Article

WTR 2012;1:264-275 http://dx.doi.org/10.7165/wtr2012.1.4.264

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Establishing National Science and Technology Park in Pakistan

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Abstract : This paper presents the concept of the National Science and Technology Park (NSTP) in Islamabad, Pakistan. Keeping in line with Karl Popper's Piecemeal Social Engineering theory, a critical-pragmatic approach is adopted in shedding light on the strategic thrusts and expected outcomes of this knowledge-driven, entrepreneurially-spirited, multi-industry project. Based on Triple-Helix perspectives, we investigate the role of the National University of Sciences and Technology, Islamabad in efforts aimed at developing NSTP as an intermediary hybrid organization that enhances industry-academia-government linkages, with the potential to serve as an engine for regional and national economic growth and competitiveness.

Keyword : University-Industry Linkage, Triple-Helix, Piecemeal Social Engineering, Glocalization, NUST, Global Think Tank Network Program, Corporate Advisory Council

1. INTRODUCTION

Karl Popper (1947), in the first volume of *The Open Society and its Enemies*, opposes the mode of thinking he designates as social engineering to what he calls the historicist mode of social thinking. For Popper, social engineering prioritizes the element of free will and goal-oriented approach to solving social problems without getting bogged down by grand questions of historical destiny and first principles – two related preoccupations of historicism. Social engineering, as a way of solving problems, takes a pragmatic approach and focuses on efficiently matching means to ends. Popper reckons social engineering approach to be sounder for social reconstruction and development than the historicist approach. Popper further distinguishes between what he calls utopian social engineering and piecemeal social engineering; utopian social engineering acts as an attenuated form of historicism and erects unrealizable ultimate social ideals. Piecemeal social engineering, on the other hand, undertakes specific projects with specific goals, avoiding totalizing narratives and ambitions in the process.

Science park establishment may be posited as a variant of Popper's piecemeal social engineering since it promotes science-based regional development through specific, rational, and sectoral strategies instead of ideology-based radical societal transformation. Science parks achieve this development mainly by catalyzing the movement of knowledge and technology out of the university into market and society at large. This movement provides suitable contexts in which researchers employed in public and private sectors can come together to collaborate and facilitate the transformation of scientific research into economic value (Hansson, Husted and Vestergaard 2005).

This marriage of industry and academia presupposes a major shift in the perceived function of universities from being solely centres of academic and research excellence to becoming active economic agents for generating wealth through deploying commercially viable knowledge inputs

[†]This paper draws upon the National University of Sciences and Technology's (NUST) Concept Paper for National Science and Technology Park and various internal NUST documents.

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World Technopolis Review

into the economy. Science parks are a real estate property-based enterprise that: focus on new product and process research and development through formal and operational links with universities; facilitate technology transfer from university to tenant firms and provide business skills aimed at the on-site creation of new small to medium high-growth technology-based firms with considerable innovation potential for accelerating sustainable regional economic development and growth; help the establishment of an amenable environment for evolution of links between multinational businesses and a specific centre of knowledge and value creation; and develop collaborative interaction between university, industry and government (Etzkowitz 2008; Kang 2004; Salvador 2011; Tan 2006).

The interaction between university, industry and government has been characterized as the triple helix of innovation and credited, inter alia, with the creation of science parks as a hybrid entity born out of this triadic interaction along with universities being perceived as the pivotal element of knowledge creation in contemporary knowledge-based societies (Etzkowitz 2008). The renewed emphasis on innovation as the key to development is compelling universities to take the entrepreneurial turn. Entrepreneurial university is endowed with the four attributes of visionary strategic leadership, proprietorship of university physical and intellectual property, organizational capacity for technology transfer and an entrepreneurial culture among management, staff and students (Etzkowitz 2008, p.27). Triple helix embodies the paradigm shift from the traditional university function of teaching and research to the third mission of social and economic development. Science parks exist as a specific form of fulfillment of this third mission of the university.

2. NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY

National University of Sciences and Technology (NUST) is well-positioned to utilize its knowledge potential to become the top entrepreneurial university of Pakistan through the development of its National Science and technology Park (NSTP), the country's first-ever proper science park. NUST possesses the dynamic potential to successfully undertake the construction and development of NSTP. This potential is vested in the actual resources embodied in various kinds of capital owned by NUST: physical infrastructural capital in the form of constituent colleges, schools, research centres, training institutes etc; organic (human) knowledge capital in the form of highly-qualified faculty, researchers and students; inorganic knowledge capital in the form of an advanced ICT infrastructure that facilitates rapid flow of information; and strategic capital in the form of active collaboration with industry and international alliances with foreign universities. These different forms of capital are geared to utilizing knowledge and technology for innovation-led social and economic development goals and correspond broadly to the four attributes of an entrepreneurial university. NUST's quest to become an entrepreneurial university is guided by its five key strategic development thrusts:

- **Excellence in Teaching and Education**: The university will ensure the provision of high-quality education in sciences and technology coupled with ensuring it remains accessible to all strata of society;
- **Focus on Research**: The university will ensure the provision of high-quality relevant research to support the emerging knowledge-based economy and society;
- **Spirit of Enterprise**: The university will focus on the development of instruments and mechanisms for promotion of enterprising spirit and entrepreneurial culture among NUST graduates and create strong linkages with industry.
- **Internationalization and Global Vision**: The university will develop strong international linkages to ensure inflow of new knowledge and state-of-the-art technologies, while building a positive international image of the University and country; and
- **Positive Social Impact**: Structure curricula and programmes to influence a wider cross-section of the population in terms of education and absorption of new technologies.

2.1 NUST's Ecosystem for Research, Innovation and Entrepreneurship

NUST has a thriving culture of research and entrepreneurship. The University comprises 16 core constituent colleges, schools and centres (Table 1). These constituents undertake the first and second academic missions of transmission of knowledge on one hand, and research and creation of knowledge on the other. These core constituents provide the basic R&D platform for inter-university and industrial collaboration.

