Technology and Urban Form: A Philosophical and Historical Perspective

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ABSTRACT: Urban form has undergone tremendous changes throughout history. These changes have stemmed from various causes. Technology has been one of the most influential forces in changing the face of cities, leaving different marks on the city form. In fact, technology has gained an increasingly more important and integrative role in bringing changes to the urban form. In addition, recent plethora of developments and advances in various fields of technology more than before necessitates an examination of the relationship between technology and urban form. However, such an inquiry should be based on an understanding of the underlying philosophical and historical foundations underlying such a relationship. Throughout human history, a direct relationship has existed between the philosophical outlook on the world, the view on technology and its application, technological developments and consequently their effects on the city. The first step in understanding the relationship between technological developments and urban form changes and also in explaining the philosophical tenets, underlying urban form changes throughout history, is to realize the nature and philosophy of technology per se. The present study aims to facilitate and present such an understanding in order to broaden the horizons projecting the relationship between technology and urban form.

Keywords: *Urban Form, Technology, Industrial age, Information age, Phenomenology, Philosophy, Historty*

1. INTRODUCTION

The present paper unfolds with presenting a definition for technology and its various underlying philosophical theories. This will be followed by a concise survey of the technological developments and its concomitant repercussions in the urban form having occurred in different historical periods, the aim being identifying and assessing the philosophical bases underlying such a likely relationship. The paper will conclude by presenting a summary of findings on the relationship between the philosophical-historical nature of technology and the rationale underlying the behaviors associated with urban form changes in different historical contexts. It should be noted that the historical context of the present study predates the new information and communication age. The findings will transpire as the missing link and an appropriate basis for understanding of evolution of urban form in Information age.

2. Philosophical views on Technology

The word Technology in English constitutes the two Greek stems of Techne and Logia which, respectively, mean art and studying or understanding. Technology may be defined as a set of methods employed for making and using tools, machines, materials and processes that may solve some of the problems man faces. Accordingly, one may assert that technology as a human activity predates knowledge and engineering (Wikipedia, Technology, 11/5/2010).

Currently, there are different views on and approaches to the philosophy of technology, which can be grouped into three categories of Instrumentalism, Determinism and Existentialism (Vafamehr & Khobreh, 2007) (Table 1).

Heidegger might be regarded as a first philosopher who distinguishes between the nature and the craft of technology. He asserts that technology and the nature of technology are two quite distinct matters (Ibid). Technology per se is not a mere instrument to achieve a certain goal (Kroes, 2005). In Heidegger's view, "technology as a mere instrument for science" is a correct but superficial definition of technology. However, he rejects an instrumentalist definition of technology as the true conception of technology defining and revealing its nature (Heidegger, 1977).

In general, although the instrumental and deterministic definitions of technology may sound correct they fail to reveal their true nature. Rather, they bridge our quest toward an

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Table 1: Philosophical views on technology

Approach	Prominent theorist	View on technology
Instrumentalism	John Galbraith, Ernest Braun, Alexander Rosenberg, Firschtak, Claxton, Khalil, Daniel Bell, James W. Carey	Technology as instrument
Determinism	Karl Marx, Marshal Mcluhan	Technology as self-evolving & society has to accept new products
Existentialism	Martin Heidegger, Lewis Mumford, Michel Foucault	Technology as the starting point explaining the nature of man & his relationship with nature

understanding of the true definition of technology, forming an appropriate perception. It is this very nature of technology that bestows on us a framework to perceive the world, understand it and forge a connection with the surrounding world. Therefore, we are led to two views on technology. A first one is an engineering view which requires a developmental perspective and which regards technology as an all-human practice legitimizing its penetration into every aspect of life. The second one is a humanitarian view which sees technology inhering a limited aspect of humanity and which is concerned that this very restricted aspect may dominate other human aspects in every way. It is clear that progress in technology, science and human thinking throughout history has come to mean achieving the things unknown to man and realizing their presence in all aspects of human life, resulting in a humanitarian view more profound and more valuable than an engineering one.

