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URBAN MORPHOLOGIES OF MILL TOWNS AND POSITIVE TRANSFORMATION:

Analyzing the regenerative capacity of the morphology of Holyoke

Ipek Kaynar Rohloff
Mount Holyoke College
e-mail : irohloff@mtholyoke.edu

Abstract

Industrial cities and historic mill towns of North America have increasing needs to adapt to use changes in morphology to improve economic and social viability, along with the quality of life of residents. Many historic mill towns of North America are currently in a period of urban distress due to economic decline. Revitalization efforts for these distressed historic mill towns frequently concentrate on economic redevelopment and urban renewal strategies. Economic redevelopment can be sustained within urban environments, as the urban morphology facilitates use patterns emerging from redevelopment. This paper discusses the ways in which urban morphology of historic mill towns can support economic redevelopments. The urban morphology of the historic mill towns may play an important role in redevelopment as morphological characteristics can support new social and economic transactions. This paper investigates: 1) What opportunities and challenges can the urban morphology of historic mill towns present for regeneration of economic and social structures? 2) What challenges and limitations presented by urban morphology can be addressed in urban renewal plans? 3) How can urban morphology properties make cities adaptive to changing social and economic conditions? We address these questions in the case of Holyoke (Massachusetts, USA), a historic mill town of North America which has been in decline for several decades and is currently attempting revitalization. Holyoke has a distinctive urban morphology characterized by a rigid street grid interlaced with industrial infrastructure. We analyze downtown Holyoke with a method that can reveal reciprocal relations between morphology and land use patterns. Our method examines urban morphological characteristics (block size and properties, building footprints, and street network properties) in relation to the planned economic redevelopment. Our analysis of downtown Holyoke's morphology provides graphic and quantitative evidence that the street layout proposed in the urban renewal plans is likely to provide a good capacity for in the neighborhood planned as a "smart growth" zone with the mixt of uses. We demonstrate a few limitations of a historic mill town morphology characterized by unified grid and industrial infrastructure. Holyoke's urban grid is barely sufficient to support the development of new nodes as proposed in urban renewal plans due to a rigid geometry and divisive infrastructural elements. The implementation of pedestrian segments for localized place-making decisions, like the canal walk in Holyoke, remain too modest to have a strategic impact on the movement patterns and facilitate the formation of new social and economic centers. The major challenge in revitalization of historic mill towns lies in the fact that current economic redevelopment strategies rely on diverse market sectors and use patterns, yet the rigid and permanent morphology of mill towns such as Holyoke are not conducive to diverse uses. Most historic mill towns were shaped to support industrial infrastructure which staged directed, predictable and less varied use patterns (of industrial communities.) Strategies for greater resilience in historic mill towns and industrial cities require more strategically formulated and perhaps dramatic changes within the preserved and rigid morphologies.

Keywords: *Urban morphology, industrial city, diversity, economic redevelopment, walkability and destinations*

Theme: *Urban Space and Social, Economic and Cultural Phenomena*

1. Introduction

Changing social and economic conditions can be a source of distress in communities that were established for specific economic activity (Teaford 1986, 1990). An example of this are historic mill towns of New England which are challenged due to declining local economies and difficult economic redevelopment. Economic redevelopment, such as in the mill towns, can be regenerative for new urban landscapes as long as emerging social and economic structures are well supported within the urban morphology. In most cases, revitalization efforts include urban renewal plans that can adapt urban morphologies to newly implemented market sectors and emergent land uses. This paper discusses the ways in which urban morphology of historic mill towns can support new developments and become conducive to creating economic value and social vibrancy.

Most industrial towns in North America present an orthogonal grid as the underlying system of planning. The grid system has been adopted in American urbanization due to its advantages for flexibility and expandability (Trancik 1986). However, in many cases urban morphology developed on a grid system may be less supportive of the formation of social and economic sub-centers due to the grid systems' being less expressive of land use hierarchies. A unified grid system may depress the character and connectivity of spaces between buildings (Dietsch 1981; Trancik 1986) and thus would be less effective in facilitating social encounters. These aspects of the industrial town morphologies may create challenges in revitalization which usually relies on economic redevelopment with diversity of markets sectors. Recent experience has shown that declined economies are more likely to be restored due to commercial activity, tourism, information technology and leisure economy, or a combination of these sectors (Gospodini 2006; Farrell 2000; Evans 2001). Parallel to these trends, vibrancy in urban environments is maintained by mixing the uses emergent from these sectors. This urban model can ideally be supported by urban morphologies that facilitate serendipitous encounters among diverse groups of people and unplanned overlaps of different uses. Urban environments with these characteristics generate new social and economic patterns which can also create the need for other market sectors and thus create synergy with economic redevelopment (Hillier and Penn 1991).

In an effort to explore such synergistic capacities in mill towns, this paper explores the following.

(1) What opportunities and challenges can historic mill towns morphologies present for economic and social regeneration?

(2) To what extent can challenges presented in the morphology be addressed in urban renewal plans?

(3) How can morphological properties make cities adaptive to change and more generative of new social and economic structures?

