Technology and Urban Form: From the Horse-Drawn Carriage to the Information Highway

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Abstract: This paper examined the impact of technological advancements in transportation, construction systems, and telecommunications on urban forms. The purpose is not to provide an exhaustive review of future development possibilities but a rather selective exposition of technological advances with considerable implications for social and cultural organization of cities. The urban form in this paper was explained in terms of the dialectical interrelations between technology, social structures, and physical patterns. The ease of transportation and deployment of digital telecommunications is redefining the city from being a repository of localized economic, social, and cultural forces to a regional or global entity that attracts a broader and heterogeneous mix of social and capital accumulation interests. The paper was generally divided into three parts. The first part provided an overview of unbuilt city visions that have inspired architects and engineers to explore the future possibilities of massive super tall construction. The second part examined the social, economic, and cultural implications of telecommunication and wireless technologies. The third part provided a critical perspective on the likely impact of such technological advances on the city and urban culture. The main contribution of this paper is not only to highlight the remarkable possibilities of technology in boosting human performance but also underline the need to moderate its negative impact on future urban developments.

Keywords: Technology, urban form, urban transportation, modern city, telecommunications, urbanism, architecture

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1 INTRODUCTION

Throughout history, technology has had a dramatic impact on peoples’ lives and especially urban development. The horse drawn wheeled carriages of the 18th-19th century transformed the Baroque City and precipitated a change in its street network and geometry. Wider radial avenues with long straight segments were integrated with the street grid to facilitate fast pace movement (Figure 1). Later, electrified street car lines facilitated the early suburbanization movement. They provided the affluent population with opportunities of larger estates and extensive open green spaces outside the congested industrialized urban cores (Figure 2). Movement patterns were later redefined by the advent of the high-speed internal combustion engine, and cars and highways began to dominate and shape urban development patterns. Residential, industrial and commercial developments followed the highway construction post Second World War (Falcocchio and Levinson 2015) (Figure 3). As discussed below, the technological developments that took place post Second World War transformed not only the shape of cities, but also the social, cultural and economic underpinnings of the world urbanity.

1.1 Post Second World War Technological Developments

Technological advancements have always fueled the imagination of architects, engineers and planners and provided impetus for new ideas in building configurations and development patterns. In the mid1950s, Wright envisioned a very low density city with single family home, and each was on one acre farm. He conceptualized airborne transportation gadgetry that allows residents to move freely throughout his vast broad-acre city. Wright used technology to configure a new human landscape that was anticipated several decades earlier. Peter Kropotkin (end of 19th century) and many subsequent theorists argued that electrification, the automobile, telegraph, telephone, and other telecommunication means would abolish the tyranny of geography and afford humans the freedom to decide where to live, work and play (Wright 1958; Schaffer 1988; Catanese and Snyder 1988; Lang 1994; Hall 1996).

More recently, information technology, wireless telecommunications, advances in robotics and materials have led some theorists to predict dramatic changes in the make-up of communities, public and private discourses, cultural and entertain-
ment activities, and political practices. (Kashef 2008a; Kashef 2016). Some of these predictions have already become a reality and others seem to be making headways to a future that’s on one level, very promising, and on the other apocalyptic or worrisome level to say the least.

Advancements in building systems and construction techniques provided urban centers with soaring towers and vertical city developments that were previously confined to utopian and futuristic literary schemes. Modern skyscraper design and development was primarily driven by the invention of the safety elevator and the steel frame towards the end of the 19th century. The elevator made it feasible to increase building heights beyond the modular six or seven stories, the height to which people can reasonably ascend on foot. However, increasing building heights in wall-bearing systems of the 19th century mandates an increase in the wall thickness, thereby decreasing the usable area especially in lower floors. The development of the steel frame and curtain wall construction around the 1870s unlocked height restrictions and afforded architects and engineers an unprecedented freedom in increasing building heights. The earliest steel skeleton skyscraper in Chicago (1884) was a mere ten stories high (Kostof 1991), but it laid the ground...
for a revolution in building heights that have currently exceeded 2,717 feet in Khalifa Tower, previously named Burj Dubai (Baker et al. 2008; Al-Kodmany 2015; Prasad 2016).