Technological developments, Social evolution and Urban form

Technological developments enjoy a history predating human habitats, including the city, dating back to the nomadic stage of social evolution (Pacey, 1990, 7; Rousseau, 1960,19-32; Morris, 1974, 12-14, 39). Since the present study attempts to examine the relationship between technology and urban form and life on the basis of various categorizations, including those of Clark's, Toffler and Kevin Lynch's paradigmatic classification, from an industrial point of view we can accordingly divide the history of the influence of technology on urban form and life into three eras of pre-industrial, industrial and post-industrial society (Galantay, 1975, 2-3; Toffler, 1980, 8; Lynch, 1981, 93-105) (Table 2).

The foregoing theorists have enumerated various reasons to account for the technological developments pertaining to a specific era. As a matter of fact, Toffler considers an agricultural economy as the foremost factor in the formation of urban societies. However, Lynch considers spiritual and metaphysical tendencies as underlying forces forming cities. It should be noted that, no definite date can be found to mark the beginning or end of the foregoing eras. The form of human habitats in general and the city in particular has always retained the influences of these three periods. Stated in other words, these eras still persist. As noted before, the Industrial Revolution of the 18th century can be regarded as a turning point in this evolutionary course.

The application of technology in different stages of urbanization history (before the post-industrial era) and its effect on the urban form has manifested in different ways despite different degrees of the functional integrity of technology as a concept and a role in the evolution of urban form in different historical eras(Mumford, 1968; Lynch, 1981; Heidegger et al,1998; Rousseau,1960; Ostrowski,1970; Weber, 1966; Pacey, 1990; Benevolo, 1980)(Table 3).

In the pre-industrial age, the growth rate of cities and their physical and demographic sizes were gradual. The majority of the world population lived in rural areas. Cities had limited function in commerce, government, inter-route, religion and agriculture in comparison with the post-industrial revolution era. The form of cities, from the earliest ones to those developed during the industrial revolution, inhered combined traces of military, religious, political, governmental, natural, cultural and economic characteristics each with a peculiar technology shaping and touching upon the ultimate urban form (Ibid).

Unified with pure materialistic science, technology emerged on the scene after the industrial revolution and in the 18th and 19th centuries, in particular. The face, form and fabric of the cities were a function of environmental force before the industrial revolution. However, the changing forces shifted once the industrial revolution spread technology. The formal effects of

Table 2: Historical milestones and Urban form

Historical era	Theory	
Pre-industrial	Agricultural Age	Universal urban form
Industrial	Industrial Age	Machine model of urban form
Post-industrial	New Age (information)	Organic model of urban form