As an initial study of our ongoing exploration, we investigate the above questions by focusing on Holyoke (MA USA), a declining historic mill town in New England with distinct morphological character. The analysis is framed within a brief discussion of other historic mill town cases from the region. Our analysis of Holyoke focuses on block size, building types, and street segment modeling in the current form of downtown and recent urban renewal plans focusing on the same area. Our objective is to explore the capacity of downtown Holyoke's morphology to offer public spaces for diverse uses and serendipitous social and economic exchanges so as to create synergy for economic regeneration targeted by the revitalization.

The discussion in the rest of the paper is as follows. The next section reviews urban theories relevant to understanding the links between morphology and human experience as well as recent studies that analyze morphological properties of declined industrial cities. In Section 3 we discuss current challenges in Holyoke in comparison to a few historic mill towns that benefited from economic redevelopment. Section 4 summarizes the method we use to analyze downtown Holyoke's morphology. Section 5 provides spatial analysis of downtown Holyoke in comparison to the urban renewal plans. The final section discusses to what extent proposed changes in Holyoke's morphology may be generative of social and economic value and identifies the major challenges that needs to be addressed in future urban renewal plans.

2. Historic Mill Town Morphology in Urbanism Theories

Economic decline and urban decay in mill towns is nearly inevitable when technological and economic change reduce the profitability of mill towns' businesses. Although historic mill towns are rarely discussed in recent debates on 'change' and urban renewal, declined mill towns are common throughout the rustbelt of North America. Mill town morphologies and their capacity for redevelopment can be better understood in the light of urbanism theories that discuss human experience and recent studies that analyze declining metropolitan areas.

2.1 Urbanism theories after 1960s analyzing urban grid and social encounters

Urban morphology can be intrinsic with social and economic processes. Yet, this phenomenon was better understood in late twentieth century as negative effects of Modernist planning strategies have been observed on land use patterns (Jacobs 1961; Newman 1972). Large scale planning and divisive zoning rules alienated users, created deserted and vulnerable public spaces and hindered connectivity of neighborhoods. With lessons learned from these consequences urbanism theories after 1960s advocated developing incremental planning strategies by taking human experience into consideration and mixing different use patterns (Alexander 1965; Gehl 1987; Hillier 2009; Jacobs 1961; Newman 1972; Whyte 1980; Alexander 1987). Theories developed in the light of empirical studies suggest that urban design can contribute to generating social and economic structures when morphology mixes land uses, integrates public spaces and promotes the diversity of people and places (Gehl 1987; Jacobs 1961, 1984). Urban morphologies in that nature can intensify people's encounters and increase the possibilities of social, cultural and economic transactions. Therefore, most of these urbanism principles have been taken, formalistically or strategically, as guidelines of urban renewal efforts to create vibrant, community oriented and economically and socially sustainable urban environments (Yang 2008; Downs 2005).

More specifically, Jacobs (1961) advocates for smaller building blocks as they create frequent intersection of streets and thus facilitate chance interactions and subsequent development of economic activity. Alexander (1965) and Gehl (1987) point to programmatic conditions such as the overlap of the occupied areas of different facilities and optional activities which create the mixed uses in natural patterns of people (Alexander 1965; Gehl 1987). With a greater emphasis on morphology, Schumacher (1978) elaborates that urban space can maintain density of movement if a sense of closure is defined by building blocks and if streets are continuously connected like in "network-like" structure instead of being segregated away from major arteries ("tree-like") like in cul-de-sacs (Schumacher 1978).

Consistent with the insights of Schumacher (1978) and Jacobs (1961), the space syntax framework, which was first introduced by Hillier and Hanson (1984) demonstrates that the position of street segments on an urban grid affects the pattern of movement (Hillier and

Hanson 1984; Hillier 1996; Hillier et al. 1993). In the light of cognitive theories and correlations with behavioral data, the scholars further explained the ways in which people move in urban grid to reach destinations or to choose passing routes. Accordingly, street segments that are reached in the least costly manner (or minimum impedance) are those most likely to be traveled by people (Hillier and Iida 2005; Hillier 2008). Evidence from behavioral data suggests that the minimum sum of angular change is the perceived least costly way of traveling (more so than least number of turns and shortest metric distance). Those streets reached by a route offering least angular change are most likely the destination points (Hillier 2008, 32). Space syntax theorizes that the street segments that are reached in a least costly way (be that with the minimum sum of angular change fewest turns or shortest distance) are places of social encounter, co-presence and commerce. Due to creating capacities for human encounter, the position of street segments determining the patterns of movement also determine where commercial use patterns are likely to locate. Retail, commerce and other attractors are likely to migrate to hierarchically important destinations (those likely to be place of encounter), while passing trade or major transportation traffic may concentrate on the likely thoroughfares. In return, these economic entities such as shopping centers or passing trade also operate as attractors of movement. Therefore, space syntax theorizes that people's spatial activity is predicted within the synergy created between street networks and programmatic attractors (Hillier 1996; 2008, 37).

On the basis of the space syntax theories, Hillier, Peponis and others make further observations on overall street density characteristics and their effects on land use. Hillier argues that the street networks that form social and commercial centers are denser and less homogenous than the street grid in residential areas (Hillier 2009). Peponis et al (2008) indicate that the denser the street network, the greater chance that people deviate from routine movement and explore unfamiliar places and experience spontaneous encounters such as window shopping (Peponis, Bafna, and Zhang 2008).