WTR 2012;1:264-275 http://dx.doi.org/10.7165/wtr2012.1.4.264

Table 1. NUST's core constituents

Army Medical College	NUST Business School
College of Aeronautical Engineering	School of Art Design and Architecture
School of Chemical and Materials Engineering	School of Electrical and Computer Engineering
School of Civil and Environmental Engineering	School of Engineering and Manufacturing Engineering
College of Electrical and Mechanical Engineering	Atta ur Rahman School of Applied Biosciences
Military College of Engineering	Centre for Advanced Mathematics and Physics
Military College of Signals	Research Centre for Modelling and Simulation
Pakistan Navy Engineering College	Centre for Energy Systems

These core teaching and research outfits are further complemented by a strong innovation and entrepreneurship ecosystem to perform the third university mission of economic and social development with its focus on technology transfer by means of new technology-based firm-formation. This ecosystem is embodied in the Centre for Innovation and Entrepreneurship consisting of distinct offices of Research, Innovation and Commercialization (Fig. 1).

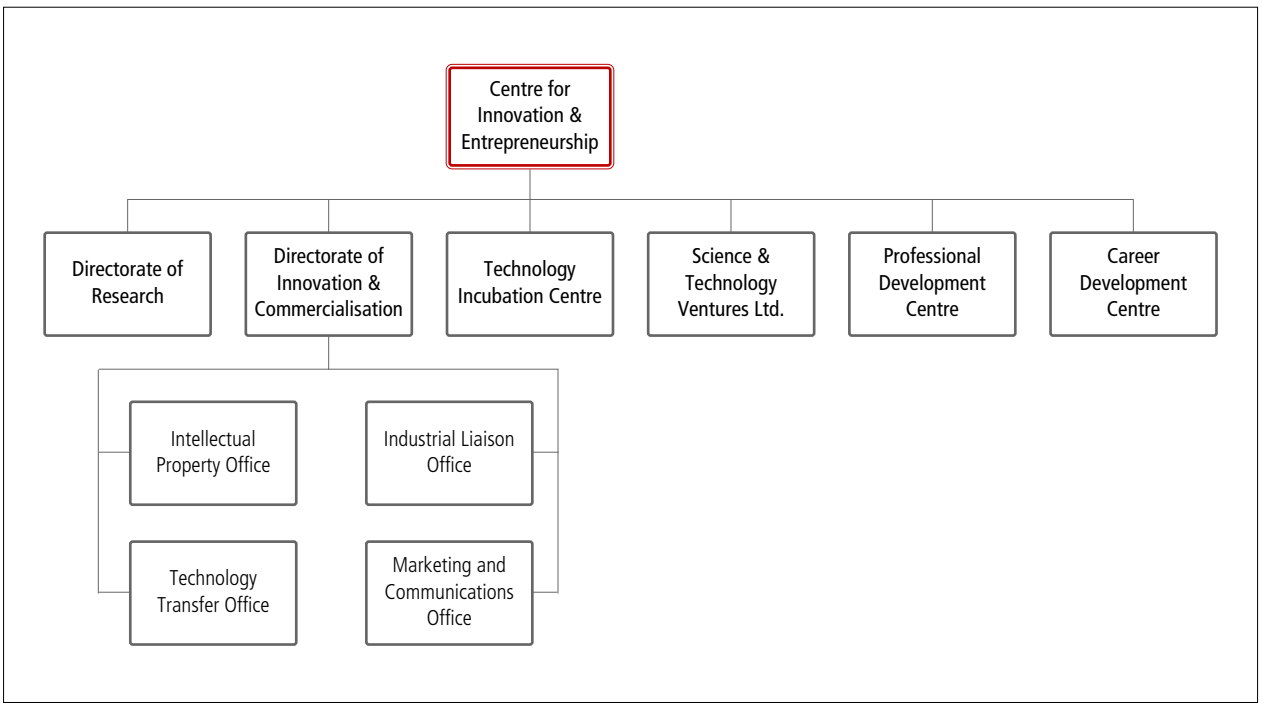

Fig. 1. NUST's Centre for innovation and entrepreneurship

2.2 Strategic Planning and University Development Cell

Strategic Planning and University Development Cell (SP&UD), headed by the Advisor to Rector-NUST, is a highly flexible entity entrusted with developing appropriate projects to realise the University's five strategic thrusts. SP&UD has harnessed teaching, research, innovation, and entrepreneurship together by formulating critical initiatives like the Corporate Advisory Council (CAC), Global Think Tank Network Program, and National Science and Technology Park (NSTP) aimed at maximising triple helix interaction amongst different institutional spheres.

2.2.1 Corporate Advisory Council (CAC)

Established in 2010, CAC is geared to establishing a mutually beneficial relationship between university and industry, where cutting-edge knowledge from academia is shared with the business world for social and economic development. The Council uses intellectual capital to function as an interface through which a two-way flow of knowledge takes place between industry and academia. There is a strong element of public policy input through institutional interaction with high-level public policymaking and advisory organisations like the Planning Commission of Pakistan, Ministry of Science and Technology (MoST), Higher Education Commission (HEC), National Engineering and Scientific Commission (NESCOM). The CAC is structured along the following distinct lines:

1. Development of Industrial Linkages with the aim of creating harmony between NUST R&D and industrial output.
2. Conducting research into the core dynamics of each sector under the CAC's purview.
3. Engaging in advocacy with the public sector for reform/planning.
4. Engaging in advocacy/research collaboration with private sector for identified areas of growth.

