Manufacturing and the City

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Keywords: manufacturing, land use planning, industrial, spatial patterns

ABSTRACT

Contemporary land-use planning and zoning regulations often regard manufacturing as a detriment to attractive urban living. This resulted in loss of urban industrial areas to other uses such as housing and services. With recent scientific and technological changes to industrial production, manufacturing could return to the core of cities as an integral part of the existing urban fabric.

This paper examines the efficacy of current land use planning in fostering manufacturing activities within urbanized areas through two methods: a) by tracing the evolution of historical relationships between manufacturing activities and urban form, and b) by conducting an exploratory survey of U.S. cities’ practices and their planning officials. By understanding the social forces and theoretical planning principles that have affected the location choice and morphology of manufacturing facilities over history, this analysis identifies four major shifts of spatial pattern of manufacturing activities in relation to cities: the Mercantile City; the Industrial City; the Garden City; and the Composite City.

The survey reveals that U.S. cities and their planning officials are realizing the importance of keeping manufacturing activities within their jurisdiction as a way to secure sustainable economic base. Nevertheless, the results also indicate that current zoning regulations are still discouraging manufacturing activities in highly-urbanized areas, whereas some emerging types of manufacturing activities strongly desire to locate in an urban core. In order to accommodate such needs hybridized land use policies may be required.

1 INTRODUCTION

In our highly mobile and globalized society, cities all over the world are competing against each other to attract businesses and people to sustain healthy economies. Manufacturing of goods is central to creating such competitive economies. However, traditional urban planning practices often regard manufacturing within cities as a detriment to attractive urban living. This has resulted in a segregation of manufacturing from other urban uses to protect citizens from “noxious” activities. The outcome has been loss of manufacturing in core urban areas in favor of remote or suburban locations. Furthermore, as developing countries attract manufacturing production and investment away from developed countries, the less competitive cities, such as the shrinking post-industrial cities in the U.S., are suffering from a weakened economic base. To overcome this economic decline, there have been various attempts to revitalize the shrinking cities by emphasizing cultural or service economies in lieu of manufacturing of goods. Even as urban planners have developed innovative new approaches, such as the smart growth, to accommodate a diverse mix of uses within a single neighborhood, they tended to overlooked the importance of industrial activities that contribute to diverse, innovative, and more resilient local economies (Leigh and Hoelzel, 2012).

1.1 Objectives
This paper offers a particular understanding of manufacturing facilities’ changing spatial urban patterns over time. It aims to provide a better understanding of manufacturing spatial patterns and urban form as well as current regulatory and zoning practices associated with industrial location.

1.2 Methodology

The paper deploys two different methods to examine the efficacy of current land use planning and zoning regulations in fostering manufacturing activities within urbanized areas. The first method is a morphological analysis, which traces the history of changing spatial patterns of manufacturing facilities in relation to cities. Distinct manufacturing morphologies are studied in terms of their socioeconomic context and the theoretical ideas of urban planning that led to such spatial patterns.

The second method is a qualitative survey of U.S. cities’ practices and their planning officials to assess how existing zoning regulations are managing manufacturing activities and also to get a sense of the emerging needs of contemporary manufacturing activities. The survey targeted municipal city planners of close to 200 U.S. cities and collected 80 responses so far.

2. THE EVOLVING SPATIAL PATTERN OF MANUFACTURING ACTIVITIES

2.1 The Mercantile City: Before the Industrial Revolution

The emergence of concentrated manufacturing activities within cities dates back to the Middle Ages. Large-scale urbanization came from manufacture as much as, and perhaps more than, from trade (Vance, 1977). According to Brucker, Florence, Italy, was one of the most prominent manufacturing cities. Cloth manufacturing was widely spread, but some of the most demanding and mechanized stages of the production were beginning to show concentration, such as dyeing industries along the Arno River, arms-making and pariah industries located at the edge of the city (Bruker, 1969). After the end of the Middle Ages, the merchants’ town that grew from trades of goods and wholesale became one of the most rapid emerging patterns of urbanization of the Western Civilization. The expansion of the trade frontier that the Age of Discovery allowed reshaped urban form of European cities in two ways: first, it created an increase in trade that made necessary the enlargement of trading facilities - shops, warehouses, and counting houses. Second, the transportation facilities, which mainly were ports at the time, were elevated to a dominant position as the acknowledged lifeline of urban existence. As its port grew, a city tended to divide between a working area of quays, warehouses, and shops and an area for upper class housing (Vance, 1977).