The theoretical and analytic framework discussed above provides insights to improve urban grid in order to facilitate desired use patterns in the case of economic redevelopment. These insights can inform urban renewal strategies for historic mill towns.

2.2. Studies exploring urban morphology and the change

Although historic mill towns are characterized by less complex morphology, they present issues similar to declined industrial cities. Several studies analyzing declined industrial cities discuss urban distress in relation to morphology, land-use and transportation network (Moudon, 1986; Psarra, 2012; Ryan, 2006; Ryan, 2008; Scheer and Ferdelman, 2001). A number of researchers examine the effects of morphology on the deterioration of urban environments. In particular, Scheer and Ferdelman (2001), Ryan (2006, 2008) and Psarra (2012) report that morphologies with poor street connectivity have deepened the effects of economic downturns on urban environment. In a study examining Over-the-Rhine, Cincinnati, Scheer and Ferdelman (2001) show that buildings facing discontinuous and short streets were the first parts that deteriorated. In his analysis of Detroit and its massive shrinkage over recent decades, Ryan found that the developments disrupting the street interconnectivity, such as implementation of a highway system and large scale urban renewal projects into the city fabric have accelerated the urban decay (Ryan 2006; Ryan 2008). Psarra indicates that the Detroit street network became increasingly segregated over the decades due to large scale projects with the change in transportation patterns from streetcar to railway and to the interstate highway system (Psarra 2012) and suggest that this change in the transportation pattern may have played role in the city's urban deterioration.

A number of other studies discuss morphological characteristics such as block sizes and property division predict survival and adaptability of the urban environment in the process of social and economic change (Anderson 1993; Moudon 1986; Siksna 1997; Scheer and Ferdelman 2001; Ryan 2006; Ryan 2008). Scheer (2010) argues that a fine grained tissue with small parcels and multiple owners in the urban blocks create challenges for adaptability; as each building will change individually and different times, the overall structure and character of the place remains the same because a small parcel framework dictates certain types of buildings (Scheer 2010; Campoli 2012). Depending on the physical and fiscal conditions of the declined town, the urban block and parcel size define both challenges and opportunities for adaptability to new and multiple industry sectors and housing choices. As discussed by Campoli (2012), vacant land in former industrial sites offers larger footprints for new industries, while intact remaining mill buildings may open up the entire block only for single use and diminish the diversity of the street (Campoli 2012). Contrary to this argument, Siksna discusses that the cities initially founded with very large blocks tended to invite greater number of modifications of the urban fabric, which usually led to the creation of more successful smaller blocks (Siksna 1997).

The cited studies inform our investigation as they identify particular characteristics of urban morphologies that play a role in economic health, urban decay and positive transformation. As informed by these studies, we examine opportunities and challenges for revitalization in the analysis of block, building and parcel size and street segment connectivity. Before proceeding with this analysis, we briefly introduce current challenges faced in Holyoke in comparison to a few other mill towns in the region.

3. Declined Historic Mill Towns and Holyoke Revitalization

The City of Holyoke was established in 1830 by wealthy investors as a manufacturing community on the land where Connecticut River changes elevation and thus provides a reliable water source for power canals to run mills. As one of the first planned industrial communities in North America, Holyoke's population consisted of Irish, French Canadian, German and Polish worker groups which mostly remained segregated with little social mingling (Green 1939). Segregation was also apparent between workers and more affluent groups, as observed in spatial relations among the neighborhoods (Davis and Davis 1985). Following the decline in the 1950s, lowered property values attracted another wave of immigrants. Yet, unemployment rates and subsequent impoverishment continued to rise as there was no significant economic redevelopment downtown. The only major development was in late 70s with a large mall complex on the freeway on the western edge of the town. This development took away the potential retail development from downtown while providing employment for the local community.

Today, land use in Holyoke includes limited retail, small manufacturing and residential buildings. Blighted areas, empty lots and abandoned buildings highlight urban distress. Holyoke currently lacks economic health with interdependent market sectors and is thus unable to attract and maintain diverse population groups.

Holyoke shared its fate in economic decline with other historic mill towns in New England, such as Lowell MA and Maynard MA, among many others. Maynard and Lowell, however, took different paths than Holyoke in their formation of social and economic sources.

Maynard had one large mill complex and major economic redevelopment was driven by the settlement of a high-tech firm, Digital Equipment Corporation (DEC) in that mill. DEC was the largest producer of mini-computers in the world and provided employment for Maynard residents (Mullin, Armstrong, and Kavanagh 1986). Even after its bankruptcy in 1990s, DEC left

a large trained worker community which could be employed by other high tech firms in the region (Mullin, Kotval, and Karamchandani 2008). DEC's transformative effect on the town physical environment remained limited with the adaptive reuse of the single mill building, yet DEC transformed the social capital of the town and has had a long-lasting impact on the regional economy.

Lowell, on the other hand, was revitalized through a comprehensive plan that combines historic preservation (of mills) and regeneration through tourism and service economies. Once the town was granted National Park status in 1979, mill buildings and the entire industrial landscape were retrofitted to interpretive sites to present early industrial history of the United States. This development brought new business to accommodate hundreds of people visiting the town each year (Malone and Parrot 1998; Peskin 1985). Some of the settlement characteristics of Lowell created greater adaptability for economic redevelopment. Lowell was planned with a more farsighted "systems thinking" for place-making. Lowell investors "landscaped the mill yards, canal banks, house lots, and streets" to create an attractive setting by defining parks and promenades along the canals for the workers community (Malone and Parrot 1998). Today, those green open spaces by the canals are prominent places of strolling and sightseeing.