Cars, trucks, highways and telephone communication technologies as well as other twentieth century advances in structural systems and building materials have shaped the character and geography of the modern city. The eagerness of modern architects and engineers to erect towering structures and the desire of business corporations to maximize their profits has ultimately coalesced to alter the shape of cities throughout the world. The modernist commercial architecture in the U.S. persisted in embracing new technologies, and through the works of SOM (Skidmore, Owings, and Merrill), the technique of building skyscrapers was perfected and transferred worldwide. By the 1960s the vertical slab wrapped in glass, often denoting its structure, became the symbol of the American downtown, while expanses of low-density suburban developments cluttered the countryside (Kashef 2017).

1.2 Approach and Method

The paper tackled some futuristic themes raised in the literature. It is not meant to be an exhaustive review of futuristic themes but covers select areas related to urban development, social and cultural organization and engineering practices. The paper arguments were generally divided into three parts. The first part provided an overview of two un-built city visions that have inspired architects and engineers to explore the future possibilities of massive super tall construction. The city is generally perceived as a building or a technology-driven object. The second part examined the social, economic and cultural implications of telecommunication and wireless technologies. It discussed potential transformations in human settlement patterns arising from the locational freedom and spaceless economy. The third part provided a critical perspective for the likely impact of such technological advances on the city and urban culture. The paper conclusion highlighted the remarkable possibilities of technology in boosting human performance and the need to moderate its negative impact on future urban developments.

2 THE CITY AS AN OBJECT AND A TECHNOLOGICAL UTOPIA

Visions for technological utopias stretch in time from the renaissance 15th century Leonardo da Vinci or even earlier, passing by futurama in 1939, and culminating in some mega skyscraper cities in Asia. The examples discussed here are rather selective and the paper aims to highlight unique technology based visions that have already found their way into reality or believed to be achievable in the near future. Futurama was part of the New York World’s Fair of 1939 and contained an exhibit for the future city designed by Norman Bel Geddes and sponsored by General Motors Corporation (Hall 1996). A large scale model equipped with a ride akin to theme park arrangements paraded a city of skyscrapers and highways (Figure 4a). The exhibit displayed a great deal of optimism in the capacity of cars and highways to relieve cities from traffic congestion and provide a healthy alternative to the industrial city. Whether Futurama merely extrapolated the ongoing development trends twenty years into the future or itself had a profound impact on later urban restructuring is now irrelevant. What was demonstrated as a future vision in 1939 is today a reality, albeit with increased and massive environmental impact (Figure 4b).

Two future city visions are popularized in the media as solutions for over congested cities with limited land resources, Tokyo’s Sky City and the Shimizu Mega-City Pyramid. Both utilize extreme skyscraper visions and offer alternative built forms with revolutionary technologies in building materials, construction methods, energy generation and transportation. They are designed to be self-sufficient with homes, offices, outdoor green spaces, commercial establishments, restaurants, hospitals, trains, cars and conceivably everything that hundreds of thousands of people need during the course of their lifetimes (Kashef 2008b). Vertical city schemes such as these hark back to Le Corbusier Radiant City and Frank Lloyd Ryde Mir High School proposed in the 1930s (Kostof 1991; Francesco and Tafuri 1986). The premise of all these visions is that creating vertical urban configurations would relieve congestion and provide a healthier alternative with reduced footprint and more green space on the ground.

2.1 Tokyo Sky City

This was proposed by Takenaka engineer with a project-ed height of 3520 feet to accommodate more than hundred thousand people. Most innovative about the Sky City concept is the vertical mass articulation into 14 clusters separated from each other by intermediate air gaps (Figure 5). Each of the vertical clusters is 180 feet high and designed with central outdoor space larger than a football stadium. The proliferation of open-air green spaces would make the tower feels like city neighborhoods stacked up vertically in order to avail of cleaner air and optimized movement patterns. Each cluster is conceived as a mixed-use self-contained neighborhood connected with others via sophisticated vertical transportation systems. Multi-decker elevators and high speed monorails traveling at high speeds would move thousands of residents horizontally and vertically throughout Sky City (Kashef 2008b; Discovery Communications 2018). Highly automated construction equipment, robotics and management systems are proposed to complete construction. Though technically sound and a feasible project proposal by today’s standards,
the scope, volume, height and structural configuration of the Sky City is still beyond the current technological capacity for construction systems and materials.