Several studies on American cities before the industrialization support the idea that manufacturing was of great importance in the Mercantile City (Vance, 1977; Pred, 1965). According to Dix (1827, pp. 14) New York City was portrayed as a “mercantile town” with the “character of a general mart for the exchange of foreign and domestic productions.” Gottman (1961, pp.103) described other major Atlantic ports and New Orleans were characterized as “hinges,” linking the national agricultural economy with Europe through a “network of trade relationships on the continent and on the high seas.” Manufacturing of the Mercantile City can be characterized by an emphasis on consumer goods, which are products directly purchased by consumers for personal or household use, rather than capital goods, which are used in the production of other goods or commodities. Such consumer goods were mainly produced through handicraft in individual household units, which contrasts to the post Industrial Revolution machine techniques and factory organizations. As household production was the predominant form of manufacturing before the Industrial Revolution,
manufacturing activities were dispersed throughout urban fabric and did not have its distinctive urban form.

2.2 The Industrial City: 1750 – 1860

2.2.1 The First and the Second Industrial Revolutions

The Industrial Revolution signaled a major shift in how we live and work. The first Industrial Revolution occurred during 1750 to 1850. The evolution of technologies such as, introduction of steam power fueled primarily by coal, wider utilization of water wheels and powered machinery mainly in textile manufacturing, gave rise to the increased manufacturing efficiency by quantity and speed. In addition to the revolution in the manufacturing technology, the first intercity railway powered by steam engine, the Liverpool and Manchester Railway, opened in 1830. The dimension of the railroads originated from the early wagonways and has been adopted as the international standard gauge, used by about 60% of the world’s railways. The standardization of the dimension spurred the spread of rail transport outside the UK.

During the second Industrial Revolution around 1850, technological and economic progress gained momentum with the development of steam-powered ships, railways, and later in the 19th century with the internal combustion engine and electrical power generation. Along with the second industrial revolution, the public health problems surfaced in dense urban areas. Diseases, such as cholera, were caused by the lack of sewage system and proper standards of living conditions. London represented the stereotypical mid-nineteenth century urban conditions of Europe. By the 1840s, London’s population numbered over 2 million. As the living conditions of working class became a major issue, an awareness of the need for sewer-system reform and development led to the first comprehensive study of the metropolis for the purpose of planning improvements.

2.2.2 Birth of Regulations

The first careful formulation of the theory of use zoning was suggested by a German civil engineer Reinhard Baumeister in his book entitled, “Stadterweiterungen in technischer, baupolizeilicher und Wirtschaftlicher Beziehung (Town extensions: their links with technical and economic concerns and with building regulations)” in 1876. This book was used as the first textbook in urban planning education. The book traces use zoning back to the decree of Napoleon I, issued October 15, 1810. This decree provides that establishments, which disseminate an unhealthy or unpleasant odor, shall be erected only on administrative license. It divides such establishments into three classes of which, the first shall not be erected near a human habitation, their exact location and distance from residences to be fixed by the administrative authorities. Out of this system grew the practice of establishing one or more “protected districts” and therefore residences and businesses were secure from the intrusion of most, if not all, heavy manufacturing and similar nuisances. The 1912 zoning of Frankfurt, Germany states: in the residential districts, factories are so discouraged by severe bulk regulations as to be practically forbidden; in manufacturing districts along the railroads where the prevailing winds will blow the smoke away from the city, the bulk restrictions are mild; and prohibits residences, except one for the owner or an employee, within manufacturing districts (Williams, 1922).