In comparison to Lowell and Maynard, revitalization efforts in Holyoke focus on economic redevelopment through innovation industry and urban renewal through adaptive reuse of historic mill buildings, restoration and beautification of streets and canals for broader community use. Economic redevelopment of Holyoke is recently being aided by a high performance computing center which operates as a data processing node for major universities elsewhere in the state. The computing center has a limited impact on local employment. Nevertheless, the center is hoped to attract innovation economy which is considered pivotal for economic redevelopment and revitalization of the downtown (Mass.Gov 2013). The innovation district is envisioned to seed developments for a new economic node in Holyoke with mixed uses of residential, retail, and commerce functions while bringing walkability potential, vibrant public realm and a diverse community. Whether an innovation industry will be able to create such capacity and thus attract diverse land use patterns is still an open question due to relatively modest size of innovation start-ups.

In the light of Maynard and Lowell cases, one can argue that economic redevelopment in Holyoke can prevail as long as market changes in urban environment are supported and synergized within the urban environment. New market sectors implemented in the process of the redevelopment may trigger new use patterns, yet these patterns may or may not be supported by the historic mill town environment. Our analysis explores what potentials and challenges Holyoke's urban morphology presents to support the economic redevelopment and new land-use policy proposed by the city.

4. Method of Analysis

We analyze downtown Holyoke with the techniques that can reveal reciprocal relations between morphology and use patterns. The first part of our analysis looks at urban form characteristics such as street layout and urban block properties as can be observed on the original site plan of Holyoke. We examine urban block size properties also through color coded rendering of the block sizes. This technique visualizes places of frequent street intersections which imply intensified pedestrian encounters. A more conventional technique, a figure-ground analysis of existing building footprints, visualizes decayed areas in town in conjunction with districts selected by the city for urban transformation. The second part of our analysis briefly reviews economic redevelopment and urban renewal plans proposed by the city of Holyoke in reference

to our observations of block size and properties. In this review, we look at neighborhoods, arteries and nodes that are going to be restored with new market sectors, land uses and physical planning.

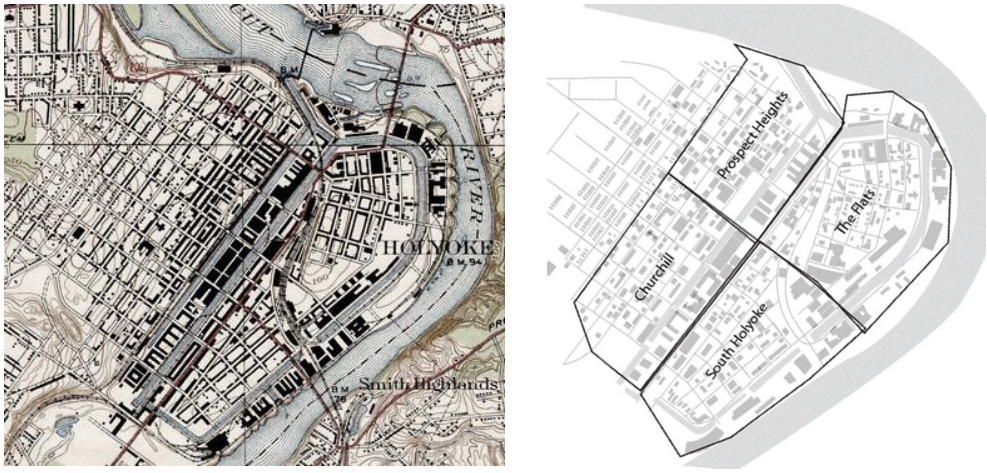
The third part of our analysis includes street segment modeling to forecast the patterns of movement based on space syntax methodology. For the purpose of our discussion, this analysis explores which parts of the Holyoke urban grid may attract people's movement and act as destination points or as passing routes as a function of street segment connectivity. The analysis that forecast likely destination points is based on angular integration measure which looks at the extent to which each segment can be reached with route offering least angular change. This analysis also predicts local scale passing routes in order to understand walkability capacity of the segments, measuring the extent to which each segment is part of a route offering least angular change. We run the street segment analyses forecasting destinations and passing routes in both the current urban grid and the street grid improved with proposed renewal. We compare these two sets of graphs to see if urban renewal proposals utilize potentials of the existing urban grid, or address the challenges and limitations associated with the grid geometry. In the end, we provide an assessment of redevelopment and renewal plans on the basis of capacities we explored in the original and proposed urban grid, as well as our brief formal analysis based on block characteristics and size properties. This comparison reveals if urban renewal strategies restore the urban definition in the decayed neighborhoods and improve the street grid in such a way that greater number of segments can attract movement and create new destinations to be social and economic centers in the future.

5. Holyoke: Morphological Characteristics and Revitalization

5.1 Current Urban Form and Block Properties within Rehabilitation

The distinctive morphological character of Holyoke is defined by an orthogonal urban grid interlaced with power canals. The most uniform part of urban grid is shaped within 450x250ft (140x80m) size blocks. The urban blocks are defined by mill buildings and worker house tenements in rowhouse form in large parcels, single family houses (of mill owners) in smaller parcels, and a few town parks scattered in the urban grid. The mill buildings are positioned along the power canals and the riverfront, which is the industrial district developed first.

