Knowledge-based urban development in Wuhan, China

Xuefeng Wang

x.f.wang@ncl.ac.uk

Newcastle University, UK

Gateway: Regions as innovation hubs?

Abstract

Knowledge-Based Urban Development (KBUD) has now become a fashionable term both in terms of urban policy making and academic study. This is the case not only in post-industrial cities in developed countries, but also in cities which are still in the process of industrialisation in developing countries. In responding to this, urban development policies have been redirected in recent years to enhance and to build on the strengths of cities' knowledge resources regardless their state of development. Meanwhile, studies into KBUD have attracted interest that links interests of planners, economists, geographers, and other social scientists. Nevertheless, in many cases the term is confused by a plethora of competing, implicit, and unarticulated assumptions that have resulted from different interpretations by various disciplines. From perspective of economic geography, this paper distinguishes two successive forms of KBUD i.e. technolopoles and knowledge city. It focuses on institutional innovations – the development of Science Park, the most common form of KBUD across the world, and highlights the changing role of university in the creation of urban innovation network and fostering knowledge environment. The paper puts this background into the Chinese context, the largest developing country in the world, which has managed successfully a fast growing economy following a unique industrialisation strategy over the last three decades. Recently, China has responded positively to the rising globalised knowledge society by reoriented its economic centred development strategy to which they would call the "Scientific Development Concept" where development is being made rely more on the use of all types of knowledge. Taking Wuhan, the largest city in central China, as a case, this paper highlights two reciprocal themes: knowledge environment and knowledge synergy in Wuhan in general and the development of the East Lake High-Tech Development Zone (now nationally known as "Optical Valley of China", the Chinese version of Science Park) in particular. Specific attention is paid to the changing role of universities, which are transforming from purely teaching institutions into entrepreneurial ones guided by central government, in knowledge synergy activities in the process of the development of China's Optical Valley. The review of China's national program on High and New Technology Industrial Development Zone reveals that it is the integration of high-tech industrial complex, science park, technopolis, and science city elsewhere in the world. In the early stage of the program, it failed to develop a systematic policy framework, which made the program less in favour at city level than that was expected. The change of policy from 2000 onward, however, have reoriented the program to follow the knowledge city approach, which paid more attention to create high quality of knowledge environment, though, there is still a lack of interactive relations between government, academia, industry, and public. Findings from the

case study indicate that the development of OVC has improved significantly the knowledge environment within the area and provides an institutional mechanism for synergising knowledge, in which academia is emerging to play a vital role. However, to its host city as a whole, it may cause social tensions between OVC its self and the old urban area.

Key words: KBUD, Technopoles, Knowledge city, HNTIDZ, Wuhan, China

1 Introduction

Knowledge-Based Urban Development (KBUD) has now become a fashionable term both in terms of urban policy making and academic study. This is the case not only in post-industrial cities in developed countries, but also in cities which are still in the process of industrialisation in developing countries in recent years. Literature on KBUD shows multi-disciplinary interests ranging from planning, institution, economic geography, and IT, to management perspectives. Planners see KBUD as a new form of urban development for the 21st Century that could, potentially, bring both economic prosperity and sustainable socio-spatial order to the contemporary city (Lee et al., 2008, Yigitcanlar et al., 2008). From institutional point of view, it is a institutional innovation (Dvir, 2006, Ergazakis *et al.*, 2006b), while economic geographers refer KBUD to as a powerful strategy for economic growth and the post-industrial development of cities to participate in the knowledge economy, which creates high value-added products using research, technology, and brainpower (Edvinsson, 2006, Metcalfe and Ramlogan, 2005). KBUD is also seen as a strategic knowledge management approach applied to social level (Carrillo, 1999). Last but not least, technological study into KBUD views it as scaling up of information and communication technology (Aurigi, 2005, Baqir and Kathawala, 2004, Graham and Aurigi, 1997).

Like many other theories, KBUD was not born perfect but evolving in nature. The early attempt of KBUD initiatives can be traced back to the 1980s when the success of Silicon Valley in the US and Cambridge Science Park in the UK in the 1960s and 1970s triggered international enthusiasm of development in this kind. Such as the Japanese technopolis program, Hsinchu Science and Industrial Park in Taiwan, Taedok Science Town in South Korea, Singapore Science Park, French Technopoles

program and so on are seen as typical examples of efforts, which Castells and Hall (1994b) would assign a general term – Technopole – to represent this phenomenon. Theoretically, all these initiatives were economic centred and based on an assumption that there was a linear relation between technology advancement and economic growth.

Despite the enthusiastic, studies into the actual performance of Technopoles show mixed results. Massey et al. (1992) argue that technopoles are a form of prestigious urban development with few productive synergies generated and these is no significant evidence supporting that geographical proximity between universities and a science park accounting for the promotion of technology transfer. Storey and Tether's (1998) study shows that most science parks in Europe have made only a modest direct contribution to employment and it was difficult to assess their contribution to technology transfer. Westhead and Storey (1995) fund that the actual links between university and firms which located in the science park were less significant than that anticipated. Similarly, based on a comparative analysis, Vedovello (1997) shows that geographical proximity between partners is not an important influence for the existence or strength of formal links between university and industry.

The rapid advancement of information technology in the 1990s and the global trend of transforming into knowledge society brought with it a new form of KBUD – knowledge city. Carrillo (2006) refers in this respect to the tendency that the 21st century will be the "century of knowledge" where knowledge is the driving force of development (Drucker, 1993) and the "century of cities" where majority of the world population will live in urban areas. Ever since the birth, knowledge city has immediately received attention both from urban policy makers and academic researchers. Many cities around the world have established their strategy to develop toward knowledge city. Meanwhile, it has attracted research interest that links interests of planners, economists, geographers, and other social scientists.

Although literature on knowledge city has not been systematically developed yet and there is even no commonly accepted definition given to it so far, it can be ascertained that knowledge city is an advanced form of urban development which can fully

respond to the needs of KBUD (Ergazakis *et al.*, 2006b). Moreover, knowledge city appears to be adopted as an umbrella term that may cover many other related terms such as "ideopolis" (Work Foundation, 2005), "intelligent city" (Komninos, 2002), "creative city"(Landry, 2000, Landry and Bianchini, 1995), "learning region" (Florida, 1995), "digital city"(Aurigi, 2005), and so on, which each alone may represent a specific aspect of knowledge city as a whole.

In responding to the global trend of KBUD, Chinese government has also launched its KBUD programs at the beginning of the 1990s. taking the suggestion of four leading Chinese scientists who appealed China to join the international race for high technology development in March 1986, the central government called together 124 senior Chinese scientists to draft China's strategic plan for the development of science and technology, now known as the "863 plan". One year later, the State Council announced to invest in "High-Tech Research and Development Program of China", known as the "Torch Pogram". The main objective of the program was set to "develop high- and new-technology products, establish technology-oriented enterprises, and pave the way for the commercialization of innovations that will come out of major national science and technology programs (the 863 plan)" (Yuan and Gao, 1992, p.197). 20 themes ranging from biology, spaceflight, information, laser, automation, energy, new materials and oceanography (Wang et al., 1998) were selected as priority. However, the plan would not work due to the lack of institutions that would support new- and high-technology firm formation and other mechanisms of technological diffusion (Hu, 2007). In facilitating the implementation of the "Torch Program", a so called "High and New Technology Industrial Development Zone (HNTIDZ)" program was launched by the State Council in 1991. The initial expectation, the HNTIDZ was to foster and facilitate commercialization of domestically originated new- and high-technology (Walcott, 2003).