![Figure 5. Sky City concept images and diagrammas (Kashef 2008b; Discovery Communications)](image)

2.2 The Shimizu Mega-City

It is conceived as an offshore city in the middle of Tokyo Bay. The Mega City Pyramid design relies on the future availability of super-strong, lightweight materials based on carbon nanotubes. These are nanoscale cylinders of carbon with a lattice of carbon atoms, each of which is covalently bonded to three other atoms. When perfected, carbon nanotubes are expected to be vastly lighter, stronger and longer lasting than steel. Mixing nanotubes with plastic and metal can give them extraordinary strength, and create a new generation of super-strong and super-lightweight composites that would make steel obsolete (Gasman 2006; Poole and Owens 2003). Notwithstanding the unavailability of nanotube construction materials, the proposed scheme is beyond the logistical means of construction companies today. The designer calls for spider-shaped, robotic plants that would spin a web of massive trusses, transforming carbon and other materials into miles of support right on site. The most innovative aspect of the Mega City Pyramid design concept is its three-dimensional transportation system. The truss members forming the pyramid are hollow, with an internal space large enough to allow trains and cars to move freely between different parts of the city, and structural members double as the city highways or subway tunnels. Trusses connect at hollowed spheroid nodes, which would provide structural support and serve as transfer points for travelers (Figure 5). Residents and visitors could also connect to an outside transportation system that carries them to the heart of the city of Tokyo (Kashef 2008b; Discovery Communications 2018).

![Figure 6. The Shimizu Mega-City Pyramid proposal (Discovery Communications)](image)

3 THE CITY AS A SOCIAL AND CULTURAL ORGANIZATION SYSTEM

Over the last several decades, there has been a dramatic restructuring of metropolitan America. While most inner cities declined, edge cities and select neighborhoods in the center of large metropolitan areas flourished. Telecommunication technology along with the unparalleled amount of information they circulate around urban centers have impacted local economies, suburbs and towns, industries, travel patterns, and floor space requirements. Information technology is splitting the traditional industrial, commercial, or office organization into two distinct functions: standardized activities that may be performed efficiently by automated procedures, and creative activities that demand a dynamic human interface. The ease and cost-effectiveness of establishing a real time communication link between both functions without the need for physical adjacency provided corporations with an ample freedom in relocating parts of their facilities where each function may achieve economy of scale and avail of different market characteristics. Thus, manufacturing facilities, back offices, and other routine operations are relocated to regions that offer cheap real estates and labor while management headquarters, design centers, and similar functions cluster in large metropolitan centers (Sassen 1991; Knox and Castells 1995; Blais 1999; Castells 1996; Castells 2000). Governments around the world today are actively developing their information technology infrastructure and planning massive online service platforms to replace face-to-face and real-time contact (PCAST 2016).

Information technology is transforming the economic and social landscape of urban areas around the world (Dubbelman and Stephen 2015). Blais (1996) contended that that we are moving towards a jobless economy. While managerial and professional occupations particularly in high-tech fields in the U.S have grown steadily over the last decade, labor occupations have relatively declined. Information technology is resulting in a more polarized occupational structure, consisting of highly skilled, well-paying jobs at one end and lower skilled, low-wage jobs at the other, and fewer jobs in between. This means that the occupational profiles of individual communities are being transformed as well. Those with high concentrations of routine functions may be vulnerable to job losses, while those with creative or non-standardized activities are more likely to grow. As multi-locational organizations expand and seek out the best locations for individual functions, communities may become less occupationally and socially diverse, attracting a narrower band of occupations (Kellerman 1993; Mitchell 1995; Graham and Marvin 1996).

Some theorists today cast doubts on the future viability of the city’s social and physical institutions. Information technology has the potential of creating what might be called a “space-less job market.” People preferring rural or natural
settings will be afforded the opportunity to live and work from remote, digitally connected, country houses or “electronic cottages” (Dubbeldem and Stephen 2015; Mitchell 1995). The notion of space-less jobs means that a smaller proportion will be accommodated in traditional workplaces such as downtown offices or suburban business parks. “Hotelling”, shared workspaces, Mobile offices, “Telecenters”, “Telecommuting” and other ideas are currently being considered by small and large organizations as a way to reduce costs and facilitate performing and delivering various services electronically (Blais 1999). All of these trends shift the demand for work space away from the traditional employment environments, reducing the demand for conventional, centralized workspaces, while increasing the need for flexibility in residential neighborhoods to accommodate both live and work functions. As a result, communities will become less occupationally and socially diverse and will perpetually attract narrower ranges of occupations leading to extreme social, economic, and physical differentiation within and amongst cites both locally and globally (Sassen 1991; Castells 2000; Blais 1996; Mitchell 1995; Mitchell 2000).