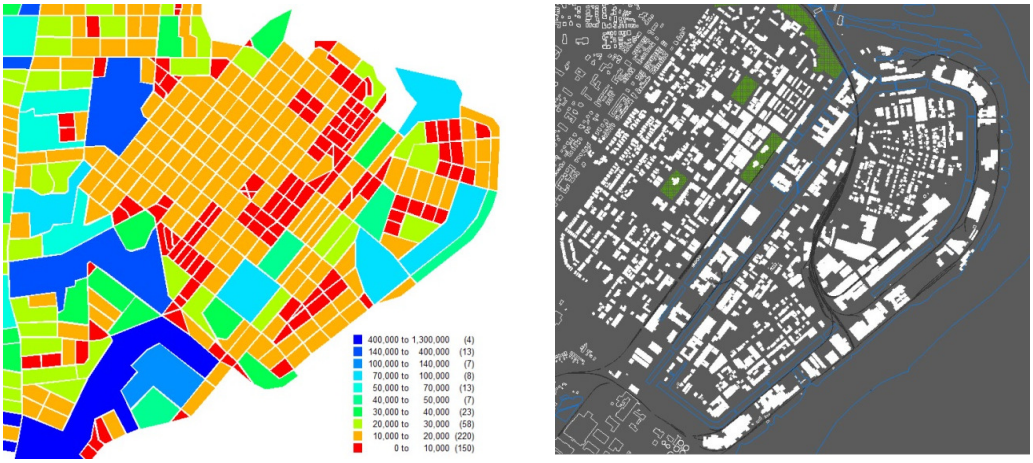
Downtown Holyoke (also known as The Center City) compromises four districts, the Flats, South Holyoke, the Prospect heights and Churchill (Fig. 1-b). The Flats and South Holyoke are characterized by mill buildings and worker tenements and delineated by the railway in between and were resided by ethnically different worker groups. The Prospect Heights and Churchill are on the northeastern side of the canals and part of a more unified grid and located on a higher elevation than two other districts. Northeastern edge of the Prospect Heights and Churchill housed more affluent groups (historically the mill owners), and were characterized by single family housing units (Fig. 1-b).



a) b)

Figure 1 a) Map of Holyoke Canal System (Holyoke, Massachusetts, USA), c.1938. b) Four districts of the Center City, Holyoke.

We further our observations on the urban form with analysis of urban block size properties and building footprints in the current state. This analysis allows us to examine street and building footprint density which may affect pedestrian encounters and incremental urban change. Block size analysis of downtown Holyoke (run by Confeego in GIS Mapinfo) shows that the majority of blocks are uniformly sized. Smaller size blocks (marked in red) are present on the northeast side of the core canals and a few blocks in the Flats and South Holyoke districts (Fig. 2-a). Block size becomes much more differentiated towards the northeast edges of the city which includes the recently developed (marked with blue in Fig.2-a). There are also larger blocks along the riverfront due to large mill buildings. We examine the building footprints in a figure-ground analysis where town parks are also denoted with green. In the figure-ground map (Fig.2-b), voids in the building fabric denote urban decay due to various causes such as arson, physical damage and abandonment of the lots. The analysis visualizes large buildings by the core canals area and the riverfront (southeast of the South Holyoke and the Flats districts). The locations of town parks on the map indicate that green open spaces are apart from each other.



a) b)

Figure 2 a) Block size analysis, b) Building footprint analysis with green open spaces.

Figure 3 Proposed rehabilitation areas and smart growth district within the urban block and tissue properties. Source: Analysis by author using information and map provided by the City of Holyoke.

Figure 3 presents a closer look at the parcel size, and marks the areas of rehabilitation determined by the planning department of Holyoke. The rehabilitation areas in the northwestern neighborhoods include residential areas with smaller parcels and buildings. These areas are to be redeveloped with mixed use units offering affordable houses. In Areas 1 through 4 some of the smaller lots will be merged to provide more enticing investment opportunities for developers. There are also plans to turn some other vacant lots as green open spaces in (Areas 1-2) and to provide rehabilitation of existing parks. These plans present a potential to form a better connected green open space network and help promote access to natural grounds for community recreation. The rehabilitation areas on the southeast side of the canals (Areas 5, 9 and 10) are planned to be redeveloped with commercial land use such as food retail, light industry, and public parking that can serve to the region by taking advantage of railway transit. Larger size mill buildings and their parcels along the riverfront suggest reconstruction of these buildings will change the urban landscape more dramatically. Therefore, the rehabilitation plans overall suggest that the southern half of the center city will have a greater transformation yet connect the town to the immediate region as a hub, whereas the northern districts seems to present potential for diverse groups of local residents with promotion of green open spaces and mixed used development offering affordable housing options.