The Chinese HNTIDZ appears to embrace all forms and features of technopoles elsewhere in the world and has evolved in the last few years to transform into knowledge city. However, this has generally been overlooked by western researchers. Taking Wuhan East Lake High-Tech Development Zone (the Optics Valley of China), one of the first designated HNTIDZs in China, as a case, this paper explores the evolution of China's KBUD, highlighting the change of knowledge environment and

knowledge synergy in the process of HNTIDZ development. Specific attention is paid to the role that universities are playing in knowledge synergy. The paper is part of the PhD research project that the author is currently undertaking.

The rest of the paper is organised in the following way: section two will review the literature related to the technopoles and knowledge city. The movement of Chinese HNTIDZ will be discussed in section three, which will be followed by the case study of the Optics Valley of China. Then a conclusion remark will be offered in the final part of the paper.

2 Literature on KBUD

2.1 Technopoles

Four forms of technopoles distinguished by Castells and Hall (1994) are key areas of study: science park, high-tech industrial complex of firms, technopolis, and science city. Science park is referred to a mechanism for setting up an infrastructure in which the interaction between university and industry might be forged and strengthened (Goddard *et al.*, 1994). It was university-oriented initiatives originated in the United States in the early 1950s as a means of complementing academic programmes and raising income (LaValle, 1982), better exploiting academic enterprise and research (Lowe, 1985), and capitalising on land resources and encouraging greater academic entrepreneurship (Grayson, 1993). However, the involvement of government in the 1980s shifted away from these objectives to become an institutional arrangement of promoting regional economic growth (Luger and Goldstein, 1991). Three common objectives of science park are often mentioned in this regard: economic development, transfer of technology, and property development (Grayson, 1993).

Industrial complexes of high-tech firms are spontaneously formed geographical agglomerations of R&D facilities and related manufacturing establishments developed from science park. Typical example of this kind is Silicon Valley and Boston’s Route 128 in the United States. The success of Silicon Valley can be attributed to a number of factors such as: (a) a large pool of technical talent, (b) availability of preexisting infrastructure and large network of suppliers, (c) access to venture capital, (d) access to excellent educational facilities and research institutions, (e) well-developed

information networks, and (f) entrepreneurial culture (Koh *et al.*, 2005, Lee, 2000). On the other hand, the uncontrollable urban sprawl which has led to the environmental deterioration and social polarisation in Silicon Valley have been the major concern that may affect the sustainability of the region (Saxenian, 2005, Siegel and Markoff, 1985).

The concept of technopolis was originated in Japan and soon became an international phenomenon in the 1980s (Breheny and McQuaid, 1987, 1988, Castells and Hall, 1994a, Gibb, 1985, Glasmeier, 1987, Smilor *et al.*, 1988, Tatsuno, 1986). To compare with science park, technopolis is a region that generates sustained and propulsive economic activity through the creation and commercialization of high or new technological knowledge (Preer, 1992). Differ from industry cluster, technopolis tend to foster a broad swath of industries, support high-technology industries that prosper in environment with readily available infrastructure and strong inclinations toward public-private partnerships (Phillips, 2006). Okubo (quoting in Gonzalez et al., 2004) characterises technopolis as: (a) incorporating technological advances in a basic infrastructure and utilities; (b) comprising institutions and resources that hasten the application and diffusion of technological innovation; (c) enhancing and protecting the quality of life and overall human condition; and (d) linking the inhabitants of the technopolis globally for the widest possible range of forms of communication and transaction. Nevertheless, empirical studies found that there was little scientific network and synergy produced by the spatial agglomeration of research activities in Japanese technopolises. No milieu of innovation formed in the area and no linkage or feedback developed with manufacturing or application of any kind in the first two decades of its existence (Bass, 1998). Tatsuno (1986) ascertained that this was because while technopolis cloned deliberately the form of Silicon Valley, it generally ignored the spontaneously emerged Silicon Valley's culture which would be hardly duplicated. Ohoka (quoting in Bass, 1998) refers to one of the Japanese technopolis – Kyushu's 'silicon island' as 'silicon colony', because the integrated circuit production attracted by its technopolis consisted only of branch plants, which has led to a new spatial division of labour.

The concept of "science city" has already been used in many places with very different institutional contexts since the 1960s. Science city can be understood as the

creation of city in which scientific research, high-tech industry and high-quality living are all brought together in an organised relationship (Castells and Hall, 1994b). Maruyama (1985) observes that a science city presents “a healthy living environment with cultural amenities, combined with high technology industries away from existing overcrowded industrial centres and adapted to local characteristics”. Grayson (1993) maintains that a science city must have at least one existing university providing courses in high technology, and have sufficient local enterprises to form a nucleus of entrepreneurial skills and good communications links, to encourage development in areas that are relatively lightly industrialised. A science city is a new settlement which is generally planned and built by governments, aiming to generate scientific excellence and synergistic research activities by concentrating a critical mass of research organisations and scientists within a high-quality urban space (Benneworth, 2008). Differ from science park and technopolis, which are either university-led or government-led, recent science city initiatives are initiated jointly by government, university, and industry, which forms a “Triple Helix” (Etzkowitz and Klofsten, 2005) leading model for innovation. Benneworth (2008) argues that the involvement of “Triple Helix” as the leading force makes science city more meaningful for KBUD than other forms of technopoles.

2.2 Knowledge city

To compare with technopole, literature on knowledge city appears to provide comprehensive insights about KBUD. First, development is understood address not only economic growth, but also social and cultural concerns. Second, the need for knowledge to sustain urban development has been expanded to include the whole sets of knowledge, i.e. scientific knowledge, human knowledge, social knowledge, metaknowledge, ethic knowledge, and wisdom (Carrillo, 2006, Laszlo and Laszlo, 2002).

Success factors identified by authors from various disciplines can be divided into two categories: static/positioning factors – knowledge factors and dynamic/driving factors – knowledge movers. While knowledge factors form an environment – knowledge environment – facilitating knowledge process, knowledge movers represent the dynamic forces which form a system for innovation. The most influential knowledge

factors cited by the literature are: knowledge base, knowledge culture, and quality of place. Meanwhile, positive interactions between key knowledge movers, which have been identified as including government, academia, industry, and public community, synergising knowledge factors to improve a city's knowledge environment.