2.2.3 Models
**New England Mill Towns: Lowell, MA**

In the United States, the introduction of steam power and rail transportation spurred the development of the “Mill(factory) Towns.” These towns developed around one or more mills or factories. The concept originates from England, as represented by the term “Cottonopolis, Manchester.” These mill towns typically developed along major rivers in the New England region to utilize the water power and to use canal system for transportation. Typical characteristics of these towns are that textile factories were built as the main economic engine for the immediate settlement and that the city grew depending on the needs of these factories. Therefore, in contrast to the company towns and factory designs influenced by the Garden City movement, the mill towns provided housing for workers in close proximity to the factories. Founded in 1820, City of Lowell, Massachusetts, represents the history of early mill towns. In the 1932 map of the city (Fig 1) factory mills, major public, and religious buildings are shown in black footprints. This map is an illustration that the City of Lowell originally grew out from the manufacturing facilities.

![Figure 1 Map of the City of Lowell in 1932.](source: Lowell Historical Society)

**Company Towns: Pullman, IL**

During the late nineteenth century, model company towns materialized as enlightened industrialists recognized that many poor workers were living in appalling conditions. These industrialists wished to combat the unsanitary and congested conditions common to working class districts in order to create better living conditions for workers. Model company towns such as Port Sunlight (1888) and Bournville (1895) were influential in regards to their building and planning innovation. The ideas generated from these model towns are regarded as having a significant influence on the Garden City movement (Garner, 1992). The creation of model company towns was particularly evident in Britain during the latter half of the nineteenth century with the creation of Saltaire, Bournville, Port Sunlight, Creswell, and New Earswick, and coincided with the housing reform movement that emphasized the improvement of housing for the working class. These model towns contrasted with the overcrowded conditions in British working class districts, which were often characterized by congested housing, unsanitary conditions, and poor provision of open space and facilities. Model company towns promoted the idea of orderly planned town development as well as the notion of planning for the needs of the community in order to provide healthier living conditions.
One of the first company towns in the United States was Pullman, Chicago, developed in the 1880s just outside the Chicago city limits. The town, entirely company-owned, provided housing, markets, a library, churches and entertainment for the 6,000 company employees and an equal number of dependents. Employees were required to live in Pullman, despite the fact that cheaper rentals could be found in nearby communities. In 1886 plan of the town (Fig 2), we can see that manufacturing field (left) and the worker’s housing district (right) is severed by a main boulevard. Pullman was an attempt to create an industrial city that provides quality living conditions to factory workers.

Figure 2 Map of Pullman in 1886.

2.3 The Garden City: 1860-1970

2.3.1 The Garden Cities

In 1902, one of the most influential text of the modern city planning practice, Garden Cities of To-Morrow, was published. Howard’s garden city concept combined the town and country in order to provide the working class an alternative to working on farms or “crowded, unhealthy cities” (Howard, 1902). He intended for industrial uses to exist within city limits, as it was a necessary part of the Garden City economy, however, it would be sited around the periphery of the Garden City. Howard’s ideal also maximized the utility of urban transportation system. The industrial area was to be located around outskirts of a city in order to take advantage of rail transport.

At the time of WWI, the Garden City movement was at its peak. Wartime generated the need to build new settlements from scratch to create housing for workers near their work places where they manufactured war supplies. Consequently, the United States government embarked upon an initiative to plan and construct neighborhoods and housing for American workers and their families near war-related industries and shipyards. The agency, United States Housing Corporation (USHC), was formed in 1979 and built over 80 new housing projects in 26 states within a period of two years.

The members of the USHC were strong advocates of the Garden City movement. They considered garden cities as a solution to the problem of housing the workingman protected from the evils of the industrialized city. As shown in Figure 3, the residential development of Norfolk is located just outside the shipyard to house the workers following typical Garden City principles: A distinct community with its own identity; Set in a Park-like environment with an
abundance of well distributed open space; Roads designed according to their planned level of use with few sharp turns; Mixed housing types but all designed with ample front, side and rear yards; Strict land use zoning for housing and commercial areas (Ben-Joseph).

Figure 3 Norfolk, VA


Towards the end of the Second World War, from 1939 to 1945, attention was directed to the post-war reconstruction of towns and communities in the United Kingdom. The 1946 New Towns Act established an ambitious program for building new towns to provide housing for citizens who lost their original home during the wartime. It gave the government power to designate areas of land for new town development to provide modern living conditions for the citizens in need of a place to live.