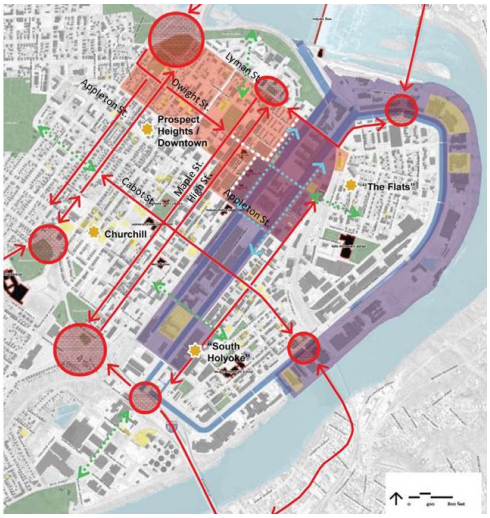
5.2 Economic Redevelopment and Urban Renewal Plans

Current revitalization efforts in Holyoke rely on economic redevelopment and urban renewal plans proposed by Holyoke planning department within a public and private partnership. Figure 4-a maps opportunities explored by the city planning department of Holyoke and marks the areas that are open to determined markets sectors. This map shows two major redevelopment

patterns. One is Arts and Industry zone along central canals and riverfront where most mill buildings (with large parcels) are currently located. The other one is “smart growth” zone in northwestern neighborhoods (Prospect Heights, Fig. 1-b) that will offer affordable housing and the mix of uses with small retail functions.

The urban renewal plan for downtown Holyoke is formulated to support the redevelopment and the planned land-use. The urban renewal plan for Holyoke addresses issues concerning main arteries and pedestrian experience and therefore proposes three major changes in the downtown urban form:

(1) Urban definition of the arteries orthogonal to the canals (Lyman, Dwight, Appleton, Cabot and Sargent streets) will be improved, and the connectivity of those arteries will be maintained beyond the canals (Fig. 4-c). (2)Four new urban nodes will be developed with emphasis on transportation, civic, Main St. and educational identity based on the influence of the nearby landmarks (Fig. 4-e). (3)The former industrial zone will be redeveloped as an Arts and Innovation district and be supported by rehabilitation of canals and a “canal walk”. The canal walk will offer scenic urban spatial experience, improved walkability and bike transportation (Fig.6).



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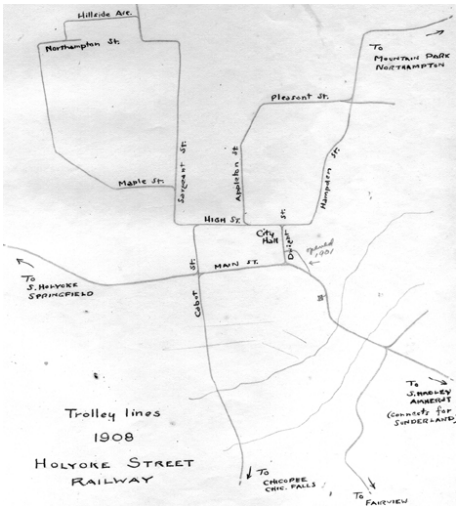

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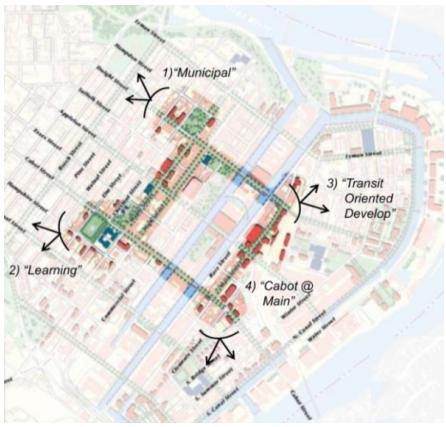

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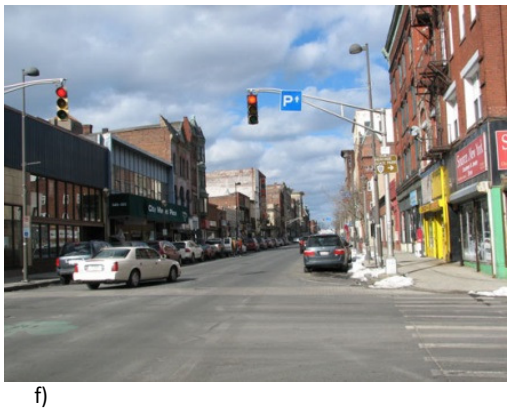

f)

Figure 4 Holyoke urban renewal maps: a) Opportunities and challenges diagram developed by the city of Holyoke, b) Street car network showing the connectivity of High Street to the other parts of downtown Holyoke (source: Wistariahust Museum, Holyoke, MA). c) Center city vision plan, d) High St. in 1910, b) Key nodes development, e) High St. today.

Figure 5 The canal walk; the rehabilitated section of the canal walk today (left), and envisioned canal walk (right).

5.3. Street Segment Modeling Exploring Capacities for Redevelopment and Land-Use

We created segment modeling of downtown Holyoke to examine potential areas for social and economic centers as well as capacity for walkability in the current and improved street layout. To predict potential places (destinations) for social encounter, we look at the local least angular integration that captures the extent to which segments attract people's movement due to being reached by routes offering the least angular change. For the latter, an assessment of walkability capacity, we run the segment analysis with local choice measure that captures the likelihood that the involving segment is on the way to a destination point and thus carries a through-fare potential.