Knowledge base is a positioning condition which determines to a large extent the starting point of a city to compete in the era of global knowledge society (van den Berg *et al.*, 2005). Lever (2002a, 2002b) defines a city's knowledge base as including tacit knowledge, codified knowledge, and knowledge infrastructure. Carrillo (2004) refers both tacit and codified knowledge to human capital, while Florida (2002) refers in this respect to the creative knowledge base highlighting the presence of creative class. Amidon and Davis (2006) emphasise the presence of computer communications system as a key to knowledge-based infrastructure. The Work Foundation (2005) maintains the key element is the knowledge intensive businesses. Last but not least, mechanisms which facilitate knowledge creation, dissemination, and utilisation are also regarded as being indispensible.

As suggested by Michaud (2003), culture of knowledge across all sectors within a city is an indispensible characteristic of a knowledge city. Knowledge culture can be distinguished as a value in which the pattern of knowledge creation, transmission and utilisation is conducive to the transformation into knowledge society. Different from cultural products, knowledge culture is social beliefs, attitudes, and socially transmitted patterns.

Grassroots' desire for knowledge is essential to develop a knowledge culture (Malone and Yohe, 2002, Wilson, 1998). Michaud (2003) refers in this respect to value creation to citizens by developing consensus over urban development strategy, which can generate cooperative value of seeking, sharing, creating, and applying knowledge whenever and wherever needed. The most significant segment of knowledge culture is learning. As Laszlo and Laszlo (2007) put it, the culture of learning distributes the benefits of access to knowledge across the society by offering a higher quality of life and greater opportunities for meaningful living.

Knowledge sharing is another key segment of knowledge culture. Hauschild (2001) notes that interaction between individuals is essential in the innovation process.

Dialogues between individuals or groups are often the basis for the creation of new ideas and can therefore be viewed as having the potential for creating knowledge. McDermott and O'Dell (2001) suggest that the most efficient way for knowledge sharing is human network. Allee (2000) refers in this respect to the presence of knowledge networks and communities of practices. Dvir *et al* (2004, 2006) exemplified the way in which urban public spaces can be turned into knowledge sharing places. Moreover, applying knowledge to practices also holds for a key segment for creating knowledge culture. De Muro *et al* (2005) maintain that public participation enhance capability of social innovation.

As Abu-Anzeh and Ledrea (2007) state, a knowledge city must offer an appealing and high quality urban environment for people to stay, live, learn, and work. Drawing on the literature, important in this respect are attractively physical environment, cultural environment, economic base, low costs access to knowledge and living, urban innovation engines, social services facilities, connectivity and accessibility, urban diversity, and social equity (Dvir and Pasher, 2004, Florida, 2002, Knight, 1995, Michaud, 2003, van den Berg *et al.*, 2005, Work Foundation, 2005).

The presence of knowledge factors reflects the availability of its knowledge resources. As Laszlo and Laszlo (2002) noted, such knowledge resources are valuable only if they are put in good use for greater collective interest. This requires a consensus among all players working together to develop a vision and to act cooperatively to transcend the existing techno-economic paradigms (Leydesdorff, 2000). Knowledge movers are the dynamic forces of knowledge. As city development involves all stakeholders and members who have a home in the city, anyone of them can be regarded as a knowledge mover. However, knowledge-based innovation studies have identified the key innovation forces for regional development which include government, academia, and industry (Etzkowitz and Klofsten, 2005, Etzkowitz and Leydesdorff, 2000). Meanwhile, for many other researchers (e.g. Baum *et al.*, 2007, De Muro *et al.*, 2005, Dvir, 2006, Dvir and Pasher, 2004, Ergazakis *et al.*, 2006a, Martinez, 2006, Yigitcanlar *et al.*, 2008), public involvement is seen as the primary force for knowledge movement. To a large extent, the attitudes and actions of these key knowledge movers are determinants of knowledge city.

The transition to a knowledge-based society is changing the role that key knowledge movers played traditionally. In industrial societies, government and industry were the primary institutions, whereas university (academia) played a supporting role. With the emergence of knowledge society, university is transforming from a secondary to a primary institution. This results in a situation where university, industry and government constitute the key institutional framework of knowledge-based societies (Etzkowitz and Leydesdorff, 2000). Meanwhile, local community has moved increasingly into the central stage, influencing both KBUD strategy and its implementation (Yigitcanlar, 2003).

By taking some of the traditional roles of industry and government, university has been transformed from a teaching institution into one which combines teaching and research. The transformation is still ongoing and the so-called entrepreneurial university has been emerging, which plays a role as a source of firm-formation and regional development in addition to its traditional role as a provider of trained persons and basic knowledge (Bramwell and Wolfe, 2008, Goddard and Chatterton, 1999, Grunwald and Huang, 2006, Harloe and Perry, 2004). Government helps to support the new developments through changes in the regulatory environment, tax incentives and provision of public venture capital. Industry takes the role of the university in developing training and research, often at the same level as universities (Etzkowitz and Klofsten, 2005). The changing roles of institutions are viewed as a major potential source of "innovation in innovation", which make a greater contribution to the economy and society. The emerging role of local community, which appears to be willing to actively participate in the KBUD strategy making and implementing, is an unexpected outcome of the changing roles of the above three institutions.

3 KBUD in China, a national campaign

It took less than ten years for China to pass through the transformation from technopoles development to the process of knowledge city. The first HNTIDZ was designated by the State Council in 1988 soon after the launching of the "Torch Program" in Beijing for experimentation (State Council, 1988). Meanwhile, other cities were encouraged to prepare for development of their own such zones. In 1991, after about three years of experimentation, another 26 HNTIDZs were designated by

the State Council (State Council, 1991). One year later, the State Council designated another 25 national level HNTIDZs (State Council, 1992). The establishment of the Yangling Agricultural Technology Development Zone in Shannxi in 1997 brings the total number of national HNTIDZ to 53.

China's effort to develop HNTIDZs is unique both in terms of its large scale and mechanisms of managing the fast growth. NHTIDZs were modelled on the general concept of technopoles, but with their own characteristics (Wang et al., 1998). They are not duplicates of any of the four types of technopoles discussed above. China's NHTIDZs are larger in land area (ranging from 10 to 200 square km) than typical technopoles elsewhere in the world and usually contain more than one parks. A typical NHTIDZ consists usually of innovation centres/business incubators, specialised high-tech industrial parks (manufacturing base), foreign educated returnees' business park, national university science parks, and university park (not common). Depends on the capability of research and development, some companies' R & D centres and labs were granted "national key R & D centres and labs" (China Association of Development Zones: www.cadz.org.cn). Furthermore, in 1995, with encouragement from UNDP, China started to set up international high-tech business incubators. By 2006, nine selected HNTIDZs have established international high-tech business incubators aimed to help foreigners who intend to start business in China (MOST, 2006). There were 614 innovation centres/high-tech business incubators, 62 university science parks, 21foreign educated returnees' business parks within the 53 NHTIDZs in 2007 (MOST, 2007).