CAC's core aim revolves around having long-term economic impact for the sectors within its purview. CAC has positioned itself in the academic and business landscapes of Pakistan by creating effective industrial linkages as well as providing external users a premium data and knowledge repository. The distinguishing factors behind the CAC are its academic links and its access to the NUST research facility. It further distinguishes itself by providing industry-related and business-generated research projects, with a clear objective to create streams of value for the partner industries.

The alignment of traditionally opposed academic and industrial worldviews in Pakistan is embodied in the 11 Sector Committees of the Council, including Automotive, Health & Pharmaceuticals, Infrastructure, Information & Communications Technology (ICT), Engineering, Banking & Financial Services, Energy, Chemical, Defence Technologies, Intellectual Property Rights (IPR), and the Social Sector (Fig. 2). Each sectoral committee is headed by an Industry Co-Chair as well as a NUST Co-Chair. Senior executives and accomplished academics use this platform to diagnose problems and provide value-added solutions to these specific industry problems. Since SMEs are a substantive component of Pakistan's economy and their regional clustering presupposes economic growth, CAC works towards this focus by

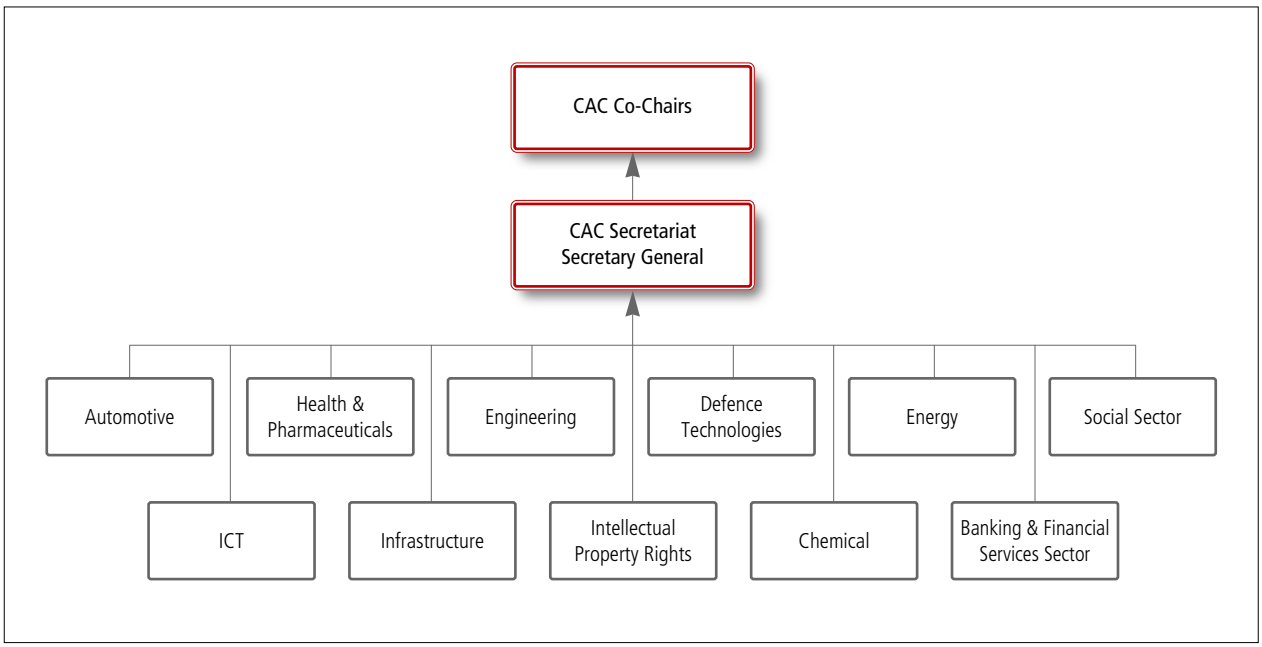

Fig. 2. Corporate Advisory Council

WTR 2012;1:264-275 http://dx.doi.org/10.7165/wtr2012.1.4.264

facilitating university-industry projects to identify areas of locked value within partner firms, address the issues of under-utilized production capacity, channel investment to finance-starved projects, help find commercializable technology in NUST academic research and transfer this technology to market. In a period of less than two years, CAC membership has grown to include more than a hundred members from top-line local and international business and industrial firms, banking and investment houses, and high-level domestic public policy-makers and intellectuals. Cooperation and collaboration between industry and NUST academia has led to innovative projects aimed at providing solutions to industrial and corporate partners.

CAC, in collaboration with teaching, research and entrepreneurship units of NUST's ecosystem, has helped human capital development of NUST in practical, industry-specific, and meaningful terms, ranging from periodic curriculum revision in line with industry priorities, to student placements including internships, on-job training and employment within the industry that is aimed at the creation of an overall environment of industry-specific human capital development. CAC's promotion of university-industry cooperation can create the impetus for the "virtuous circles" of the development of "solutions of specific local problems" (Arocena and Sutz 2001, p.1233), a trend that shall find enhancement in the establishment of NSTP.

CAC represents the embryo of advanced triple helix to be activated through NSTP development. CAC's collaborative relationships with industry and government shall be optimally utilized for the development of NSTP. The CAC shall geographically shift to the NSTP premises upon the latter's establishment to increase its effectiveness.

2.2.2 Global Think Tank Network Program

SP&UD has launched an ambitious program of international knowledge collaboration through the establishment of a network of partnerships with think tanks in Asia, Europe, and North and South America to conduct research on regional as well as global issues. NUST is using its affiliations with foreign universities and other domestic and international linkages to develop this network. China-Pakistan Joint Think Tank has already been launched with the collaboration of two top Chinese universities, Tsinghua University (THU), Beijing, and the Southwest University of Political Science and Law (SWUPL), Chongqing, to conduct high-quality, original policy research and advocacy on a range of areas of common and regional concern. The network aims to promote the *glocalisation* of knowledge that syncretises the local and global sources of knowledge for enhancing the local culture of knowledge utilization. NUST views this process of melding the global with the local as essentially consisting of two strands. The first strand focuses on the need to draw upon international sources of knowledge to meet domestic knowledge needs and scarcities (Ernst 2002); the second aims to create interactive processes that will lead to the sustainable production of domestic knowledge that enjoys international relevance.