Street segments with angular integration capturing places of social encounter

To forecast locations where pedestrian movement will be attracted within walking distances, we performed a street segment analysis on the current street layout of downtown with local angular integration measures of 1600m and 800m radii. These radii correspond to distances one can cover within 20-minute and 10-minute walks. The graphs of local integration for these walking distances can be seen in Figs. 6-a and 6-b. These graphs also reveal overall character of the urban grid. While northwestern neighborhoods have a more uniform grid and the southeastern neighborhoods presents two different geometrical systems divided by a railroad (South Holyoke and the Flats). The integration graphs show northern streets along the Flats and the South Holyoke districts are the most segregated sections. The segments around the central canals also seem segregated from the rest of the street layout despite the geometrically central

locations. These observations show that in Holyoke industrial infrastructure, such as canals, railroad and large mill buildings, create divisions among the neighborhoods and hinder the connectivity of surrounding arteries.

Note in particular the local angular integration graph at 800m radius indicates that central segments of High Street (between Dwight and Cabot streets), and segments of Appleton streets are most likely destinations that can be reached by pedestrians in a 10 minute walk (Fig.6-a). The integration graph at 1600m radius shows Appleton Street orthogonal to the canals and the High street is a destination at a greater extent for 20 minute pedestrian activity. The high degree of integration of High Street extends south, while other orthogonal arteries, Cabot and Sargent Streets, appear more integrated with the 1600m radius analysis (Fig.6-b). Indeed the High Street is currently where small street shops, restaurants, the city hall and other public buildings are located. In previous decades, capacity of the High

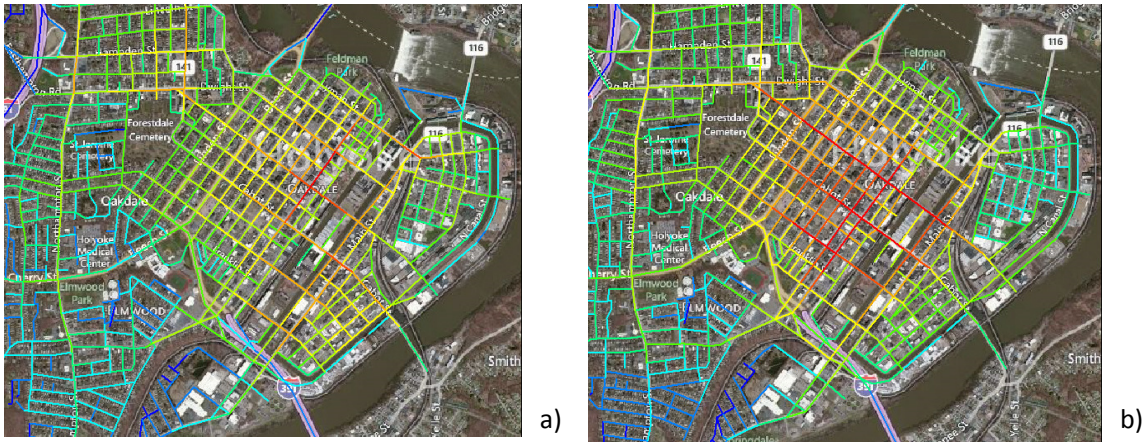

Figure 6 Angular integration maps of current Holyoke street layout, a) integration at r=800m (10 min. walk), b) integration at r=1600m (20 min. walk).

Figure 7 Angular integration maps of Holyoke street layout with improved pedestrian paths, connected streets and canal walk; a) integration at r=800m (10 min. walk), b) integration at r=1600m (20 min. walk).

St. to be a core artery of the city is contributed to by its connectivity to other neighborhoods through a street car network, a significant aspect of the town history (Figs.4-d and 4-f).As reviewed in the previous section, the urban renewal plans for Holyoke propose two major improvements in the urban grid. First, the main arteries running orthogonal to the canal core will be extended towards the southeastern side of the central canals in order to better connect the districts on this side. Second, there will be additional pedestrian walkways around the central canals in order to increase pedestrian activity and make the canals core as a place for

social encounter. Our analysis aims to test to what extent these modest changes in the urban grid would shift movement patterns and whether this shift brings new capacities to Holyoke downtown for social encounters and increased economic activity.

Therefore, we ran the least angle street segment analysis with the proposed street segments The angular integration graphs that include the new canal walk, improved street connections and pedestrian paths in the park areas, we see that integration levels improved in High Street and Main Street (Figs.7-a and 7-b). In particular, the integration map resulting from an analysis at 800m radius (Fig.7-a) shows that high degrees of integration extended towards the arteries crossing the canals and make the core area extending from Dwight to Cabot streets and from Maple Street to the canal walk more likely reached within 10 minute trips. Our analysis shows that for pedestrian activity at 20 minute distances, arteries in the north side of Appleton Street become better integrated with these changes, and yet the integration levels remained more concentrated towards the canals. The canal walk segments appeared as additional segments with moderate integration. The addition of canal walk segments increased the number of paths running parallel to the canals at the core, high integration levels of the arteries crossing the canals became more close to the canals core. The concentration of integration towards the canals' core area suggests that improvements in street layout shifted the patterns of movement towards and make potential destination areas more concentrated (Figs 6-b and 7-b).

