel Gottlieb, Long Swings in Urban Development, National Bureau of Economic Research, New York, 1976.

2. Moses Abramowitz, Evidences of Long Swings in Aggregate Construction Since the Civil War, NBER, Columbia University Press, New York City, 1964, p. 129.

3. Gottlieb, op. cit., p. 20.

4. Abramowitz, op. cit.. See also Gottlieb, op. cit., and Nathanial Mass, Economic Cycles: An Analysis of Underlying Causes, Wright Allen Press Inc., Cambridge, Mass., 1975.

5. See, for example, William C. Wheaton and Raymond G. Torto, The National Office Market: History and Future Prospects, II, Center for Real Estate Development, Massachusetts Institute of Technology, Cambridge, February 1985, and Kenneth T. Rosen, "Toward a Model of the Office Building Sector," AREUEA Journal, Volume 12, No. 3, 1984, pp. 261-269.

6. This earlier research appears in Cynthia A. Kroll and Linda M. Kimball, "The Santa Clara Valley R&D Dilemma: The Real Estate Industry and High Tech Growth," Center for Real Estate and Urban Economics, Working Paper 86-116, University of California, Berkeley, October 1986.

7. Kroll and Kimball, op. cit., Section VI.

8. See for example Cynthia Kroll, Employment Growth Along the 680 Corridor: Booming Supply and Potential Demand, Center for Real Estate and Urban Economics, Working Paper 84-75, February 1984, pp. 48-60.

9. The significance level of the rent results is actually quite weak--at below a 75 percent level of confidence. However, the significance levels improve considerably, to 90 percent, if tenant industrial categories are broken out in more detail, to a 2-digit SIC level. In this break out, software tenants are by far the highest paying tenants. The weak results on rents by tenant type probably relate to the initial identification problems within the samples as well. Rental variations by location, in contrast, are highly significant.

10. See R. Gordon and L. Kimball, The Electronics Industry in Santa Cruz County, prepared for County of Santa Cruz, October 1986.