Abbas Shieh

Table 3: Major factors in urban form

| Pre-industrial age | | | Industrial Age | | | | | | | | | | |
Ancient city	Medieval city	Renaissance & Baroque city	Transportation	Infrastructures	Old Communication Systems	Building	Economy	Population & Social Factors	Advancement of Knowledge	Power leverage	Land use	Inventions	Discoveries
-Defense -Culture -Beliefs -Governance -Basic inventions -Nature -Iron & Bronze -Writing system -Forging	-Defense -Supplementary inventions -Feudalism -Nature -Governance -Beliefs -Ethnicities -Culture -Magnetic Compass -Compasses -Time piece -Printing machine -Building development -Paper -Discovery of America -Irrigation techniques	-Defense -Social classes -Aestheticism -Nature -Economy -Publications -Communication -Revolution in routes -Revolution in knitting & weaving -Forging and design -Machines -Topography -Army -Bureaucracy	-Development of roads -Automobile -Train -Airplane -Import & Export -Revolution in speed -Transportation system -Subway -Ship	-Water supply system -Power supply system -Telephone system -Sewage system -Piped gas system -Drainage	-Radio -Television -Press -Telegraph -Telephone	-Improved Engineering -Improved building techniques -New methods -Building developments -Graphic duplication -Materials diversity -Architectural styles and schools -Land use changes -World expos	-Expansion of industries -Centralization of industries -Centralization of commerce -Trade developments -Income diversity -Job diversity -Specialization & task sharing -Working methods changes -Production methods changes -Land price changes -Land ownership changes -Economic theories -Efficiency in agriculture & livestock husbandry -Centralization of banks -Tourism	-Population increase -Immigration increase -Social interventions -Social & artistic styles & schools -Socio-economic classes -Diversity in traditions & custom -Diversity in recreation Cultural exchanges	-Physics -Chemistry -Biology -Health engineering -Civil engineering -HVAC engineering -Crafting -Drawing -Math -Philosophy -Architecture -Urban planning -Urban design -City management -Medicine -Economics -Sociology -Psychology -Transportation engineering -Agriculture -Scientific views	-Education -Health -Governments -Religion -Group sports -Industrial firms -Construction developments -Authors -Theorists -Strategic defends -Capitalists -planning regulations -Construction companies -Municipalities	-Industrial land division -Land use change -New urban spaces -Urban planning & modeling -Urban theories -Megastores -Urban terminals -Hospitals -Urban parks -Urban inns	-Electricity -Brass -Steel -Machines -Construction materials -Computer -Cinema -Still & video camera -Printing advanced -Military inventions -Conquering space -Other inventions	-Steam energy -Water energy -Pathogens -New mines -Astronomy -Other discoveries

Table 4: Technological developments and urban form changes in the industrial age

Area	Historical event	Effects on city form
Transportation	• Stretching of railways to the core of cities • Development of urban railway transportation systems • Horsecars in the 1830's, cable cars in the 1870's and electric trolleys in the 1880's • Use of water energy to power factories • Steam power in the 1830's • Railway transportation in early 1830's • Horsecar lines 1830-1880's • In mid 1890's electric trolleys and wagons and also express railway systems • Development of automobiles in the 1920's	• Extensive expansion of urban habitats • Establishment of early factories outside large and major cities, along rivers for access to water power • Establishment of factories inside cities neighboring harbor facilities, railways and urban labor force • Convenient commute between suburbs and downtown areas and expansion of suburban population • Development of streets, highways and expressways to accommodate automobiles • Development of suburban services and activities • Transfer of production facilities to locations accessible by railway and highway
Utilities	• In mid 19th century, industrial development, enlargement of cities and population density increase, need for energy and health services • From late 19th century: invention of light bulb and need for more household appliances • Concentration of electric machinery and facilities inside cities • Continuous growth of urban population	• Establishment of utilities networks (water, sewage, electricity, pipeline gas); cities are entangled in wires and pipes • Suburban development • Establishment of factories inside cities • Introducing novel services and electronic technologies into cities • Continuous development and enhancement of utilities with higher quality
Building	• Invention/harnessing of electric power • Invention of elevator • Development of metal case manufacture methods • Progress in technology and materials • Using a mechanistic view as an ideal in design as mechanical system and architectural machine	• Discovery of new building forms as low-rise structures in the suburbs and high-rise buildings in city centers • The commercial and business district (C.B.D.) underwent radial changes by development of high-rise buildings and skyscrapers between 1870 and 1900. • Development of suburban high-rise buildings in later years • Emergence of varied industrial buildings in various forms, from large factory complexes in industrial estates to small workshops
Communication	• Development of a network of physical infrastructures such as urban highways in mid 1950's to 1960's • Invention of traditional communication means such as telegraph, telephone, radio and television	• Facilitation of suburb-downtown commute for the white collar employees and the stabilization of residential life in city centers • Facilitation of functioning speed between business centers dependent on white collar work force • Relative decentralization of certain major downtown businesses

technology on the city in the industrial age can be recognized in the four areas of transportation systems, utilities, buildings and communication systems. It should be underscored that these systems and elements are not mutually exclusive and enjoy extensive interactions (Ibid).