Despite the concentration of local integration and potential destination points towards the central canals, the Holyoke downtown street layout presents weakness in two aspects concerning the places of social encounter. First, street segment relations do not seem to support the development of four different nodes as proposed in urban renewal plans. The existing street network is too homogenous to attract people's movement to those areas, and those proposed nodes are less likely expressed with further density of streets. Second, the implementation of the canal walk as an attempt to urban place making around a scenic feature does not make the canals zone the most likely destination point, unless scenic feature of canals operate as a strong attractor. Instead, the canal walk intensifies the existing destination and places of social encounter around the High and Main Streets between Dwight and Cabot Streets that run orthogonally to the canals and makes this core as a center of commercial and social activity. The "canal walk" is likely to be a leisurely artery and yet it's still not the topological center of the urban grid.

Street segments with local choice capturing walkability capacity

In addition to creating a capacity for destination and development of economic nodes, walkability is an important aspect of vibrant urban environments. Walkable streets provide safer environments for the community and increase the chances of human interaction and economic transactions. We assess the walkability capacity of downtown Holyoke in the current and proposed street grid by using a local choice measure of street segment modeling. Choice measure describes the degree to which each segment lies on least angle routes between all other pairs of segments within a radius. Therefore, choice measure captures the likelihood that the involving segment is on the way to a destination point and thus carries a thoroughfare potential.

With a small scale radius, choice measure indicates the degree to which involving segments are likely chosen by pedestrians to get to destination points. To assess walkability capacity within a 10 minute walk, we ran a street segment modeling analysis with a local choice measure at 800m radius in the current and proposed street layout with improved pedestrian segments. The choice graph of the current street segment shows that the downtown has a good capacity for walkability thanks to the density of the street network, especially in the northeast half of the town (Fig. 8a). The local choice graph obtained from street segment modeling of the proposed

urban grid (with added canal walks and other pedestrian paths)

Figure 8 The least angle analysis with local choice (r=800m) a) Choice measure in street segments before urban renewal plans, b) Choice measure in segments including canal walk and new connections.

indicates the highest degrees of choice at 800m is intensified along the High Street and Maple Street arteries (those running parallel to the canals) towards north, while the addition of the canal walk increase the degree of choice in the crossing arteries. In the proposed street layout, local choice values concentrate towards the northwestern quarter, while segments extending away from the core area are appear with lower choice values (Figs. 8-a and 8-b). These values suggest northern segments of High Street and Maple Street arteries are most likely thoroughfares for pedestrian in the north-south axis, while the orthogonal streets (Lyman, Dwight, Appleton and Cabot streets) are most likely paths on the east-west axis. The area defined with the highest local choice in the northwestern quarter coincides with the district (originally named Prospect Hill) that will be developed as a “smart growth” zone. Walkability is one of the fundamental goals of smart growth development which can support encounters of diverse groups of people while providing a healthy living with minimum environmental impact. Our analysis provides graphic and quantitative evidence that the street layout proposed in the urban renewal plans is likely to provide the Prospect Hill district with a good capacity to be developed as a smart growth zone.

5. CONCLUSIONS

Our analysis of the downtown Holyoke urban block properties and street grid presents a number of interesting findings that can be taken into consideration for the renewal of historic mill towns and similar industrial cities characterized by infrastructure elements and unified grid as an underlying system of planning. First, Holyoke’s urban morphology presents limitations in the formation of new social and economic centers to support diverse market sectors. In downtown Holyoke, the unified urban grid in Holyoke barely facilitates increased activity in the four nodes proposed. Second, industrial infrastructure elements such as power canals and railroad lines create divisions which hinder the connectivity of surrounding streets. Determined by the divisive role of the infrastructure elements as well as the block size properties, economic redevelopment and urban renewal plans will render two different urban characterizations at two sides of the central canals. The districts between the riverfront and the canals will be regionally connected and will enable a more dramatic transformation of the blocks and implementation of uses serving to the region. The districts in the northeast seem appropriate for more mixed use development with residential character, supported by smaller blocks, street density and improved walkability and social encounters. Third important finding is that street

layout proposed in the urban renewal influences patterns of movement in a quite unexpected direction. The addition of pedestrian paths in the central canals area attracts the potential movement to the northwestern quarter and towards the canals area. However, the canal walk addition lessens topological importance of major arteries running orthogonal to the canals especially their segments extending away from the core are less likely destinations. This effect of the proposed segments is not conducive to the improved urban definition and beatification of those arteries in the urban renewal plans. Another finding of our analysis is that large mill buildings preserved around the central canals in downtown Holyoke appear to be an obstacle against the formation of places for social encounter because of hindering the permeability to the canal walk. These findings suggest that when improvements in urban grid is motivated by a less strategic thinking and with a more localized place –making decision, like "the canal walk", opportunities for greater scale adaptation of urban morphologies to economic redevelopment may be missed. .

Our study reveals one of the major issues that can present both an opportunity and a challenge for the revitalization of historic mill towns: implementation of diverse market sectors and use patterns in a rigid and permanent morphology. One of the factors causing the economic decline of the industrial cities was their reliance on a single market sector. Smaller industrial cities, such as historic mill towns, present this reliance more severely as there was not much capacity for diversity in their smaller scale settlement. Today's resilience strategies require greater diversity in market sectors. The contemporary urban environment could create synergy for diverse and mixed uses and the unplanned encounters between different groups and this may require more strategic changes within the preserved and rigid morphology.

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