The New Towns Act was greatly influenced by the Garden City movement and as the practice of New Town building transferred to other international countries many international countries adopted this concept to create the “New Industrial Towns.” In countries such as Israel, Iran, Sweden, and Japan, some of the new towns were built as the “New Industrial Towns.” These industrial towns typically incorporated industrial uses within the newly planned city. Yet, the industrial and residential uses were typically located at areas where they would have the least amount of influence to each other. For example, the town plan of Kiryat Gat, Israel and Kista, Sweden, illustrate a land use plan where the industrial and residential uses are completely separated by rail tracks.

2.3.2 Establishment of the American Zoning Regulations

In 1926, the U.S. Supreme Court sanctioned comprehensive zoning in the watershed case of Euclid v. Ambler. After this ruling, comprehensive “Euclidean” zoning, characterized primarily by the separation of uses into geographically dispersed zones, spread across the nation. As the Euclidean zoning became the norm of land use planning, the parting of industrial use from other uses became even more apparent.

In devising a preliminary land use plan for a metropolitan area, the concept of industrial density, which is the number of manufacturing employees per acre, was used to estimate the
space needs for industrial expansion in the future. For instance, according to the *Industrial Land Use in the Detroit Region*, February, 1952, prepared by the Detroit Metropolitan Area Regional Planning Commission, the City of Detroit classified its industrial uses into two categories: the “intensive (40 or more workers/acre)” and the “extensive (fewer than 40 workers/acre)”. The *Industrial Land Use Plan*, December, 1950, of the City of Philadelphia employed three density classes: intensive, intermediate, and extensive. And gradually, we begin to see industrial uses being less desirable than residential uses in the urbanized areas. According to the Comprehensive Plan for the City of Philadelphia, 1960, the city discouraged industrial uses in the Inner Zone by decreasing the FAR from 2.50 to 1.50 and in the Outer Zone from 1.00 to 0.60.

### 2.3.3 Post-War Manufacturing Boom

During the 1960s, the productive capacity of the American economy nearly tripled. Exports to overseas markets and production abroad were more than matched by the domestic market growth. This meant uninterrupted, unparalleled, and unprecedented economic expansion from the end of 1961 (Eisenhower) recession to the 1970 (Nixon) crash (Bluestone and Harrison, 1982). The automobile industry was at the heart of this rapid economic boom. Therefore, careful analysis on the location and design of the U.S. auto-industry facilities from 1860 to 1970 is critical to understand the spatial dynamics of manufacturing in this period.

With the introduction of mass production technique, the assembly line technique, and the improvements of railroad and highway system, manufacturing plants started to flee out to suburban and rural areas where land was cheaper and where there was more room for growth. Facilities needed substantial amount of land to accommodate assembly line system and for storage ground. Furthermore, some large industrial parks, such as Ford’s River Rouge Park Plant, started to incorporate the processing of primary materials within their complex (Bucci, 2002). This meant that the geographical factor lost its importance even more, as manufacturing facilities of the primary materials did not need to locate near the source of material.

Railroads, the primary mode of freight, and the spatial dynamics of manufacturing facilities display strong mutual relationship. Although the dynamic shifts depending on the types of industry, most of the factories such as primary metal and auto industry, were located near rail tracks. The railroad developments; financing innovations adopted by industrial enterprises; precipitation of an enormous demand for steel rails, steam engines, and rolling stock; and elaboration of consumer demand through wages paid to line employees and construction works; played a significant role in the extension of markers and increase in the scale of production, which were the outward expressions of rapid industrial growth (Pred, 1966).

The 1956 Federal Aid Highway Act, which is the epitome of the commercial Keynesianism, had profound impact on freight transportation in the United States, therefore, re-shaped the American manufacturing landscape. According to the Highway Cost Allocation Report, released in 1961, “throughout the period 1929-58 the railroads have been the principal carriers of intercity freight…. Although railroads have increased the volume of their traffic since 1929, their relative position as carriers of intercity freight has deteriorated, both before and after World War II. Since 1953, the railroads have carried less than 50 percent of total intercity freight traffic - as opposed to 75 percent in 1929.” The increased share of intercity freight via highway indicates that the location choice of manufacturing facilities was not tied solely to the geography of railroad tracks anymore. The Interstate Highway Network accelerated and intensified the decentralization of manufacturing from dominant cities.
2.3.4 Models

*Industrial Park: Ford’s Highland Park Plant and River Rouge Plant near Detroit, MI*

Initially, the production of the first Model T had taken place at a facility located near the Detroit city center known as the Piquette Plant. However, to accommodate the exponential increase of production capacity due to adopting the assembly line technique, Henry Ford created a new plant in the outskirts of the city to fully realize the assembly line technique and to secure large land for storage.