Transportation modes, including non-motorized vehicles, automobiles, train and mechanical carriages roaming the cities have influenced the urban area through their continuous evolution. One may parallel the development and sprawl of cities with the growth of transportation technologies. Had there been no fast travelling automobiles and subways, cities would not sprawl so extensively and the distance between residential environments and non-home environments, including the workplace, recreation centers and educational institutions, would be minimized in terms of travel time. Urban buildings and structures are now functions of the conditions of utilities such as water, electricity and telephone. In case water supply networks failed to pump water to the higher stories of

buildings or if power lines failed to supply enough electricity to the elevators, cities would not undergo significant changes in height or in form. Buildings are not exception to the effect of the evolutionary processes of technology. The advances in the building technology have clearly exerted influence on the form, height, volume, area and similar characteristics of the buildings. Land-use patterns in cities and features such as building densities and demographic variables and the division of lands and their price are functions of achievements building technology has presented as an enabling factor. These factors influence the economic efficiency, power consumption, traffic volume, social relations and environmental pollutions and even the urban life mechanisms among others. The form of routes and the way buildings are located along them, the beauties and cityscape designs are requirements influenced by technology. In terms of communication, the application of old age communication systems especially in the industrial world prepared the ground for a close communication between

cities and citizens despite the long distances lying between them. Traditional communication systems, from telegraph and telephone to mobile phone and television and radio, played such major roles. These achievements functioned the reverse of transportation systems, including automobiles and trains. Therefore, their effects on the city face and form and the use of routes, buildings and cityscapes were different. These technologies influenced the processes involved in areas as diverse as finance, administration, commerce and education and even linking networks such as highways.(ibid) (Table 4).

The Nature of Technology and Urban Form

Throughout human history, a direct relationship has existed between the philosophical outlook on the world, the view on technology and its application, technological developments and consequently their effects on the city. The first step in understanding the relationship between technological developments and urban form changes and also in explaining the philosophical tenets underlying urban form changes throughout history is to realize the nature and philosophy of technology per se. Heidegger's view provides an adequate explanatory note. In interpreting phenomena, Heidegger employs his own phenomenological approach. Heidegger asserts that phenomenology enables one to discern what is observed, an approach that allows an entity to reveal as it is.

Discussing art, Plato uses the term Techne in addition to the integral concepts of matter and form. The term Techne is a challenging concept to grasp in the modern language. The Greek used this term to apply to a work of art in a similar vein as it was applied to a piece of craft. The modern man tends to understand this concept as a kind of production method. In addition, the modern man encapsulates in this concept everything imagined to originate from the modern technology. Technology is not originally intended to mean as manufacture or production; rather, it refers to an understanding associated with any attempt of man to produce. Nevertheless, Techne refers to an understanding which guides man in producing something, either a tool or a work of art. However, the term art in its modern usage refers to production of fine objects. Furthermore, reflections on art commonly focus on beauty and aesthetics (Kockelmanns, 1985: 8-9). Heidegger contends that technology is a way of truth and discovery that explores the world in a certain way (Heidegger et al, 1998). In his view, man is an invader on nature and objects, active in exploration and baring, for whom technology provides an explorative instrument to encroach on the nature (Heidegger, 1977).

Naturalists, from Lao Tse to the modern era, think of technology as a destructive force which tears down nature's beauties. In their view, roads, bridges, ships and other trappings of industrial technology have engulfed man's life with fears (Russell, 1962, 114-116) . Before the Industrial Revolution, thinkers such as Copernicus, Galileo, Newton and Kepler prepared a fertile ground for an industrial revolution followed by scientists and philosophers such as Ampere, Lavoisier, William Gilbert, Einstein, Darwin, Voltaire, Decartes, Kant, Hegel who coined new concepts for the new thinking era, detached from the ancient classical traces. An apt context being set, technology as a changing wind more than before left its marks in the history of mankind (Mozayani, 1997, 125-130). As Bertrand Russell remarked, science had a good progress during the 17th and 18th centuries, but it was not until late 18th century that it impacted production methods. Thus, the technological developments since 1750 in total outweigh the aggregate technological developments the world had seen from the ancient Egypt to then (Russell, 1962, 114-116). The world had taken a long stride in innovation and inventions regardless of its relationship with phenomena such as art and science.