3.1 The Urban “Bit Sphere”

William Mitchell (1995, 2000) carried the impact of digital technology on human life to a whole different level. He envisioned an environment where physical and virtual realities become fluidly interchangeable and seamlessly united. His digital utopia transforms the make-up of public and private discourses, the forms of cultural activity and entertainment, political practices, and the experiences that shape peoples’ mundane protocols and daily routines. The deployment of global digital networks is antiquating the tyranny of geography and allowing active human interaction at a distance or “telepresence”. Cyberspace or the information superhighway is interlacing with and gradually superseding the physical networks of streets and highways as well as air and other physical traffic channels. Mitchell indulge in a rollercoaster ride that virtually transposes readers from a physically glued or bonded universe to a totally free and elastic human existence that no longer requires a corporeal presence. “Cyborgs”, the new expression denoting digitally connected humans, will be able to open synchronous as well as asynchronous information windows or digital clouds that put them virtually and sometime “effectuatively” through “telemanipulators” anywhere in the world. Special actuators connected to digital channels and other physical embodiments will be able to convey approval, rejection, trust, and even love relations from dispersed geographic locations. Robotic effectors combined with audio and video sensors will provide “telepresence”. Superimposition and multi-layering digital techniques that may blend actual scenes with conjured or virtually composed events will create new modes of experiencing traditional activities such as theatrical and movie production and watching. Spectators may find themselves on stage with the actors trying to distinguish the scenery from the walls or as active participants in movie events that evolve and change as they modify their roles and decisions (Mitchell 1995; Mitchell 2000).

Recent developments in augmented reality technology (AR) have transcended gaming and entertainment possibilities and is currently integrated in various engineering, medical, and other scientific endeavors. In a sense, what Mitchell talked about as a possibility in the 1990s has already become a reality (Mekni and Lemieux 2014). Telesurgery, telementoring, and teleconsultation have become common terms in the medicine practice today. Developments across these fields enhance people’s access to medical services (Valente et al. 2015). Though not common or systematically done, surgeons today may perform operations from remotely located clinics using robotically extended scalpels with precise and instantaneous video interfaces. They may delicately execute surgeries that were even hard to carry out with physically synchronized human hands (Kumar 2008). Sci-Fi miniature electronic bugs that travel inside tiny human arteries to display and possibly perform unclogging, reconnecting, or retinal surgeries seem closer to reality than ever before.

A similar argument goes for libraries, art galleries and museums where physical visits can be transformed into smart virtual tours able to display and convey the exhibits colors, textures, and compositions and also share relevant anecdotal and historical information. Prisoners will be detained at their homes with miniature smart electronic devices embedded in their bodies that allow monitoring, tracking movement and possibly incapacitating for maximum security offenders. The sphere of communication is limited by new rules of bandwidth availability and other accessibility concerns. Mitchell (1995, 2000) talked about a new form of human existence, and a world that is totally different and in many ways transcendent to existing social, cultural, and physical contexts. The current technological advancements in wireless networks and nanotechnology are facilitating Michell’s prediction of the seamless integration of physical and virtual environments. Nano-based products coupled with extreme bandwidth speeds create remarkable possibilities for boosting performance, durability, energy efficiency, and information exchange, and interaction between users and products at large. Examining the role of technology in reshaping human settlement patterns is crucial for drafting appropriate public policies aimed at regulating product development and moderating potential negative externalities (Kashef and Sabouni 2010).

4 A CRITICAL PERSPECTIVE ON TECHNOLOGY AND URBAN FORM

Developments in transportation, construction systems and building materials have precipitated fundamental changes in urban development patterns. Street networks and morphology of the Baroque city were defined by the improvements in horse-drawn wheeled carriages. The automobile subsequently caused a revolution in mobility patterns and set the stage for the construction of very complex road and highway networks that define modern cities today. It’s worth noting that the proliferation of cars as the dominant mode of transportation led to the creation of sophisticated layers of land use regulations and public policies that changed not only development patterns but also the socioeconomic structure and civic institutions of the city. Critical studies have revealed that land use regulations and public policies are inextricably linked with transportation, home ownership, gender, racial, and class conflicts within cities. The urban economy shifted away from
the mono-centric to polycentric or decentered model. In the past, all employment was assumed to be concentrated in the downtown with the remainder of the land devoted to housing. The ease and efficiency of movement afforded by cars diffused the urban pattern and prompted the development of multiple centers that lacked self-sufficiency. Sprawl and leapfrog development typical of suburbia and car dependent developments have dislocated traditional urbanity and changed the face of the city. Telecommunications and digital technologies created a locational flexibility in housing, employment, industrial, and business operations. This has contributed to a state of urban stress and duality within cities and regions resulting in ever widening economic and social gaps.