The Highland Park Ford Plant, which opened on January 1, 1910, was located in a concentrated industrial zone outside the urbanized areas. Its site was a 230-acre plot on Woodward Avenue in Highland Park, which at that time, was several miles outside the periphery of greater Detroit. The site was served by the Detroit Terminal Railway, which was a belt line that connected every railway entering Detroit. In choosing this site, Ford tried to take advantage of the good transportation infrastructure and the agglomeration effect of likely industries.

In the early-1900s, production activities were linked to the urban area by limitations in the transportation network. However, the assembly line organizational models first tried within single buildings were extended to the entire production cycle. The concept of assembly line was applied to a complex as a whole, joining together single buildings that accommodated specific tasks. This resulted in the construction of River Rouge plants in Dearborn (1917 - 1939). As noted by Ford himself in his autobiography of 1922, *My life and work*, “The entire complex was constructed according to a single idea of simplification of the flow of materials, as the entire manufacturing cycle from raw materials to final product became possible.” Consequently, geographic concerns became less of a problem for manufacturing plants.

Figure 5 illustrates the relative location and the transportation network of the Highland Park Ford Plant and the Ford River Rouge Plant. The city boundary of Detroit in 1900 is shaded in light grey.
**Manufacturing Metropolis**

According to a comprehensive study done by Pred (1966), the spatial dynamics of industrial growth in the U.S. from 1860 to 1914 is represented by the growth of the metropolitan area. Cheaper freight cost, permissiveness of longer journeys to work, lower land costs and availability of larger sites, escalated by the coming of railway electric traction heralded the factory construction at the urban periphery and eventually the decentralization of metropolitan manufacturing. A series of study on economic geography of U.S. manufacturing also demonstrates similar phenomena after the study period of Pred. In 1927, Steen de Geer identifies the original delimitation of the “Manufacturing Belt,” based on the census data of cities having at least 1,000 industrial employees. A revised study done by Harthshorne, published in 1936, proposes a new delimitation of the Manufacturing Belt, in attempt to include small, scattered outlying centers of manufacturing. In this study, Harthshorne identifies top seven major location factors: 1) Coal field, 2) Iron ore field, 3) Major Atlantic ports, 4) Area of richest commercial agriculture, 5) Trans Appalachian Route to interior, 6) Great Lakes Transportation, and 7) the Agglomeration effect (Harthshorne, 1936).

As emphasized above, access to goods and cheap transportation costs has become the most important factor for the location choices of manufacturing facilities aside from the geography of raw materials. Therefore, the improvement of the transportation network through railroad as well as interstate highway became one of the most influential events in shaping the American manufacturing landscape. More than half of the U.S. steel industry is located in the outskirts of the cities of a million people: Chicago, Pittsburg, Detroit, Cleveland, Buffalo, Baltimore, Philadelphia, St. Louis, Los Angeles, and San Francisco (Alexandersson, 1961). In addition, a study on the concentration of high-value-added manufacturing, those that are predominantly composed of highly skilled workers, reveals that high-value-added manufacturing facilities are centered in highly urbanized and industrial areas along the Manufacturing Belt. Such manufacturing has the strongest tendency to decentralize from the dominant city because in these industries, transportation costs are secondary element in their cost structure. Rather, the primary consideration in their location choice is its close proximity to a strong labor market (Pred, 1965; Zelinsky, 1962).