More than any time or place else, the impacts of developments in technology are to be observed on cities to the extent that multiple direct and indirect influences could be discerned on urban lifestyles and forms. The most pronounced impacts may be seen in city forms and technological solutions intended for urban problems, urban innovation, industrial developments, new economic-social procedures and their indirect spatial impacts and also changes in beliefs and scientific and philosophical views on urban planning, design and management.

In its spreading course throughout history in general and after the beginning of the Industrial Revolution in particular, technology has culminated in various economic changes. The farmland worker was transferred into the factories. Traditional production methods made their way into factories and workers and their households immigrated to larger cities. Standardization, specialization and synchronization changed in line with the extension of factory-based manufacture methods (Toffler, 1980, 62-84). Changes in technology led to changes in economy. And changes in economy entailed social and demographic changes resulting in different views that influenced the city and urban form and travelling to spaces away from the cities and near the nature. Urban forms and urbanization changed in response to the establishment of different social and economic institutions. This culminated in modernity and, once enabled, the spirit modernity was blown into urban forms, influencing even the human spirit and creating new demands. Industrial developments created extensive changes in demographic distribution. Industrial centers were established on city outskirts or in city centers and new urban social classes were born, including the working class (Jaberi Moghaddam, 2005, 161). In addition, the diversity of trading methods created new spatial and location boundaries. The organized and intertwined fabrics of traditional cities were replaced with network fabrics allowing the traffic of automobiles and cable cars, which resulted in changes in habitation and social behavior patterns. The principles of rapid functional response and economical cost-benefit ratio were the major goals targeted by these developments. As the application of technology vastly expanded following the Industrial Revolution, new cities were developed founded on the basis of new consumption patterns. Such a view included principles

such as the Shared space principle, the Public goods principle, the Stockholding principle, the Impartiality principle, the Equity principle, the Revocability principle and the Negligence principle. Such a perspective reveals numerous points which can transform cities, though with other direct economic and social consequences (Jaberi Moghaddam, 2005,96).

The nature of technology after the Industrial Revolution, influenced by mass production pattern, based on the factory view of production line instead of traditional production, handicraft and workshop methods, gained the special characteristic of extensive multiplication. Such a characteristic found its acme in the 20th century schools of Fordism and Post-Fordism as two economic models that emphasized rational and efficient organization to attain high efficiency in producing maximum possible number of products with minimum possible cost. The most significant impact of technology on urbanization was the competitive edge they granted to cities in comparison with the rural villagers in terms of labor concentration and the provision of space required for factories and companies. During Fordism period, raw materials and the work force were the most important spatial factors for factories and firms. However, during post-Fordism era, these factors were replaced with the attainability factor in site location, which led to the transfer of factories to places out of city. Factories formed clustered areas on city outskirts, eventually forming coagulated blots of facilities. The sites left after removal of Fordism period factories found new uses, where new companies and offices were to be built.

On the other hand, various thinkers throughout the world proposed short-term and long-term solutions for overcoming life challenges created by the developments brought on by the Industrial Revolution. In addition to presenting solutions for removing the problems of modern life, using the capacities of the modern technologies some thinkers created innovative ideas and urban models that were to impact urban development in the coming decades. Frank Lloyd Wright's Broad Acre City concept was such an innovative model. Wright believed that with the invention of telephone and automobile, old cities more than before lost their modernity. He optimistically awaited the demolition of overpopulated and cramped cities of New York and Chicago to be replaced by rural areas with detached houses where on the one hand people would live far enough to ensure life stability and on the other hand people would be in touch and close enough through the use of new technologies such as mass media and transportation, nurturing a sense of belong to a real community. Personal values such as freedom and self-fulfillment would thrive in such environments (Legates & Stout, 2000, 344-5).