This two-pronged knowledge-based strategy can become an important vehicle for glocalisation seen as "internal globalization" (Roudometof 2005, p.113). Glocalisation can be deployed for the development of the NSTP by producing a model that combines the successful elements of science park practice around the world and syncretises them with the local development and cultural demands. Perhaps, as a result of the role of knowledge production that university performs coupled with its status as an advanced stage of socialization which solidifies the preceding stages, universities, and their associated entities like science parks, do also become dedicated sites of the reproduction of "*habitus*, systems of durable, transposable dispositions, structured structures predisposed to function as structuring structures" (Bourdieu 1977, p.72).

There is a high level of internal coordination between CAC and the Global Think Tank Network Program. The convergence between CAC and the Program is being tapped to develop and accumulate resources for NSTP establishment. A total area of fifty acres on NUST Main Campus in Islamabad has been allocated for the NSTP.

3. NATIONAL SCIENCE AND TECHNOLOGY PARK

NUST is the first institution of higher learning in the country which has taken a sustained initiative for science park development in Pakistan. The university has created an internal ecosystem that consists of components which would provide the building blocks of the NSTP. The conception of NSTP has involved a process of extensive research and consultation with domestic and international organizations to prepare a sustainable plan for its establishment. These include the World Bank, International Finance Corporation,

Pakistan Association of Software Houses (PASHA), Pakistan Software Export Board (PSEB), Institute for the Future, Research Triangle Foundation, Higher Education Commission of Pakistan (HEC), Ministry of Science and Technology (MoST), Pakistan, and World Technopolis Association (WTA). The establishment of NSTP aims to enhance the national technology base, develop efficient systems in public and private sectors, help resolve industry issues through R&D, produce goods and services of global standards and develop regional innovation system.

The primary NSTP stakeholders shall be NUST, public and private research institutes and universities, tenant firms and companies, investors, venture capital firms, start-up companies and the Government. It is important to mention here that the factors that made the region in Taiwan where Tsinchu Science Park is located so innovation friendly include "pro-active government policies, R&D alliances, industrial clusters with spatial closeness between universities ... research institutes and industrial actors" (Hu 2011, p.950). These factors are latently present in Islamabad, the city where NUST is located and need appropriate public interventions to develop. Such public policy interventions have been observed to be a key element in creating national and regional innovation systems (Park 2001).

NSTP shall aim to capitalise on and intensify existing R&D collaboration between academia and firms in order to create competitive products and services in a global context. It is hoped that this collaboration will result in science and technology ventures that have the potential to play an important role in not only enhancing the innovation capacity in the country but also help establish a knowledge-based society. Science parks have the potential to act as a point of convergence for science, technology and innovation policies of a country in the pursuit of the development of knowledge society: the hybrid environment of science parks helps bring together science policy, which focuses on the "production of