Spatially, except few NHTIDZs, which are located in built-up area, majority of them are located either close to the edge of the city or in suburban counties. At the early stage, there is no NHTIDZ located adjacent to universities except Zhongguancun HNTIDZ in Beijing. Planning and architecture in these newly developed areas are taking the advantages of advanced technologies which produced a genuine environment for companies and research institutions. However, it was not until the turn of the new century, the areas of HNTIDZ were not planned also to provide convenient and comfortable living facilities to attract knowledge workers (Fang and Xie, 2008).

Development of HNTIDZ was solely initiated and led by government. Due to its bureaucratic tradition, the management system in China's NHTIDZs is much more complex. In general, each has an elaborate Administrative Commission (AC) designated by the host city government, acting municipal powers over development of the respective zone. The AC holds a unique position in the Chinese political hierarchy. Its power ranges from admitting enterprises into the zone to planning and financing construction of infrastructure, leasing land, collecting taxes, and dealing with foreign trade and cooperation for its constituent enterprises (Wang et al., 1998). The organisational structure of AC was formed similar to the municipal council, but with no governmental legitimacy. This arrangement, on the one hand, helped consolidating responsibilities and increasing management efficiency. On the other hand, it fell into the same bureaucracy rather than the claims of "institutional innovation" (MOST, 2002).

Despite its originally designed purpose to use the HNTIDZ as a means of reforming China's innovation system so that to strengthen indigenous science and technology for knowledge-based economic growth, the preferential policies available to firms in the park areas are related closely to production incentives. Policies for encouraging research and nurturing innovation system reform, such as encouraging relationships between academic and research institutions and business have been noticeably missing (Sutherland, 2005). This has lead to HNTIDZs becoming instead among manufacturing centres. Moreover, contrary to the early claims of central policy makers that the HNTIDZs were established to help nurture capabilities of domestic corporations, foreign direct investment, especially those from multinational companies, has actually become the key to their growth (Sutherland, 2005).

It should be noted that it was not until the end of 20th century, HNTIDZs were making their efforts to encourage university and other research institutions involvement. Starting from 2000, a number of policies aiming to transforming teaching universities into research and entrepreneurial ones have been put into force. The most influencing policy measures are the program of "National University Science and Technology Park" jointly launched by the Ministry of Science and Technology and the Ministry of Education in 2000 and national subsidising plan on new campus development within HNTIDZs (MOST, 2000). These two policy measures resulted the Chinese HNTIDZs

look like more similar to technopoles elsewhere. Meanwhile, science and technology innovation centres, high-tech incubators, foreign educated returnees start-ups centres were established successively. All these are part of national science and technology plan, which offer substantial subsidies for such projects.

At the same time, national policy on land use in HNTIDZ area has also been redirected to allow mix use. This made it possible for HNTIDZs to develop residential housing, school, hospital, shopping, leisure, and all other facilities. Thanks to the advanced planning and design technology, HNTIDZs are being developed more attractive places than their host cities, which attract more talents to come and remain. Furthermore, due to the fact that there are specially designed preferential policies and criteria set out for entrance, HNTIDZs are normally treated as special zones both by policy makers and public, which to a certain extent my be seen as independent cities rather than distracts of their host cities. This is especially the case when the scale is big enough so would have to set up sub-districts for administration.

China has also responded to the global trend of transforming into knowledge society. At the beginning of the 21st century, the new Chinese leader Hu Jintao called for holistic understanding of development, which he would call "Scientific Development Concept" (Hu, 2002). Hu's interpretation of development shifted away from economic centred strategy to people centred, emphasising importance of balancing economic, cultural, social and environmental development. Based on this understanding, national policy committed investing more of national income in people and knowledge. Under this reorientation of development strategy, a list of national policies has been put in place, of which developing a "learning society" through investing in comprehension of lifelong education system has been made priority (Wu, 2005). Cities were certainly been put at the leading position for implementing the new national strategy. Many cities have launched campaigns to develop learning city, the innovative city, and resources saving and environmentally friendly city.

The next section takes Wuhan East Lake High-Tech Development Zone as example to discuss the changing definition of HNTIDZ in terms of KBUD.

4 Wuhan East Lake High-Tech Development Zone

4.1 Improving knowledge environment?

Wuhan East Lake High-Tech Development Zone – the Optical Valley of China (OVC) – sits in the eastern suburban area of Wuhan (Figure 1). It is one of the first designated national HNTIDZs by the State Council in 1991 and was granted the current name (OVC) by the Ministry of Science and Technology in 2001 because of its vast majority of capacity of R&D and production on optoelectronic information. OVC is planned to develop a 232 square kilometres new urban area.

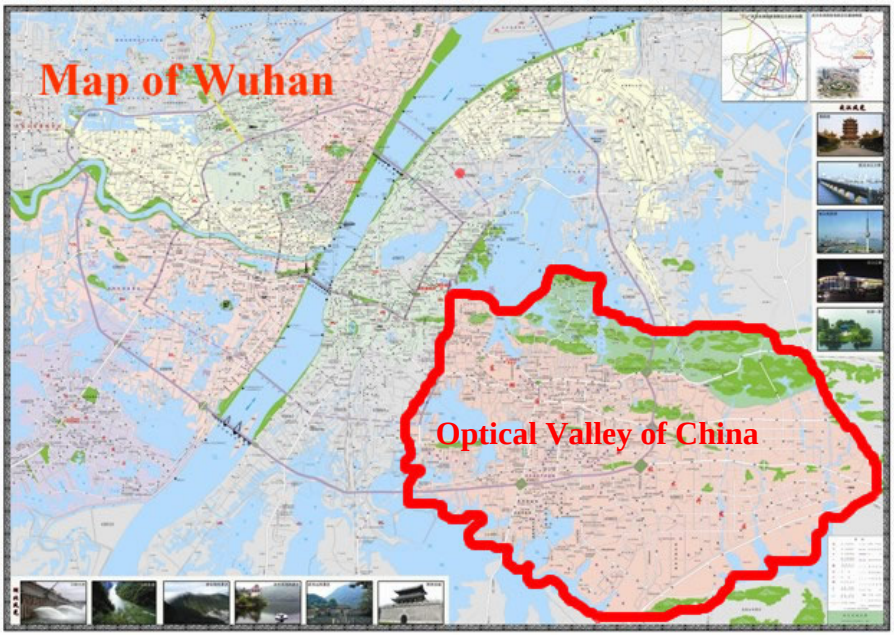


Figure 1 Location of OVC

Source: http://en.wehdz.gov.cn/structure/NaturalEnvironment/NaturalDetail1

OVC comprises six specialised parks, i.e. optoelectronic information industrial park, bioengineering and medical industrial park, national university science park, software outsourcing park, high-tech agricultural park, and modern equipment and machinery industrial park. Ten industrial clusters emerged to play a leading force to the fast growth of high-tech industries: optoelectronic, mobile communications, semiconductor industry, laser industry, software and software outsourcing, consuming optoelectronic, green energy, biomedical and high-tech agriculture, and modern

equipment manufacturing industry, employing more than 200 thousand high-skilled workers and are continuing to provide job opportunities. From the establishment in 1991 to 2007, OVC managed an average growth of 48.8 percent in annual revenue, which led to the total revenue reached 133 billion RMB in 2007. Nevertheless, among the ten, only optoelectronic industry is at the global leading group, while others failed to have any competitive advantages.

