Science parks in China: a cautionary exploration

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Abstract: Science parks have long been in fashion, originally in the US, then in Europe, and now in the rest of the world. They promise much in terms of growth and employment achieved through providing new, high technology companies with an ideal location. Clustered in pleasant surroundings alongside a university or research centre, entrepreneurs are able to transform their ideas into innovations. Yet, despite all the enthusiasm, there is little evidence that science parks work as their supporters say, and growing evidence that they do not. There may be benefits, but perhaps for those who can lay claim to a role in a particular model of innovation, rather than for the firms that occupy the science parks. This paper considers the creation of the Silicon Valley model, and then speculates on the implications for China of its uncritical acceptance in science parks.

Keywords: science park, China, high technology, Silicon Valley, myth

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Biographical notes: Stuart Macdonald is Professor of Information and Organisation at the University of Sheffield. His research has long been concerned with the role that information plays in innovation and in change more generally. Most is strongly empirical. An approach that makes information central to enquiry does not fit comfortably within a single discipline and has necessarily been pursued in several. The aim is to contribute to understanding and thereby to both corporate strategy and government policy.

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Introduction

It would be extraordinary indeed were China not enthusiastic about science parks. The rest of the world is enthusiastic and there is no reason why China should be an exception. More rationally, the science park promises so much, so many benefits for so few costs, and so quickly, that not to be enthusiastic would seem quite irresponsible. And yet, while a few science parks have proved to be enormously successful, many more have not. Why, then, should the exceptional be seen as typical, even inevitable? Is this merely the triumph of hope over experience, or is something more complicated at work? We argue here that blind optimism is not a convincing explanation and that the complex alternative is both more satisfactory and more intriguing. It reveals much about contemporary attitudes towards technology and development, attitudes that are often no more questioned than the science parks these attitudes support.

But first the paper will tackle the prosaic: just what are science parks? It will then turn to the available evidence for their performance. The next section explains reaction to this evidence in terms of the rationale behind science parks, and this is really the core of the paper's argument. The beliefs that underlie so much of the rationale make actual performance, however measured and however miserable, largely irrelevant. The science park is perhaps best understood as an article of faith, and it does not do to question faith with statistics and logic. The presence of science parks can be taken as an indicator of prevalent beliefs about technology and innovation, and about how the world should be ordered. And where there are beliefs, there is always the danger that the more fervent belief may exploit the less. This is a much more adventurous approach than trying to determine whether science parks are

good or bad, and it is the approach we will take to our consideration of science parks in China.

The science park

The harder one strives to define a science park, the more one appreciates the advantages of imprecision. The term seems to be generally synonymous with technology park, and with science and technology park, with research park and innovation park, innovation centre, science and technology centre, and sometimes even with science city and technopole. A science park can be virtually anything, and many are little more that very ordinary property developments seeking to cash in on the cachet. That there should be a cachet at all is a primary concern of this paper and will be considered later. So, too, will the curious disposition to look down on the entrepreneurialism of property developers who create science parks while admiring that of the scientists and engineers who occupy them: clearly, entrepreneurialism in itself is not admirable [1], and may actually be disruptive in the highly-regulated environment of the science park [2].

Very frequently, science parks are described in terms of what they are not rather than what they are: they are not the dirty, polluted sites of old, rustbelt manufacturing. They are not bad, so they must be good. The definition adopted by the International Association of Science Parks is that originally formulated by the UK Science Park Association. A science park is:

> "an initiative for the establishment and growth of technology-based enterprise formally and operationally linked to at least one centre of technical expertise an organization which provides management support for its tenant companies." [3]

Despite the generous variety of definitions, it is still possible to reach some sort of consensus over what a science park is. Just what the science park is supposed to do is more elusive. It is, of course, necessary to determine this before there can be any

assessment of whether science parks succeed in what they do. Massey and Wield have analysed the many purposes of UK science parks [4]. They would seem to have four in common:

- to create employment
- to establish new firms
- to facilitate the link between universities and these firms
- to encourage high technology.

Success or failure?

Judged by the Massey and Wield criteria, it would seem that many science parks fail. Most do not stimulate high technology firms and high technology employment. The mere presence of such firms on science parks is often taken as proof positive of the success of these parks. Yet, it is clearly misguided to suggest that these firms would not have existed without the science park, that they could not possibly have located elsewhere. What evidence there is does not conclude that science parks offer the optimum location for high technology firms. Indeed, it would seem that the science park offers little advantage at all.