Other changes relate to influences stemming from philosophical and scientific beliefs. Ludwig von Bertalanffy believed that progress in science has resulted in the spread of systematic processes and design of systems engineering. In this case, city is taken into account as a system (Bertalanffy, 1973). Therefore, one should note that not only has technology influenced human environments in general and in cities in particular, but also it has changed within itself. These influenced the formal structures of habitats, especially in city centers. The development of disciplines such as operation research, cybernetics and information theories and game theory, automatic controls and the like are all indebted to the new conditions and requirements (Farshad, 1983, 32-33).

CONCLUSION

A comparison of the modern conception of technology with that of the ancient world evidently reveals a degree of degradation in terms of its meaning and application, as is the case with art per se. That is technology and art diverged as they developed through different stages of human civilization. Technology in the past meant an understanding that guided the craftsman through art and craft. Today, this conceptualization of technology has been reduced to merely craftsmanship. Accordingly, the interpretation today attributed to technology has parted from science, engineering and art. More than anything else this fact shows the fluid and malleable conception of technology and the way it is viewed by man through history. In the pre-industrial age, technology was considered as a static and multidimensional element in line with an aesthetic and heuristic nature (art and science) and as an instrument satisfying the basic needs of man. In this age, technology was regarded as the facilitator of the relationship with nature and hence had an existence not detached from man. Technology lacked an independent integrative existence and was hence subject to the various grounds constructing the peculiar zeitgeist. Therefore, in this age technology lacked a dynamic existence to change the city form and was used merely as an instrument to manifest different leans and tendencies of the time on the urban form. Nonetheless, the traces of pre-industrial cities (archaic city, ancient city, medieval city, renaissance city and baroque) had evidently paved the way for social and economic changes and changes in urban form in the upcoming ages.

In the industrial age, technology transformed into a dynamic, one-dimensional (production oriented), multipliable and process element. In this age, technology served not only to meet the needs of man but also prepared the context for newer needs of man: needs that created a new life style for man. Therefore, technology served as a means of conquering and controlling the nature, independent from the man, to become an integrative and purposive phenomenon that could create history. The city in this age acquired an autonomous dynamism, self-reliant and endogenous, detached from the mechanisms seen in agriculture. With so many political, economic and social changes having occurred during the 19th and 20th centuries along with the impacts of technology as an agent both meeting the needs and solving the problems, emphasis on and trust in technology gradually lead to mechanistic thinking and conceptualization of the city as a machine (Table 5).

To sum up, it should be noted that technological advances in the industrial age in parallel with political, social and

Table 5: Historical-philosophical relationship between Technology and Urban form.

Technology	Urban Form
Pre-industrial Age • Static, multidimensional element in harmony with aesthetic and heuristic identity • Meeting the needs of man • Facilitating relationship with nature • Integral part of man's identity and existence • Following zeitgeist	Technology has no direct effect on city form. It has a static relation to the city and is a means to satisfy the political, social, economic and cultural needs of man. It is a indirect defining factor for urban form and its inner hierarchical and Spatial functions
Post-industrial Age • Dynamic, one-dimensional (production oriented) multipliable and process element • Creating new needs for man • As a means to conquer and control nature • Independent from man • With purposive integrity • Creating history	Technology has a direct effect on city form. It has a dynamic relation to the city and is a means to create new political, social, economic and cultural needs for man. It directly defines urban form and presents a new hierarchal functions and Spatial system.

economic changes of the late 20th century have resulted in a new revolution in man's way of life and life style. Based on technological changes in ICT, this revolution tends to create a totally new face of the human habitats in general and in the cities in particular.

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