The physical environment in the OVC area is attractive not only because of its beauty of natural surroundings but also high standard built environment. Within the planned area, there are three lakes: East Lake, South Lake and Tangxun Lake, among which the East Lake covers 33 square kilometres of water surface, the largest one within urban built up area in China. The six beautiful hills that sit around make the area attractive place to live.

Physical accessibility has also taken the geographical advantages of the city. Wuhan is historically famous because of its good connection with surrounding provinces both by waterways and roads. In the pre-reform era of PRC, Wuhan was a favourable city received the State investment under Maoist redistributive ideology. As a result, Wuhan has built a better infrastructure than other cities. Its international airport is the only one 4E airport in central China region, with more than 30 domestic destinations and can fly directly to Hong Kong and Soul in South Korea. Passenger liners connect the city with Shanghai and Chongqing and its international container port connect it with major ports worldwide. Both railways and highways that link the north and south and east and west of the country are crossed in the city. All of these are close to the OVC.

Form 2000 onward, taking the advantage of the reorientation of national policy of land use on HNTIDZ, high quality housing, (international) schools, hospitals, shopping, sports, and leisure centres and other social facilities has been built. Housing was sold at a subsidised price to those who are qualified to be high-skilled workers. What is more is that living costs in OVC are much lower than that of Shanghai and Beijing, and Shenzhen.

Moreover, as the indispensible knowledge infrastructure, ICT has also been made available. All four dominant Chinese telecommunication service providers: China

Telecom, NetCom, UniCom and RailCom, are operating in the Zone, proving both wired and WiFi internet services. Bandwidth of transmission has reached 40G in 2007, backbone nodes in the OVC are connected with China Telecom's 320G backbone transmission network through core nodes of China Telecom. This has eased the area to communicate with global informants.

Meanwhile, the knowledge base as measured by the presence of higher education institutions and enrolled students is also encouraging. Wuhan is rich in its education resources. There are 56 higher education institutions located in the city positioning it the third place in China after Beijing and Shanghai. Seven universities are qualified as national "211 Universities". In 2008, the number of university students exceeded 1.05 million. These together with roughly one million knowledge workers in Wuhan served as a vast talent pool. What is more, 42 of these universities are located or relocated in OVC with the number of students over 850 thousand. More then 280 thousand graduate in the OVC area every year.

However, it is noted that to compare with its good quality of place and comparative advantages of knowledge base, Wuhan has failed to harvest these advantages in the past. Most of qualified talents left to find jobs or setup businesses in coastal cities. This has been criticised as being lack of knowledge culture by the director general of Wuhan Social Science Academy (interview) who has suggested the city to launch the public campaign on citizens learning and citizens going for business respectively in 2003 and 2007. Although the municipality has put in force several policies for doing so, it takes time to make it happen.

4.2 The role of Academia in knowledge synergy

For policy makers in the city of Wuhan, development of the East Lake High-Tech Development Zone at the beginning was not self-motivated activity. Rather, it was done because of the central government's decision. There is no systematically designed framework or approach to follow. The main task of the authority of the Zone was to attract inward investments through offering extra preferential policies such as free land use, zero taxation, and political reward to investors. Potential investors have been defined mainly from coastal cities. In order to contact targeting investors, the AC officials in OVC often went to cities such as Shanghai, Shenzhen, or Guangzhou

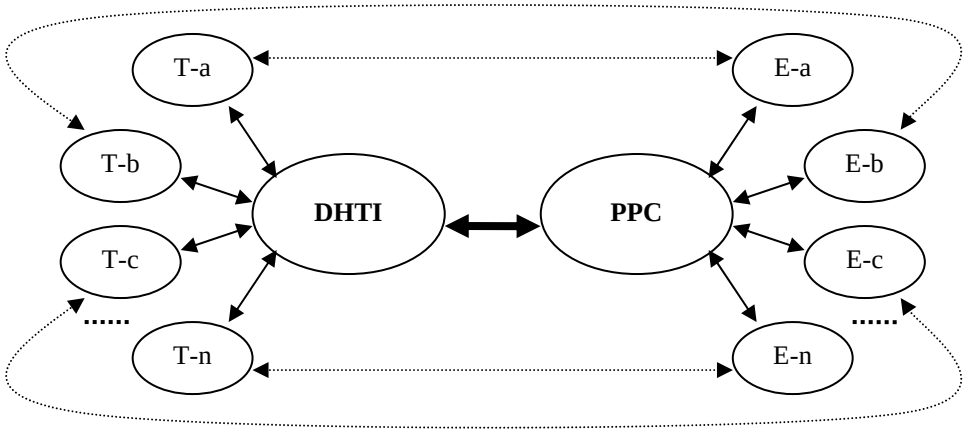
to sell their preferential policies. Meanwhile, the potential of its indigenous SMEs has been generally ignored.

During the early stage of the OVC development, universities and other research institutions in Wuhan or in particular in the OVC area were not involved. Universities were framed to concentrate on teaching, while state owned research institutions received fund from government, which by no means to link the fund with research tasks. There was even no intention to link academia with the development of the OVC. Nevertheless, the second half of the 1990s witnessed a dramatic change of attitudes following the change of national policy. First, the state owned research institutions were restructured to become self-sufficient organisations, which meant they had to make money through their research rather than had money in hand to find research. This change had led to the state owned research institutions to refine their strengths and link them with market. Second, universities were encouraged to complement funding gaps between state funds and the actual needs through the means of either increasing tuition fees or joining in market by selling their knowledge or technology. The change of approach in fund supply, which forced universities and research institutions to market their knowledge and technology, had actually made them emerged as driving force for OVC taking off from 2000 onward.

In 2000, when the policy on encouraging the development of "National University Science Park" was put in effect, Wuhan University Science Park and Huazhong University of Science and Technology Science Park were among the first to be designated. These two universities are both top ten universities in China both in terms of research excellence and entrepreneurial culture. Taking Wuhan University as an example, in order to consolidate the university's technology strengths, the Department of High-Tech Industry (DHTI) was formed under the leadership of a deputy president of the university to oversee technology transfer, high-tech investment, fostering entrepreneurial culture, and university science park development.

For technology and knowledge transfer, DHTI works closely with the Productivity Promotion Centre (PPC) in the Bureau of Science and Technology of Wuhan, which links closely with SMEs. The network in which the university's technology and knowledge can be transferred into production is illustrated as Figure 2. The DHTI

constantly collects transferable technology and knowledge information from academic schools and research centres in the university and passes it on to PPC from which the information is proceeded and then passed on to the relevant enterprises, and vice versa.