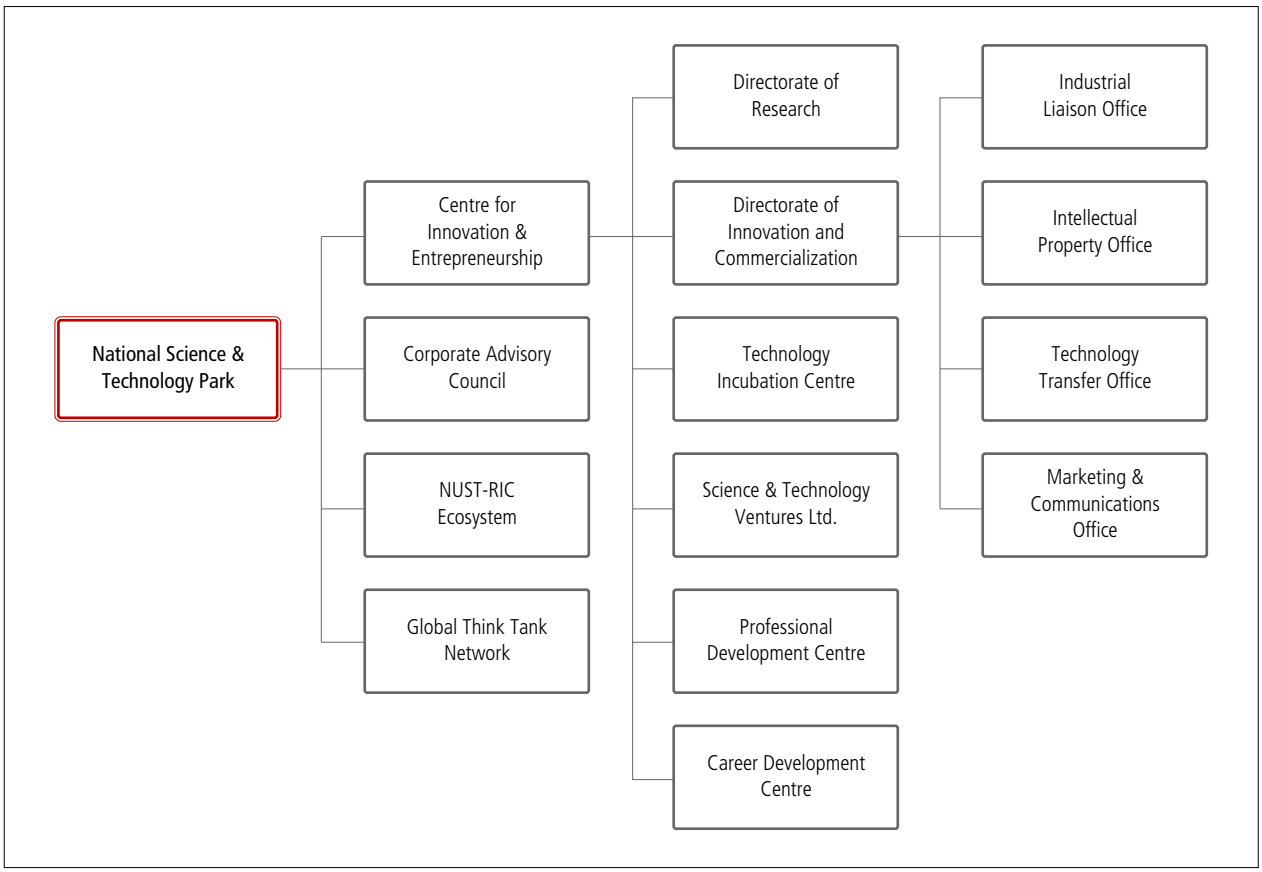

Fig. 3. NUST Ecosystem-NSTP Integration

WTR 2012;1:264-275 http://dx.doi.org/10.7165/wtr2012.1.4.264

scientific knowledge," technology policy, which focuses upon the "advancement and commercialization of sectorial technical knowledge," and innovation policy, which focuses upon "the overall innovative performance of the economy (Lundvall and Borras 2006)." Integration of NUST's research, innovation and entrepreneurship ecosystem will be achieved in the establishment of the NSTP (Fig. 3).

NSTP will operate on a 'services' model rather than a 'landlord' model. The core mission of the NSTP will be to promote knowledge-based businesses for economic prosperity of Pakistan. It will encourage the production and the commercialization of technology through close interaction between tenants and the NUST within a public-private partnership framework. The focus will not only be the provision of on-site physical facilities to the tenants but making arrangements for human resource development and R&D-based interactions between the tenant and the university to encourage knowledge flows.

3.1 NSTP Components

3.1.1 Multi-Industry Cluster

NSTP aims to contain a multi-industry cluster that will house firms in IT, Bio-tech, financial services, defence technologies, energy, automotives and chemicals. CAC's sector-based committees shall leverage its industry relationships to invite domestic and international firms to become a part of the cluster. Multi-industry cluster will have to be backed by the development of multiple linkages with the over-all regional economy because the evidence from the US suggests that university-based research parks develop rapidly if they have a specific technology focus and a unitary sectoral base (Link and Scott 2006). It is not intended to discourage the development of the multi-industry cluster but growth factors involved in the development of science parks in one country may yet have lessons for building science parks in another country.

3.1.2 R&D Centre

A multi-purpose R&D Centre will allow cutting-edge science and technology development to take place side by side. The Centre shall act as the scanning tool for the NSTP to provide latest information on global advances in technological innovation, policy research, economic and social entrepreneurship and innovation studies. One function of the Centre will be to assess Pakistan's national research programs and their efficacy. The R&D Centre will be a self-sustaining autonomous body aligning R&D to industry requirements for generating funds through provision of services to the Government and industry. The Center will build collaborative relationships with think tanks internationally and promote the exchange of ideas and research. CAC and the Global Think Tank Network Program shall form the basis from which to develop the NSTP's R&D Centre.

3.1.3 Manufacturing Resource Centre

NSTP plans to establish a fully equipped Manufacturing Resource Centre (MRC) which focuses on design, process and systems engineering and to act as one-stop-centre for design, prototyping, consulting, production and manufacturing services. By having comprehensive manufacturing and production facilities, MRC could offer technical support and business opportunities to SMEs in both local and international markets. The role of SMEs in Hsinchu Science Park is notable in this respect as they have captured a niche in electronics market worldwide, have moved from simple original equipment manufacturing activities to more complex activities like own-design manufacturing, and some have even achieved the status of own-brand manufacturing in global commodity chains (Lai and Shyu 2005). MRC shall also operate a Technical Advisory Cell (TAC). The collaboration already existing between NUST's core constituents and industry shall come in handy for the operation of MRC and its TAC.

3.1.4 Technology Commercialization Unit

This arm of the NSTP will cater specifically to technology-based firms. The spectrum of services of the technology commercialization unit would include:

a) Innovation Cell: The Cell will function as a pre-incubation unit to encourage technology-based business ideas, prevent the loss of creative ideas or projects, promote a culture of open discussion between academics, companies and students by bringing them together through formal and informal means, and stimulate innovation through building networks of cooperation, trust and reciprocity generated as a result of informal human interaction in formal events. Innovation marathons to be organised by the Cell will emphasise both radical and incremental innovation, on one hand and relevance to market, on the other. Such interactions, however, could limit the linkages between the firms in park and the university to non-technology based commercial transactions and informal interactions whereas the research-

based relationships remain significantly missing as evidenced by the study of three science Greek science parks (Bakouros et al. 2002).

b) Technology Incubation Centre: NSTP shall encourage incubation of new technology firms and facilitate interaction between NUST and the incubatees. The Technology Incubation Centre shall help new technology start-ups seek and intensify interactions with R&D managers, scientists and management faculty. Allowing access to university expertise and facilities has been observed to lead to positive outcomes for new technology start-ups (Chan and Lau 2005). One point of convergence between the NSTP's technology start-ups and the on-site presence of established transnational corporations will be the transfer of technology, although the transfer routes or mechanisms will be different in the case of start-ups and mature international tenants respectively. Phillimore (1999) confirms that there is no single omnibus method used for transferring technology in science parks since technology is not transferred in a linear manner from the university to the park next-door.