Westhead and Batstone compare the location decisions of high technology firms on and off science parks [5]. The criteria of the two groups differ little and are soberingly prosaic, the location generally being chosen because the founder lived nearby or because the firm was already based locally. Convenient car parking was among the most important considerations for both groups, and the second most important of all for those on science parks. Most important was the prestige the science park offered. Mystique commands a premium. But precisely because the science park does bestow status, it may actually intrude between the park's high technology entrepreneurs and the world outside. For decades now, it has been appreciated that innovation requires the integration of research with manufacturing, of science with production, of both research and production with customers and suppliers, of the highly qualified with the highly experienced. The science park can

make more difficult all these forms of integration [6], isolating its firms in high technology enclaves [7].

Lofsten and Lindelof also compare the performance of firms on and off science parks, this time Swedish firms [8]. Again, there is not much in it: firms on science parks grow faster in terms of employment and sales, firms off-park grow more rapidly in terms of profitability. UK evidence suggests no difference in survival rates, R&D performance, and employment growth between firms on and off parks, or in much else [9].

> "The existing evidence suggests that the 'returns' to location on an [sic] UK science park are negligible." [10]

Massey and Wield find that most employment on science parks has simply moved from somewhere else nearby [11]. And while a quarter of science park firms were indeed start-ups, most of these had been started by government or institutions rather than by entrepreneurs. Links with universities were few, much technology was not leading edge, and innovation tended to be incremental rather than radical.

Vedovello, and many others, find the science park location gives little advantage to the firm except in general terms of environment [12]. Access to university resources, including information, is not important. Links do develop with university academics and seem to contribute to the survival of firms, but they are generally informal links only marginally closer than those of firms not located on the science park [13]. The survey evidence indicates that firms on science parks are not more innovative than firms located elsewhere, nor do they spend more on R&D [14].

Why the enthusiasm?

It is now two decades since one US survey roundly declared that "well over 50 percent of science and high technology parks have failed" [15]. Why, then, is the belief that science parks are key to the growth of high technology firms quite so

general, and so fervently held? There would seem to be several strands to the explanation. One is the celebrity status that is accorded a very few, very successful science parks, such as the one at Cambridge [16]. These few have been elevated to such prominence that it is easy to forget that they really are quite exceptional.

> "For the one Research Triangle Park there is a Thousand Oaks, north of Los Angeles, a Swearingen in Norman, Oklahoma and a Sterling Forest in Rockland County, New York – parks which have not been successful in attracting significant research activity." [17]

It may be altogether naïve to assume that science parks can succeed only by doing what they are supposed to do. It may be that the very existence of a science park is itself success for a regional authority anxious to show that it is promoting economic development, or for a university demonstrating that it has come down from its ivory tower, or for a small firm trying to market a new product as high technology. We argue here that, while the benefits of science parks are widely touted [18], it is not essential that the benefits claimed are ever realized. What is important, and what is the primary function of science parks, is their ability to accommodate, propagate and promulgate a view of technology and innovation that is to the advantage of many of the parties involved in science parks [19]

Consider the basic model that underlies the idea of the science park: it is that knowledge lies within the science and engineering departments of universities and similar institutions of learning, knowledge that can be exploited by firms to innovate and create wealth. If only this information could be transferred to these firms. This is a linear model in which innovation is seen to have its origins in basic research, or science, or invention – some activity at the beginning of a process. Innovation is perceived as the culmination of this process, and so those who initiate or control the process have power over innovation. Such a model is obviously attractive to universities, and especially to scientists and engineers, because it accords them a

primary role in wealth creation. When knowledge is no longer regarded as a form of wealth, and the scholar is judged by his entrepreneurial credentials, such a role is important [20]. The model is also attractive to politicians and public servants because it affords them a role in arranging the transfer of technology. And it is attractive to managers, who need to think of innovation as a process so that it may be managed, and managed by method. The science park concept reinforces the forces of order in the constant battle against chaos. Social systems are seen to depend on system and to be threatened by innovation that is not properly channeled. There is no place for happenstance, serendipity, and chance in such innovation, for anything other than scientific rigour and managed process. The science park fits this model well, and is vigorously defended by those for whom the model is indispensable.