T-i: Technology; E-i: Enterprise; ↔ Information flow; ⇢ Contract

Figure 2: The illustration of technology transfer network

Meanwhile, academic schools and individuals were encouraged to set up their own businesses while keeping their academic roles. This stimulated largely the enthusiasm both from schools and individuals. Only in few years, more than 70 enterprises using Wuhan University as their label had been established with investment roughly 150 million RMB. However, due to the lack of relevant knowledge of managing enterprises and unsystematically designed regulations, over half of its investments were soon failed[1], which made a big lost to the university. In order to tackle with this problem, a university owned company – Wuhan University Investment Group (WUIG) – was established in 2005 to oversee the commercial side of high-techs. Although one of the WUIG's main commission was set still to invest high-tech start-ups emerged

[1] Interview with managing director of WUIG

from the university spin offs. The intention has been changed to offer support (regulatory, management, marketing, and financing) rather than to own them. This change has built a firewall between the entrepreneurial activities and the university.

With lessons learned form the early failure, the DHTI working closely with Student Union, Youth Society and the Business School, launched a competition called "Going for Entrepreneurs" aiming to foster entrepreneurial culture and enhancing management skills. Students (both individual and group) are encouraged to join the annual events. Participants are required to submit a detailed business plan to take part in a three round competitions. The winner will receive investment from WUIG to start its business in a relevant incubator in the University Science Park.

Developing University science park is another major effort to transform the university, though this is again the government-led initiative. Wuhan University Science Park was granted 135 ha land in OVC area at the bank of Tangxun Lake. Construction work started in 2000, it has now 15,000 square metres GPS, GIS, and RS related high-tech incubators and 60,000 square metres production base. 20 incubated companies have completed their incubation and moved out, among which two companies' sales income exceeded 100 million RMB in 2006. Another 36 start-ups are in incubating. In addition, built upon successful experience from Silicon Valley, Wuhan University Science Park has made intensive effort to provide services such as venture capitals, investment, marketing and management consultancy through working together with WUIG, Torch Program Office in Wuhan, venture capital investors, commercial banks, and consultant providers.

Wuhan University provides a typical example in leading the transformation of university from teaching to entrepreneurial university. The similar case is also found in Huazhong University of Science and Technology. However, given the fact that the majority universities in the OVC area are local and private funded ones, their capacity in research and national preferential policy available for them are limited, their efforts in have generally failed to meet what they were expected before.

Moreover, to compare with the huge scale of OVC, the university science parks are only a small part, and therefore is hardly to say that they are playing a key role in the development of OVC. In the contrary, the pillar of the OVC so far is its vast majority

of strengths in optoelectronic information industry, pioneered by the Wuhan Post and Telecommunications Science Research Institute, a leading research force in China. The institute used to be fully funded by central government and restructure in the middle of the 1990s. After a short shock caused by the restructure, the institute started to consolidate its technological strength and made its endeavour to transform this strength into production. The first company, Wuhan Changfei Optical Fiber and Cable Company, one of the largest cable enterprises of the world, was created six months after the management restructure. Later on, several spin off companies were emerged successively and formed spontaneously an industrial cluster. Optoelectronics & telecommunications industry in OVC has now produced annual revenue more than 60 billion RMB, employing over 100,000 high skilled workers, accounting for half of the total in OVC.

4.3 Some insights on the OVC development

Despite the fast rising of OVC, social results it brought are controversial. Positively, it represents the global trend of future urban development, which attempts to use intensively knowledge as driving force. It seems to be true in the OVC area where is full of knowledge intensive industries (contributing one third of added value to the city as a whole in 2007) and high-skilled workers. The fast growing of OVC has also changed the talent flows. As mentioned above, before 2000, graduates and high-skilled workers in Wuhan were once pulled out by coastal regions and replaced by rural non-skilled labours. This has been changed significantly because the magnet effect of OVC. Furthermore, OVC created a knowledge intensive environment which knowledge workers enjoy to work and live in.

However, to the city as whole, OVC is a small part of the city but is polarising the urban society. While OVC enjoys substantially preferential policy (such as subsidised land and housing, tax release, better social services etc.), the old urban area bears more for their development. What is more, there is little connection between OVC and the old urban area. This gives rise to the question development for what and for whom. This question, from KBUD point of view, needs to be answered in the conceptualisation stage rather than leave it until tensions occurred.

5 Conclusion remarks

In this paper the author reviewed literature on KBUD study. From the literature, it can be said that in the last few decades KBUD has followed two successively forms, i.e. technnopoles and knowledge city. While technopoles are economic centred and may cause even more serious development problems, knowledge city is argued to be fully responding the needs of KBUD. Being led by the central government, Chinese cities have also responded to the global trend of urban development regardless of the actual stage of development. The development of HNTIDZs appears to integrate high-tech industrial complex, science park, technopolis, and science city elsewhere in the world into one. Attempts have also been made in recent years to improve urban knowledge environment. Findings from the case study indicate that the development of OVC has created a good knowledge environment in its own and provides a institutional mechanism for synergising knowledge, in which academia is emerging to play an increasingly important role. However, to its host city as a whole, it may cause social tensions between OVC itself and the old urban area, therefore, calls for further study in this domain.

Acknowledgement

The author would thank the Administrative Commission of Wuhan East Lake High-Tech Development Zone for their help to conduct the fieldwork of this study. Thanks also go to the Statistic Bureau of Wuhan for providing statistic information cited in this paper. The author is grateful to his supervisors professor John Tomaney and Doctor Andy Pike for their valuable comments.

References

Abu-Anzeh, N. and Ledraa, T. (2007) 'Planning the Knowledge City: Can It Be an Option for Riyadh?' *the 2nd international symposium on knowledge city: future of cities in the knowledge economy.* Shah Alam, Selangor, Malaysia, 16-18 July Planning the Knowledge City: Can It Be an Option for Riyadh?: pp.

Allee, V. (2000) 'Knowledge Networks and Communities of Practice', [Online]. Available at: http://www.vernaallee.com/value_networks/KnowledgeNetworksAndCommunitiesOfPractice-28Jan07.pdf (Accessed: 17th May 2007).

Amidon, D. M. and Davis, B. E. (2006) 'The Triple Knowledge Lens', [Online]. Available at: http://www.entovation.com/ (Accessed: 17/09/2007).

Aurigi, A. (2005) *Making the Digital City.* Hampshire: Ashgate.

Baqir, M. N. and Kathawala, Y. (2004) 'Ba for Knowledge Cities: A Futuristic Technology Model', *Journal of Knowledge Management,* 8, (5), pp. 83-95.

Bass, S. J. (1998) 'Japanese Research Parks: National Policy and Local Development', *Regional Studies,* 32, (5), pp. 391-403.

Baum, S., Yigitcanlar, T., Horton, S., Velibeypgdu, K. and Glesson, B. (2007) *The Role of Community and Lifestyle in the Making of a Knowledge City.* Brisbane Griffith University

CURDS (2008) *Newcastle: A Science City in Action: Linking Science and the City* [Online]. Available at: http://www.staff.ncl.ac.uk/p.s.benneworth/sciencecity.pdf (Accessed: 09/09).