**Figure 5 Manufacturing Belt Mapped by Harthshorne in 1936**

![Map of the Manufacturing Belt](Source: A New Map of the Manufacturing Belt of North America (Harthshorne, 1946))
2.4 The Composite City: After 1970

2.4.1 Mass Production Economy in Crisis and the Technological Revolution

From the early-1970s, the unprecedented economic growth of Western capitalism came to a halt. With the 1973 oil shock and the economic problems in the 1970s, the industrial world entered into a time of troubles. The crisis began with widespread expressions of discontent and social unrest; then came raw-material shortage, followed by rapid inflation, rising unemployment, and finally economic stagnation (Piore and Sabel, 1984). The spread of mass-production technology beyond its original homelands has thus exacerbated the problems stemming from the saturation of markets whose growth defined the postwar economic boom.

The new model of capitalism, distinct from the “Keynesian” model of 1945-70, emerged out of this context. As a result of this restructuring process, manufacturing after state-regulated capitalism tends to decentralize to regions or countries with lower wages and more favorable business climate, hollowing out the industrial sector of the less competitive western cities such as Rust Belt cities of America. Also, as the internationalization accelerates, existing firms or countries are faced with tougher competition from the new players. The U.S. manufacturing, for example, has lost its competitiveness in both its domestic and international markets to Japan and the newly industrialized countries. Finally, the state’s support for high-technology industrial sectors formulated the new informational economy, where manufacturing is fundamentally different from that of the industrial era.

During the two decades from the late 1960s to the late 1980s, a series of scientific and technological innovations have converged to constitute a new technological paradigm. The scientific and technical core of this paradigm lies in microelectronics, building on the sequential discoveries of the transistor (1947), the integrated circuit (1957), the planar process (1959), and the microprocessor (1971). First and foremost, the innovation of information-based technology revolutionized the production, consumption, and management process. As a result, flexibility becomes a key characteristic of the industrial activities. This flexible manufacturing, sometimes termed as lean manufacturing or Toyotism, not only applies to a highly customized small batch production but is also transforming the traditional Fordist type of mass production.

2.4.2 Evolving Spatial Patterns of Manufacturing Facilities – Current Trends

Manufacturing facilities are now being located in places where used to be considered as economically non-viable places for factories and plants. Changes in the organization of employment, production, and consumption are transforming the physical structures that house these activities. For instance, there has been empirical research on firm behavior indicating that some manufacturing firms prefer center-city locations to suburban, rural, or Third World locations (Rast, 1999). This is primarily due to the evolution from the Fordist-style mass production to flexible production. As flexible production needs relatively less space for inventory, manufacturing facilities are less restricted in choosing where to locate and are much more adaptable to existing industrial facilities within city centers that have smaller footprints and multiple stories (Cohen and Zysman, 1987; Myers, 1994; Leigh, 1996). Flexible manufacturing also allows the growth of localized network of small firms, as opposed to large-scale facilities (Malecki, 1996).

Another major game-changer are the emerging types of advanced manufacturing related to high-tech industries, such as biotechnology, nanotechnology, and the semiconductors. Such
advanced manufacturing are proven to be good neighbor to residential areas as their production facilities are not the same as the traditional smoke stack factories. Furthermore, the production processes of such new economy are evolving radically as the transistor size shrinks (Williams, 2004). In summary, contemporary manufacturing facilities require less space, have higher standards for environmental impacts, and introduce new types of production method that are less harmful to human and natural environment.

2.4.2 Models

A careful observation of the spatial patterns of emerging manufacturing facilities leads to a broad generalization of current trends, which could be classified into three distinct typologies of manufacturing patterns according to their relative distance from city centers: (1) Center-city Manufacturing; (2) Urban Edge Manufacturing; and (3) Suburban/Rural Manufacturing.

The Center-city Manufacturing occurs in highly urbanized city centers. There are at least two distinct types of manufacturing that is happening in these areas. First is the reclamation or enhancement of the existing manufacturing facilities in dense urban cores, which is often found in post-industrial American cities attempting to revitalize the city’s economy through fostering manufacturing uses (Fig 6). There are also unprecedented types of small to large-scale manufacturing that are newly built within an established urban fabric. For instance, Cambridge, Massachusetts has a multiple types of advanced manufacturing facilities such as pharmaceutical plant, laboratories for biotech companies, and FabLabs on MIT campus (Fig 7). Although this emergent types are rather symbolic in character and do not constitute the mainstream of manufacturing activities, they are in the process of fundamentally changing methods of production and the definition of manufacturing, which will have a larger impact on the future spatial patterns of manufacturing uses in cities.