The Centre will provide a complete incubation program along with furnished office space, equipped with modern facilities and fully supported by secretarial and administration services. It shall provide consultancy, financial assistance and market research support to incubatees. Individuals and groups graduating from prototyping and pre-incubation stages will also be housed at the Incubation Centre. It shall also be used to foster social entrepreneurship by incubating not-for-profit organisations through appropriate modification of incubation resources. NUST, as a leading S&T university of Pakistan, is especially well-placed to promote the three on-campus criteria of involvement in social entrepreneurship projects i.e. student idealism, faculty interest in social uplift, university third mission to provide solutions to economic as well as social problems (Thorp and Goldstein 2010).

3.1.5 Business Development Unit

Business Development Unit will provide services to clients in: professional business plan writing, corporate plan development for market acquisition, product development and enhancing competitiveness; supply chain integration through strategic sourcing, benchmarking, supplier identification, rationalization and evaluation, electronic procurement activation, contracting and negotiation coaching services; business registration and licensing guidelines, in-house legal consultancy and legal transcription-cum-documentation; intellectual property such as patent registration, industrial design, trademark, copy right, franchising, licensing and technology transfer; and knowledge brokering services for clients to facilitate access to people and information critical to business performance. NUST's Centre for Innovation and Entrepreneurship (CIE), with its different offices, shall be instrumental in developing on-site incubation and business development facilities in the NSTP. In so far as business plan service is concerned, contact should be made with Taguspark, Portugal's biggest science park, to learn about the software called the "financing of innovation tool" which helps "entrepreneurs and SMEs build up their innovation business plan" and "find sources of finance (Durao et al. 2005)."

3.1.6 Corporate Finance and Management Services Unit

NSTP will offer financial management support to clients that would include: professional accounting such as book-keeping, payroll processing, cash management etc.; professional investment solutions; and financial reporting framework for investors, creditors, and tax collectors.

3.1.7 Tertiary and Vocational Education Institute

Being a developing economy science park, the development of NSTP will presuppose the development of elements that may seem primitive or, even, irrelevant from a developed economy point of view. The dearth of trained technical personnel in Pakistan is one of the major stumbling blocks for industrial development. To address this problem, a Tertiary and Vocational Education Institute will be set up in NSTP. The Institute would offer programs accredited through the Ministry of Education and HEC and would focus on producing a globally competitive educated industrial workforce by benchmarking its training and instruction against the global and regional best practice in Technical and Vocational Education and Training (TVET). This would also have the added effect of restoring the social and professional prestige of TVET in relation to higher education in Pakistan and may even create a more balanced distribution of tertiary and vocational enrolments over time.

3.1.8 Property Development Unit

NSTP will include a strong property development component to offer long-term leasing and short- to medium-term rental facilities. This shall be geared to fulfilling the opera-

WTR 2012;1:264-275 http://dx.doi.org/10.7165/wtr2012.1.4.264

tional needs of companies at different levels of their respective stages of growth. NSTP has devised a system of lots to categorise different types of clients housed on-site. Innovation lots will be available to groups and entities at the pre-incubation stage. Incubator lots, based on the idea of shared facilities, will be available to firms about to expand from prototyping and pre-production stages to market testing and production. Enterprise lots will be offered to mature businesses and R&D wings of domestic and multi-national companies. These buildings will be state-of-the-art containing the complete range of professional and leisure requirements. Land will be leased to clients to develop on a customised basis depending upon their needs which may be either R&D or assembly operations with an element of ongoing product/process development. In the initial stages of NSTP's development, rent motive will be a big temptation for park management to invite firms neither involved nor interested in new technology or product development. Caution will need to be exercised to prevent non-innovative tenants.

The construction of an environment reflecting work-life balance is one of the focuses of the NSTP development. A wide range of services including catering, sports, healthcare, shopping, and events like exhibitions, galas, carnivals and hobby clubs will be organised on a regular basis.

4. CONCLUSION

NUST shall derive value, both material and symbolic, from the realisation of four motives that are considered to drive technology transfer: "economic necessity" for the creation of wealth through new products, process and services; "social phenomenon" based on a culture that values entrepreneurship; "financial reward" for companies and innovators; and "intellectual pleasure" entailed by research and development (Lockeman 2004). This enhanced NUST-start-up relationship shall strengthen the reputation of the university in academic and business circles regionally and nationally. It shall result in an increase in NUST revenues. NUST will also benefit from the commercialization of the new technologies such as NUST equity in some of the start-ups where university efforts will be considerable (Lockeman 2004). Career prospects of NUST graduates will improve by the presence of new start-ups and transnational firms in the NSTP.

Tenants would enjoy convenient terms and conditions for access to R&D platform of NUST and NSTP. The presence of a community of entrepreneurial and innovative professionals will ensure the availability of a talented pool of high qualified individuals. Physical proximity and the important role of NUST in the management of NSTP during the initial development phase shall facilitate the process of identifying university programs and resources that match the R&D profile of the firms. Career development of the workforce of the tenants shall be enhanced through participation in NUST's professional training programs. University's technology and process patents shall benefit the tenants' product development processes. It is interesting to note here that the patenting performance of on-site technology-based firms has been observed to be higher than firms located outside (Squicciarini 2008). Technology start-ups shall be able to get mentoring and marketing support that will form an important part of the services offered by the NSTP ecosystem.

The benefits to investors shall depend upon the actual returns of start-ups and technology ventures in which they have invested. Evidence from Sweden suggests that science parks tend to attract highly motivated entrepreneurs, that on-site firms in Sweden experience more rapid growth than their off-park counterparts (Lofsten and Lindelof 2003) and that new technology-based firms located in science parks have higher chances of survival than their off-park cousins (Ferguson and Olofsson 2004). A proper representation of the Swedish evidence and that from other successful cases can become an important factor in highlighting the benefits of investing in the NSTP establishment.

Technology commercialisation shall help enhance the competitiveness of the national economy. The role of government in NSTP development shall be critical as the former has the resources to provide the broad developmental context for the science park establishment by making sure local and regional physical and social infrastructures are in place and functioning properly (Lai and Shyu 2005) so that different sorts of transaction costs can be significantly reduced for the tenant companies enabling them to benefit from and contribute to regional economies of scale (Lin and Zheng 2009).