Bramwell, A. and Wolfe, D. A. (2008) 'Universities and Regional Economic Development: The Entrepreneurial University of Waterloo', *Research Policy,* 37, (8), pp. 1175-1187.

Breheny, M. J. and McQuaid, R. (1987) *The Development of High Technology Industries : An International Survey.* London: Croom Helm.

Breheny, M. J. and McQuaid, R. (1988) *The Development of High Technology Industries : An International Survey.* London: Routledge.

Carrillo, F. J. (1999) 'The Knowledge Management Movement: Current Drives and Future Scenarios ', *The Third International Conference on Technology, Policy, and Innovation: Global Knowledge Partnerships -- Creating Value for the 21st Century.* University of Texas, TX, The Knowledge Management Movement: Current Drives and Future Scenarios pp.

Carrillo, F. J. (ed.) (2006) *Knowledge Cities: Approaches, Experiences and Perspectives.* Amsterdam, Boston, Heldelberg, London, New York, Oxford, Paris, San Francisco, San Diego, Singapore, Sydney, Tokyo: Elsevier

Castells, M. and Hall, P. (1994a) *Technopoles of the World.* London: Routledge.

Castells, M. and Hall, P. (1994b) *Technopoles of the World: The Making of the 21st Century Industrial Complexes.* London and New York: Routledge.

Demologos (2005) *Development Theories, Economic Policies and Institutions: A Dialectical Evolution* [Online]. Available at: http://demologs.ncl.ac.uk (Accessed: 18/03/2008).

Drucker, P. F. (1993) *Post-Capitalist Society.* New York: HarperBusiness.

Dvir, R. (2006) 'Knowledge City, Seen as a Collage of Human Knowledge Moments', in Carrillo, F. J.(ed), *Knowledge Cities: Approaches, Experiences, and Perspectives.*Amsterdam, Boston, Heldelberg, London, New York, Oxford, Paris, San Diego, San Francisco, Singapore, Sydney, Tokyo: Elsevier, pp. 245-272.

Dvir, R. and Pasher, E. (2004) 'Innovation Engines for Knowledge Cities: An Innovation Ecology Perspective'.

Dvir, R., Schwartzberg, Y., Avni, H., Webb, C. and Lettice, F. (2006) 'The Future Center as an Urban Innovation Engine'.

Edvinsson, L. (2006) 'Aspects on the City as a Knowledge Tool', *Journal of Knowledge Management,* 10, (5), pp. 6-13.

Ergazakis, K., Metaxiotis, k. and Psarras, J. (2006a) 'An Emerging Pattern of Successful Knowledge Cities' Main Features', in Carrillo, F. J.(ed), *Knowledge Cities: Approaches, Experiences, and Perspective.*Amsterdam, Boston, Heidelberg, London, New York, Oxford, Paris, San Diego, San Francisco, Signapore, Sydney, Tokyo: Elsevier, pp. 3-15.

Ergazakis, K., Metaxiotis, k. and Psarras, J. (2006b) 'Knowledge Cities: The Answer to the Needs of Knowledge-Based Development', *VINE:The Journal of Information and Knowledge Management Systems*, 36, (1), pp. 6784.

Etzkowitz, H. and Klofsten, M. (2005) 'The Innovating Region: Toward a Theory of Knowledge-Based Regional Development', *R&D Management*, 35, (3), pp. 243-255.

Etzkowitz, H. and Leydesdorff, L. (2000) 'The Dynamics of Innovation: From National Systems And "Mode 2" To a Triple Helix of University-Industry-Government Relations', *Research Policy,* 29, (2), pp. 109-123.

Fang, C. and Xie, Y. (2008) 'Site Planning and Guiding Principles of Hi-Tech Parks in China: Shenzhen as a Case Study', *Environment and Planning B: Planning and Design,* 35, pp. 100-121.

Florida, R. (1995) 'Toward the Learning Region', *Futures,* 27, (5), pp. 527-536.

Florida, R. (2002) *The Rise of the Creative Class.* New York: Basic Books.

Gibb, J. M. (1985) *Science Parks and Innovation Centres : Their Economic and Social Impact.* New York: Elsevier

Glasmeier, A. (1987) 'The Japanese Technopolis Program: High-Tech Development Strategy or Industrial Policy in Disguise?*' Association of Collegiate Schools of Planning, 29th Annual Conference.* The Japanese Technopolis Program: High-Tech Development Strategy or Industrial Policy in Disguise?: pp.

Goddard, J., Charles, D., Pike, A., Potts, G. and Bradley, D. (1994) *The University Advantage: Universities and Communities.* Newcastle upon Tyne: CURDS

Goddard, J. and Chatterton, P. (1999) 'Regional Development Agencies and the Knowledge Economy: Harnessing the Potential of Universities ', *Environment and Planning C,* 17, (6), pp. 685-699.

Gonzalez, R. O. M. d., Marquez, J. A. A. and Salomon, S. D. M. (2004) 'A Compilation of Resources on Knowledge Cities and Knowledge-Based Development', *Journal of Knowledge Management,* 8, (5), pp. 107-127.

Graham, S. and Aurigi, A. (1997) 'Virtual Cities, Social Polarisation, and the Crisis in Urban Public Space ', *Journal of Urban Technology,* 4, (1), pp. 19-52.

Grayson, L. (1993) *Science Park: An Experiment in High Teechnology Transfer*. London: The British Linrary

Grunwald, N. and Huang, C. (2006) 'The Role of the University in the Field of Regional Development: A Case Study of Hochschule Wismar', *10th Baltic Region Seminar on Engineering Education, Seminar Proceedings,* pp. 93-96.

Harloe, M. and Perry, B. (2004) 'Universities, Localities and Regional Development: The Emergence of the 'Mode 2' University?' *International Journal of Urban and Regional Research,* 28, (1), pp. 212-+.

Hauschild, S., Licht, T. and Stein, W. (2001) 'Creating a Knowledge Culture', *the McKinsey Quarterly,* 1, (1), pp. 74-81.

Hu, A. G. (2007) 'Technology Parks and Regional Economic Growth in China', *Research Policy,* 36, (1), pp. 76-87.

Great Britain. Parliament. (2002) *Speech to the 16th Congress of Cpc* Central Commission Communist Party of China

Knight, R. (1995) 'Knowledge-Based Development: Policy and Planning Implication for Cities', *Urban Studies,* 32, (2), pp. 225-260.

Koh, F. C. C., Koh, T. H. and Tschang, F. T. (2005) *An Analytical Framework for Science Parks and Technology Districts with an Application to Singapore.* Singapore: School of Economics and Social Sciences, Singapore Management University.

Komninos, N. (2002) *Intelligent Cities.* London: Spon Press.

Landry, C. (2000) *The Creative City : A Toolkit for Urban Innovators.* London: Earthscan Publications.

Landry, C. and Bianchini, F. (1995) *The Creative City.* London: Demos.