The second type, the Urban Edge Manufacturing, appears along the periphery of cities’ urbanized areas. This type includes the new mode of production in the digital era. For instance, the semiconductor companies locate in the urban edges because they are the advanced level of manufacturing that requires skilled labor, access to newly developing high-tech agglomerations, and final markets remain within urban areas in the U.S., Europe, and Japan (Saxenian, 1985; Glasmeier, 1988). The semiconductor industries in Austin, Texas
and Phoenix, Arizona are good examples of the concentration of advanced manufacturing facilities of high-tech branch plants (Fig 8). The Urban Edge Manufacturing also includes the large-scale assembly plants of the traditional industrial sectors, such as automobile and electric appliances. Assembly plants of BMW in Munich (Fig 9) and GE Appliance Park in Louisville, Kentucky originally located outside dense urban areas for cheaper land but became part of the larger metropolitan area as the city boundary expanded.

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<th>Figure 8 Intel manufacturing facility in Austin, Texas</th>
<th>Figure 9 BMW manufacturing plant in Munich</th>
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<tr>
<td><img src="image.png" alt="Intel Manufacturing Facility in Austin, Texas" /></td>
<td><img src="image.png" alt="BMW Manufacturing Plant in Munich" /></td>
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The last type of manufacturing spatial pattern appears in the suburban or rural areas of a city’s jurisdiction. The first sub-category features the agglomerations of manufacturing firms bound to one another through extensive subcontracting and networking relationships (Rast, 1999). The economic success of this network of small firms comes from the organizational structures of the districts, where each firm specializes in one or several phases of a total production process. Most popular locations of this type include: Third Italy region, which specializes in textiles and furniture; Baden-Wurttemberg in Germany, which specializes in machine-tool industry; and Andersdrop in Sweden, which specializes in mechanical engineering (Fig 10). The second sub-category is the legacy of traditional mass production manufacturing facilities that are located along the transportation network but far from dense urban areas (Fig 11).
3. SURVEY OF CITIES’ REGULATORY PRACTICES AND ATTITUDES

3.1 Method

As the first round of our qualitative survey, we have selected 194 U.S. cities from 49 states excluding Hawaii and Alaska. The selected number of cities per state was chosen proportionate to the total number of cities with 10,000 or more people in each state. The number was later adjusted to include at least three cities per state. As a data collection method, email was sent out to two contact persons per city whenever possible. At most of the times, the targeted personnel was at managerial level such as planning directors, managers, and senior planners. From the 194 cities, we have collected 80 responses from 74 different cities. The collected responses represent 43 states.

3.2 Attitude Towards Manufacturing

All of the 74 responded cities currently allowed manufacturing activities within their jurisdiction and for many of the cities (46%) manufacturing comprised a significant part of city’s economic base. The other 27.5% replied that manufacturing has shifted from the primary economic base to a more minor part of the economic base.

Most of the cities’ policy displayed strong positive attitude towards encouraging manufacturing uses within their jurisdiction. Only 10% of the cities discouraged manufacturing activities. When city planners were asked to rate the importance of manufacturing uses in sustaining the economy of a city, they rated an average of 3.3 importance, where 0 being not important at all and 5 being significantly important.

In order to encourage manufacturing uses, cities were taking various approaches. In addition to changing the zoning ordiances to allow greater flexibility, municipalities were also offering tax breaks, other financial incentives, and investing in workforce development to become more attractive for manufacturing activities.
3.3 Evaluation of Current Land Use Planning and Zoning Regulations

The survey result confirmed our assumption that manufacturing uses are most likely to be permitted outside of core urban areas. When city planners were asked where in their jurisdiction manufacturing uses were mostly concentrated, 49% of the cities chose the suburban industrial parks as the primary location, 38% chose urban edges, and 21% chose center-city areas. 23% chose “Other” places, but most of the responses were either equivalent to “all of the above” or rural and urban edge areas. For this question, the planners were allowed to select multiple choices. The intensity of the manufacturing activities also displayed inverse relationship with the relative distance from city centers. Despite the fact that most of the respondents (80%) consider current zoning ordinance providing adequate amount of land to accommodate future manufacturing needs, the locations for such land were mostly in urban edges or suburban industrial parks. This seemed to be due to the high land prices and lack of available land in urbanized areas, as such reasons were nominated as the two most significant obstacle in attracting more manufacturing activities within their jurisdiction. From the above set of questions, we were able to understand that manufacturing uses are constantly being pushed out further from city centers by the existing regulatory system.