These different benefits shall depend upon the availability of innovation inputs like trained and entrepreneurial manpower, active domestic and international demand for NSTP products and services, the nature of competition and reward in the regional economy, and the degree of industrial clustering in the region (Lai and Shyu 2005). Evidence from Russia suggests that technology transfer shall continue to be

weak and slow as long as the demand for high-tech products of a science park remains limited in the domestic market (Kihlgren 2003). However before these benefits start accruing to stakeholders through NSTP, the following steps need to be taken:

- Innovation research culture must be promoted in society, universities, government research institutes and the national industrial and productive base of the country needs to be revitalized. A paradigm shift is required to transition from predominantly rigid clientelistic and bureaucratic social relations to entrepreneurial society. This could be done partly by the focus of universities and education sector as a whole to offer courses in innovation and entrepreneurship.
- Evidence-based innovation and entrepreneurship policies have to be formulated that highlight the importance of incubation centres and science parks in regional innovation systems.
- Appropriate and flexible funding structure should be put in place to ensure availability of funds to eligible entrepreneurs. These funds include but are not limited to special grants as seed capital for new business start ups, access to government-subsidized loans for research and start-up businesses, incentives for banks to extend debt and equity loans to start up businesses, federally insured loans for "incubatees" by banks and venture capitalists, and flexibility to use university R&D fund for incubation, if available and necessary.
- Preferential policies for incubates like uninterrupted supply of utilities at subsidized rates, tax holidays, holidays, clear regulatory framework around entrepreneurship, red-tape mitigation and preferential support for machinery and raw material imports should be devised.

The more significant benefit of the establishment of NSTP shall be to affirm Pakistan's commitment to technology-based economic growth as this signal motive is a major factor in inducing the inflow of foreign investments and the decision of multinational corporations (MNCs) to establish on-site presence (Koh et al. 2005). Evidence from China also suggests that cities that host science parks have also experienced relatively higher inflows of foreign direct investment (Hu 2007). This shall help redress difficulties faced by new start-ups due to "lack of funding support and lack of managerial experience" (Salvador 2011, p.226) as more interaction takes place between these firms and the MNCs. The agglomeration effects of the NSTP, once it is established, can diversify the technological base of the local industry, help the cause of regional regeneration, develop the human capital of the region and check brain drain by helping retain the highly qualified personnel in industry and academia. NSTP may not only check brain drain but research suggests that increased inflow of foreign direct investment may induce the mobility of engineers, scientists and entrepreneurs who left the country for greener pastures as well as allow the country to benefit from cross-border mobility of global entrepreneurs (Filatotchev et al. 2011). The "revitalization of traditional industrial cultures" also forms an important part of science parks that intend to uplift the regional economy (Bigliardi et al. 2006, p.3). NSTP shall, therefore, need to impact the manufacturing district situated close to NUST and increase the competitiveness of the industries located therein.

The opportunities provided by the NSTP for cluster formation may allow the clustering firms to mobilize resources in a concerted manner enabling them to perform better against external competing firms (Tan 2006). Public-private investment in the establishment of NSTP, therefore, holds the potential to increase national competitiveness of Pakistan and enable the country to better come to terms with the forces unleashed by globalization. Hu (2011) underscores the importance of policies and strategies that aim to create "sustainable regional innovation system" by creating environmental interactions amongst firms, whether inside or outside a science park, that allow "one firm to use as an input what another firm has discarded as waste for reducing carbon emission and enhancing recycling." NSTP will need to develop this green potential of the firms in the regional innovation system to creative sustainable positive externalities and green integration amongst firms. NSTP can also contribute to national development by providing the pool of resources for undertaking strategic research required for tackling social problems like climate change, energy and epidemics through the promotion of "pure information research consortiums" or the development of publicly funded programs enabling "firms to cooperate by sharing information (Mukherjee and Ramani 2011, p.388)."

REFERENCES

Arocena, R., and Sutz, J. (2001) "Changing knowledge produc-

WTR 2012;1:264-275 http://dx.doi.org/10.7165/wtr2012.1.4.264

tion and Latin American universities," *Research Policy* 30:1221-34. Accessed 20 December 2011. http://dx.doi.org/10.1016/S0048-7333(00)00143-8.

Bakarous, Y.L., Mardas, D.C., and Varsakelis, N.C. (2002) "Science park, a high tech fantasy? An analysis of the science parks of Greece," *Technovation* 22: 123-8. Accessed 4 September 2012. http://dx.doi.org/10.1016/S0166-4972(00)00087-0.

Bigliardi, B., Dormio, A.I., Nosella, A., and Petroni, G. (2006) "Assessing science park performances: directions from selected Italian case studies," *Technovation* 26: 489-505. Accessed 25 July 2006. doi:10.1016/j.technovation.2005.01.002.

Bourdieu, P. (1977) *Outline of a Theory of Practice* (Cambrige, UK : Cambridge University Press).

Chan, K.F., and Lau, T. (2005) "Assessing technology incubator programs in the science park: the good, the bad and the ugly," *Technovation* 25: 1215-28. Accessed 4 June 2012. doi:10.1016/j.technovation.2004.03.010.

Durao, D., Sarmento, M., Varela, V., and Maltez, L. (2005) "Virtual and real-estate science and technology parks: a case study of Taguspark," *Technovation* 25: 237-44. Accessed 3 September 2012. doi:10.1016/S0166-4972(03)00110-X.

Ernst, D. (2002) "Global production networks and the changing geography of innovation systems. Implications for developing countries," *Economics of Innovation and New Technology* 11(6): 497-523. Accessed 24 November 2009. http://dx.doi.org/10.1080/10438590214341.