The ease of transportation and deployment of digital telecommunications is redefining the city from being a repository of localized economic, social, and cultural forces to a regional or global entity that attracts a broader and heterogeneous mix of social and capital accumulation interests.

Cities today are experiencing a mix of fragmentation and concentration dynamics based on their location and roles in the regional/global market economy. This trend is predicted to continue and urban areas will be shaped and reshaped by events and forces residing outside their territories. Some would thrive and experience growth and others would decline or disappear altogether in favor of digitally interconnected fragments of thinly populated developments.

Skyscraper building technology was perfected by the mid twentieth century following the breakthroughs in designing elevators and steel frames. Mega skyscraper projects currently anchor downtowns of modern cities across the globe. Technological advancements and scarcity of land in congested urban areas was met with an equal desire by developers to maximize their profits and create symbols of wealth and prestige. The sheer size and spectacular height of skyscrapers engages people’s imaginations, emotions, and memories. Once built, a skyscraper becomes a symbol for the place where it resides. The image of the Empire State building has come to represent New York City globally. The Sears Tower epitomizes technological prowess and corporate power in Chicago. Petronas oil company towers have become symbols for the economic success and arrival of modern Malaysia. Khalifa Tower, the current tallest skyscraper in the world, and other mega projects in Dubai have allowed the city to compete on a global scale and become a major commercial hub between the east and west.

The catastrophic collapse of New York World Trade Center Towers in September 2001 led some to predict the end of the Skyscraper Age. These predictions proved to be wrong, and New York completed the Freedom Tower in 2013. It is considered the tallest building in the United States and the Western Hemisphere. Despite the Asian financial market crisis, the Shanghai World Financial Center and China’s tallest structure was completed in 2008. Visions popularized in the media of taller, bigger, and more imposing towers reflect the excitement associated with technology and render skyscrapers as viable alternative to low-rise and large-scale urban expansion. The scientific prowess that accompanies visions such as the Shimizu Mega-City Pyramid and Tokyo’s Sky City, coupled with the need for vertical space may eventually transform them into reality. In a similar vein to the impact of telecommunications and transportation technologies, skyscrapers contribute to the economic and social polarization of urban communities. These towering structures occupy large swaths of urban land and create isolated and socioeconomically stratified population groups. Architects and planners need to develop appropriate configurational and spatial typologies that enhance the integration of skyscrapers with existing built environments.

5 CONCLUSION

This paper provided an exposition of the impact of technology on human settlement patterns. It tackled some futuristic themes from the literature and provided a critical perspective on the likely impact of technological advances on the city and urban culture. It certainly did not aim to fantasize about the future or engage into either the doom and gloom scenarios or the sci-fi version of the city of the future. Though occupying a good part of this study, the historical review of urban development has been indispensable to ground the current debate and point to future possibilities. Understanding the history of the city and the changes that took place over the last hundred years is critical for informed debate of technology and urban form. The impact of digital technology on day-to-day business and social interactions is increasing by the day. People are becoming more and more attached to their mobiles, computers, and a host of other technology gizmos that complement or replace their face-to-face social interactions. Live, work, shop, and play patterns that currently occupy diverse locations in the city are increasingly collapsed in handheld digital devises that allow people to avail of them anywhere, anytime with no need for territorial displacement. Education, entertainment, governments services, culture, commercial exchanges, and many other features associated with urbanity have been virtualized. As more people join the cyberspace, the need for streets, highways, and physical facilities would be reduced with serious consequences for cities.

Having said that, it’s worth noting that the competition between cities on a global scale to attract foreign investments and assert their presence has probably catalyzed the resurgence of urbanity and energized the minds of architects and planners to devise development patterns and transportation tools that bring mixed-use functions closer together. Cities are perceived today as engines of wealth and prestige as well as anchors for economic and social development. Perhaps, this would allow urbanity to triumph over the forces of extreme dispersion facilitated by technology. As urban life being celebrated all over the world and new megacities arriving at the global scene, the prediction is that cities would continue to thrive and recover the sense of time, place, and civic purpose. Technology will certainly continue to play a crucial role in creating remarkable possibilities for boosting human performance.

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