On the other hand, present-day regulations also displayed some level of flexibility in accommodating manufacturing activities within urbanized areas. Most of the city planners (78%) consider that manufacturing can be integrated with other land uses, especially with less intense activities such as small-scale manufacturing and high-tech manufacturing. In fact, 79% of the cities were currently allowing manufacturing uses to be mixed with other land uses. The most commonly allowed use mixed with manufacturing were office and retail uses. Residential uses were also being mixed with manufacturing uses, but only 32% of the cities that allowed manufacturing uses to be integrated with other uses encouraged residential uses to be mixed with manufacturing uses. In contrast, 94% of the cities mixed office with manufacturing uses.

3.4 Emerging Trends and Future Projections

When cities were asked whether or not they have experienced decrease/increase in manufacturing activities over the past ten years, 41% of the cities experienced decrease in the overall amount of manufacturing activities, 33% experienced increase, and 21% experienced no change. In cities where manufacturing activities increased, the increased demand in real estate was primarily being met by adaptive reuse of existing buildings (57%) and new constructions (78%), which is most likely to be in suburban or rural areas. In answering where the land for future manufacturing uses are located, 30% of the cities located them in center city areas, 64% of the cities located them in urban edges areas, and 62% of the cities located new manufacturing land in suburban industrial parks. The high percentage of adaptive reuse indicates the possibility of emerging manufacturing activities to be integrated with existent city fabric. Thirty four percent of the cities reduced the amount of industrially-zoned land recently. Nevertheless the re-zoned land were converted mostly to mixed-use land that does not necessarily excludes industrial uses.

The results also indicated that 48% of the cities encountered unprecedented types of manufacturing activities that do not fall under the traditional land use categories. Some of the recurring open-ended responses include: bio-tech and high-tech lab sapce, food production, and recycling facilities. In terms of the spatial needs of such emerging manufacturing uses, new manufacturing seems to require either smaller spaces that could be easily
accommodated in any types of existing buildings or larger and taller flexible spaces to house clean rooms and laboratory spaces.

4. CONCLUSION

We now live in a world different from the era when manufacturing was an unquestionable detriment to urban living. With scientific and technological evolution and shifting attitudes of corporates, citizens, policy makers, and urban planners towards manufacturing, such facilities are once again integrated with our everyday lives. Consequently, urban planners are facing the challenge of finding ways to manage and incorporate manufacturing uses in urbanized areas, as manufacturing is now considered to be an essential component of city’s sustainable economic viability. Several American cities, such as Philadelphia and Chicago, are already preparing themselves to accommodate and attract manufacturing uses within their jurisdictions. However, such approaches are largely ad-hoc remedies to the existing zoning regulations.

In order to overhaul the way we manage and regulate urban manufacturing we need to: a. understand the planning issues caused by traditional perception towards manufacturing uses, and b. identify the characteristics and needs of contemporary manufacturing facilities that are fundamentally different from their past.

As a first step, this paper has offered a historical overview of the relationship between manufacturing and cities in order to better understand how and why manufacturing has been segregated from cities. This section provides a broad generalization of the spatial patterns of existing manufacturing facilities and well as emerging ones.

The exploratory survey has provided some insights in understanding the existing urban planning approaches and regulatory mechanism in managing and accommodating manufacturing activities in US cities. The result indicates that manufacturing is likely to be an important part for a city’s sustainable economic future, but that current zoning regulations and municipalities’ attitude toward manufacturing is insufficient to accommodate such activities in highly-urbanized areas. Still, the fact that some cities are integrating new types of manufacturing activities with other land uses is a positive sign. However, innovative strategies to retain manufacturing within city’s existing fabric should be explored to its full extent beyond just creating mixed-use districts.

REFERENCES