Etzkowitz, H. (2008) *The Triple Helix University–Industry–Government Innovation in Action* (London ; New York: Routledge).

Ferguson, R., and Olofsson, C. (2004) "Science parks and the development of NTBFs – Location, survival and growth," *Journal of Technology Transfer* 29: 5-17. Accessed 5 September 2012. doi: 10.1023/B:JOTT.0000011178.44095.cd.

Filatotchev, I., Liu, X., Lu, J., and Wright, M. (2011) "Knowledge spillovers through human mobility across national borders: Evidence from Zhongguancun Science Park in China," *Research Policy* 40: 453–62. Accessed 28 January 2012. doi:10.1016/j.respol.2011.01.003.

Hansson, F., Husted, K., and Vestergaard. J. (2005) "Second Generation Science Parks: From Structural Holes Jockeys to Social Capital Catalysts of the Knowledge Society," *Technovation* 25: 1039-49. Accessed 15 January 2012. doi:10.1016/j.technovation.2004.03.003.

Hu, A.G. (2007) "Technology parks and regional economic growth in China," *Research Policy* 36: 76-87. Accessed 8 September 2012. doi:10.1016/j.respol.2006.08.003.

Hu, M-C. (2011) "Evolution of Knowledge creation and diffusion: the revisit of Taiwan's Hsinchu Science Park," *Scientometrics* 88: 949-77. Accessed 1 September 2012. doi 10.1007/s11192-011-0427-5.

Kang, B.-J. (2004) "A Study on the Establishing Development Model for Research Parks," *Journal of Technology* Transfer 29: 203–10. Accessed 26 January 2012. doi: 10.1023/B:JOTT.0000019538.83442.b4.

Kihlgren, A. (2003) "Promotion of innovation activity in Russia through the creation of science parks: The case of St. Petersburg (1992-1998)," *Technovation* 23: 65-76. Accessed 4 September 2012. http://dx.doi.org/10.1016/S0166-4972(01)00077-3.

Koh, F.C.C., Koh, W.T.H., and Tschang, F.T. (2005) "An analytical framework for science parks and technology districts with an application to Singapore," *Journal of Business Venturing* 20: 217–39. Accessed 23 January 2012. doi:10.1016/j.jbusvent.2003.12.002.

Lai H-C., and Shyu, J. (2005) "A comparison of innovation capacity at science parks across the Taiwan Strait: the case of Zhangjiang High-Tech Park and Hsinchu Science-based Industrial Park," *Technovation* 25: 805-13. Accessed 19 January 2012. doi:10.1016/j.technovation.2003.11.004.

Lin, C-L., and Zheng, G-H. (2009) "A value-created system of science (technology) park by using DEMATEL," *Expert Systems with Applications* 36(2009): 9683–97. Accessed 25 January 2012. doi:10.1016/j.eswa.2008.11.040.

Link, A.N., and Scott, J.T. (2006) "U.S. university research parks," *Journal of Productivity Analysis* 25: 43-55. Accessed 9 September. 12 doi:10.1007/s11123-006-7126-x.

Lockeman, P.C. (2004) "Technology Transfer: Political Pressure, Economic Necessity, Social Phenomenon, Financial Reward or Intellectual Pleasure?" *Comparative Technology Transfer and Society* 2: 133 -75. doi :10.1353/ctt.2004.0018.

Lofsten, H., and Lindelof, P. (2003) "Determinants for an entrepreneurial milieu: Science Parks and business policy in growing firms," *Technovation* 23: 51-64. Accessed 4 September 2012. http://dx.doi.org/10.1016/S0166-4972(01)00086-4.

Lundvall, B-A., and Borras, S. (2006) "Science, Technology and

Innovation Policy," 599-631 in *The Oxford Handbook of Innovation* edited by Jan Faberberg, David C. Mowery and Richard R. Nelson. (Oxford; New York : Oxford University Press).

Mukherjee, V., and Ramani, S. (2011) "R&D cooperation in emerging industries, asymmetric innovative capabilities and rationale for technology parks," *Theory and Decision* 71: 373-94. Accessed 23 January 2012. doi 10.1007/s11238-009-9184-9.

Park, S-C. (2001) "Globalisation and local innovation system: The implementation of government policies to the formation of science parks in Japan," *AI & Society* 15: 263-79. Accessed 10 August 2012. doi:10.1007/BF012 08708.

Phillimore, J. (1999) "Beyond the linear view of innovation in science park evaluation: An analysis of Western Australian technology Park," *Technovation* 19: 673-80. Accessed 29 August 2012. http://dx.doi.org/10.1016/S01 66-4972(99)00062-0.

Popper, K. (1947) *The Open Society and its Enemies* (London: George Routledge & Sons Ltd).

Roudometof, V. (2005) "Transnationalism, Cosmopolitanism and Glocalization," *Current Sociology* 53: 113-35. Accessed 14 July 2012. doi: 10.1177/0011392105048291.

Salvador, E. (2011) "Are science parks and incubators good "brand names" for spin-offs? The case study of Turin," *Journal of Technology Transfer* 36: 203-32. Accessed 29 January 2012. doi:10.1007/s10961-010-9152-0.

Squicciarini, M. (2008) "Science Parks' tenants versus out-of-Park firms: who innovates more? A duration model," *Journal of Technology Transfer* 33: 45-71. Accessed 5 September 2012. doi:10.1007/s10961-007-9037-z.

Tan, J. (2006) "Growth of industry clusters and innovation: Lessons from Beijing Zhongguancun Science Park," *Journal of Business Venturing* 21: 827–50. Accessed 24 January 2012. doi:10.1016/j.jbusvent.2005.06.006.

Thorp, H.H., and Goldstein, B. (2010) *Engines of Innovation: The Entrepreneurial University of the Twenty-First Century* (Chapel Hill: The University of North Carolina Press).