Laszlo, K. C. and Laszlo, A. (2002) 'Evolving Knowledge for Development: The Role of Knowledge Management in a Changing World', *Journal of Knowledge Management,* 6, (4), pp. 400-412.

Laszlo, K. C. and Laszlo, A. (2007) 'Fostering a Sustainable Learning Society through Knowledge-Based Development', *Systems Research and Behavioral Science,* 24, (5), pp. 493-503.

LaValle, K. P. (1982) *High Technology Park -- a Marriage of Higher Education and Industry.* New York: the New York State Senate Higher Education Committe

Lee, C.-M. (2000) *The Silicon Valley Edge : A Habitat for Innovation and Entrepreneurship.* Stanford, Calif.: Stanford University Press.

Lee, S.-H., Han, J.-H., Leem, Y.-T. and Yigitcanlar, T. (2008) 'Towards Ubiquitous City:Concept, Planning, and Ecperiences in the Republic of Korea', in Yigitcanlar, T.(ed), *Knowledge-Based Urban Development: Planning and Applications in the Information Era.*Hershey, New york: Information Science Regerence pp. 148-170.

Lever, W. F. (2002a) 'Correlating the Knowledge - Base of Cities with Economic Growth', *Urban Studies,* 39, (5-6), pp. 859-870.

Lever, W. F. (2002b) 'Measuring the Knowledge-Base and Competitive Cities in Europe', in Begg, I.(ed), *Competitive Cities.*Bristol: Policy Press.

Leydesdorff, L. (2000) 'The Triple Helix: An Evolutionary Model of Innovations', *Research Policy,* 29, (2), pp. 243-255.

Lowe, J. (1985) 'Science Park in the Uk', *Lloyds Bank Review,* 156, (1), pp. 31-42.

Luger, M. I. and Goldstein, H. A. (1991) *Technology in the Garden : Research*

Parks and Regional Economic Development. Chapel Hill, N.C.: University of North Carolina Press.

Malone, T. and Yohe, G. (2002) 'Knowledge Partnerships for a Sustainable, Equitable and Stable Society', *2002,* 6, (4), pp. 368-378.

Martinez, A. (2006) 'Knowledge Citizens: A Competence Profile', in Carrillo, F. J.(ed), *Knowledge Cities: Approaches, Experiences, and Perspectives* Amsterdam Elsevier

Maruyama, M. (1985) 'Report on a New Technological Community: The Making of a Technopolis in an International Context', *technological forcasting and social change,* 27, (1), pp. 75-98.

Massey, D. B., Quintas, P. and Wield, D. (1992) *High-Tech Fantasies : Science Parks in Society,Science and Space.* London: Routledge.

McDermott, R. and O'Dell, C. (2001) 'Oveercoming Cultural Barriers to Sharing Knowledge ', *Journal of Knowledge Management* 5, (1), pp. 76-85.

Metcalfe, J. S. and Ramlogan, R. (2005) 'Limits to the Economy of Knowledge and Knowledge of the Economy', *Futures,* 37, (7), pp. 655-674.

Michaud, P. (2003) *Montreal: Knowledge City.* Montreal: Montreal Kowledge City Advisory Commitee

Great Britain. Parliament. PRC, M. o. S. a. T. o. t., (2000) *Regulations on National University Science and Technology Park* Ministry of Science and Technology of the PRC.

Great Britain. Parliament. Technology, M. o. S. a., (2002) *Suggestion to the Reform and Innovation of Management System for Development Zones* Ministry of Science and Technology

MOST. (2006) *Development Report on China's Development Zones* Beijing: Minstry of Science and Technology

MOST. (2007) *Statistics Yearbook of Science and Technology (2007).* Beijing Ministry of Science and Technology

Phillips, F. (2006) *Social Culture and High-Tech Economic Development : The Technopolis Columns.* Basingstoke: Palgrave Macmillan.

Preer, R. W. (1992) *The Emergence of Technopolis : Knowledge-Intensive Technologies and Regional Development.* New York ; London: Praeger.

Saxenian, A. (2005) *Regional Advantage [Electronic Resource] : Culture and Competition in Silicon Valley and Route 128.* New York: ACLS History

E-Book Project.

Siegel, L. and Markoff, J. (1985) *The High Cost of High Tech : The Dark Side of the Chip.* New York: Harper & Row.

Smilor, R. W., Kozmetsky, G. and Gibson, D. V. (1988) *Creating the Technopolis: Linking Technology Commercialisation and Economic Development.* Boston: Ballinger Publishing Company.

Storey, D. J. and Tether, B. S. (1998) 'Public Policy Measures to Support New Technology-Based Firms in the European Union', *Research Policy,* 26, (9), pp. 1037-1057.

Sutherland, D. (2005) 'China's Science Parks: Production Bases or a Tool for Institutional Reform?' *Asia Pacific Business Review,* 11, (1), pp. 83-104.

Tatsuno, S. (1986) *The Technopolis Strategy : Japan, High Technology, and the Control of the Twenty-First Century.* New York, N.Y: Prentice Hall Press.

van den Berg, L., Pol, P. M. J., Winden, W. v. and Woets, P. (2005) *European Cities in the Knowledge Economy: The Case of Amsterdam, Dortmund, Eindhoven, Helsinki, Manchester, Munick, Munster, Rutterdam and Zaragoza.* Hants, England: Ashgate.

Vedovello, C. (1997) 'Science Parks and University-Industry Interaction: Geographical Proximity between the Agents as a Driving Force', *Technovation,* 17, (9), pp. 491-502.

Walcott, S. M. (2003) *Chinese Science and Technology Industrial Parks.* Aldershot: Ashgate.

Wang, S., Wu, Y. and Li, Y. (1998) 'Development of Technopoles in China', *Asia Pacific Viewpoint,* 39, (3), pp. 281-302.

Westhead, P. and Storey, D. J. (1995) 'Links between Higher Education Institutions and High Technology Firms', *Omega,* 23, (4), pp. 345-360.

Wilson, E. O. (1998) *Consilience : The Unity of Knowledge.* New York: Knopf : Distributed by Random House.

Work Foundation. (2005) *Ideopolis: Knowledge Cities.* London: the work foundation

Wu, H. F. (2005) 'Cultural Perspective of Learning City', *Journal of CPC School at Sichuan Province* (4).

Yigitcanlar, T. (2003) 'Bridging the Gap between Citizens and Local Authorities Via E-Government', *Symposium on e-government:*

opportunities and challenges. Muscat, Sultanate of Oman, Bridging the Gap between Citizens and Local Authorities Via E-Government: Arab Urban Development Institute, pp.

Yigitcanlar, T., velibeyoglu, K. and Baum, S. (eds.) (2008) *Knowledge-Based Urban Development: Planning and Applications in the Information Era.* Hershey and New York: Information Science Reference.

Yuan, G. and Gao, J. (1992) *Programs and Plans for the Development of Science and Technology in China.* Beijing National Defense Industrial Press