The Silicon Valley model

Technology – basically how things are done [21] – is not always prominent among the factors of production. It rises to the fore during times of change and uncertainty, basically when there is pressure to do things in other ways. The Agricultural and Industrial Revolutions of Western Europe are obvious examples, but consider instead the problem of poor productivity in the US in the late 1970s, a problem addressed rather than solved by the application of new information and communications technology [22]. In this case, the technological solution was considered to lie not in incremental improvement to mechanization or factory organization, but in radically new technology – high technology. In as much as the term has any precise meaning [23], it is a type of technology to which science is considered to make a major contribution. High technology is the technology of science parks.

In the early 1980s, the United States imposed export controls to prevent high technology information leaving the West [24]. The loss of this information to the Communist bloc, it was argued, would reduce the technology gap with the West and hence imperil US national security. In fact, the real threat to national security was commercial rather than military, posed by the growing technological strength of the

Japanese and even the Europeans – and perhaps now the Chinese.

"In the 1980s, the enemy was Japan: now it is China." [25]

Perceived technological threat encouraged the United States to look more and more to high technology for the competitiveness it sought, and to a model that would encompass these requirements. Silicon Valley led the world in microelectronics, rapidly becoming the technology fundamental to all methods of production and to many products. It seemed to follow that whatever Silicon Valley had was what was required for prosperous high technology industry. Silicon Valley was obviously an excellent example of the model at work. Curious, though, that Silicon Valley had been the world's pre-eminent center of high technology for just about two decades before it was considered a model. The transition to model says much more about requirements during and since the 1980s than about the qualities of Silicon Valley.

The Silicon Valley myth

Year after year, officials from all levels of government in the US and then, it seemed, from most foreign countries, visited Silicon Valley to discover what Silicon Valley had that produced such prosperous high technology firms. They sought a tangible explanation and generally concluded that Silicon Valley offered little, certainly nothing that their own regions did not already offer, or could be made to offer with judicious public expenditure. It seemed to follow that even the most desolate corners of the globe could readily be converted into prosperous centres of high technology by the application of the Silicon Valley model [26].

Visitors to Silicon Valley saw what they wanted to see, perhaps what they were conditioned to see – lots of thriving, new, high technology firms in a neat and pleasant setting with a prestigious university in their midst. It seemed self-evident that the university generated the firms through the transfer of its technology, a model that universities had propagated over the previous decade. Also unquestioned was the assumption that the greenery of the park had an essential part to play in the success of high technology firms. The greenfield R&D sites of the 1960s had already made this

part of the model familiar. And so, governments in the US, and then governments around the world, sought to establish their own versions of Silicon Valley in the science park. Consider for example, the enthusiasm in the Philippines:

> "Science and technology parks have played significant roles in the utilization and commercialization of technological innovations in developed countries. The same is observed among the tigers of Asia. Realizing the wealth of knowledge and information in the University, it can bridge the gap between technology generation and utilization." [27]

Those responsible for science parks often went to extraordinary lengths to replicate precisely the trappings of the real Silicon Valley. The manicured lawns, the trim trails, the ducks and duck ponds, the space age architecture of science parks everywhere are pure cargo cult.

Though assumption rapidly turned to conviction that Stanford University was the fountain from which high technology information flowed to the high technology firms of Silicon Valley, it is quite unfounded. In as much as there was technology transfer between the two, it was from industry to the University rather than *vice versa*. Stanford University has gained more from Silicon Valley than ever the Valley gained from Stanford [28]. Hardly any of the founders of Silicon Valley firms came from Stanford University: of 243 high technology firms founded in Silicon Valley in the 1960s, only six had full-time founders direct from Stanford University [29]. Yet, the belief persists that the University positively spawned entrepreneurs. In contrast, industry did: by 1968, some 41 firms had been founded in Silicon Valley by ex-Fairchild employees alone[30]. Of 400 delegates attending a semiconductor industry conference in 1969, fewer than two dozen had not worked for Fairchild at some time [31].

No reality was going to sway such widespread conviction that the Silicon Valley

model was valid. The cynical might see convenience and self-interest in this conviction, but this would be to overlook the power of myth. A myth is akin to religious faith in that it is dependent on belief. Whether myth is right or wrong is irrelevant and so questioning myth is always pointless [32]. The Silicon Valley model acquired mythic status in the 1980s in that what was expected of it was momentous and the means by which it would be achieved magical. Ironically, the very foreign competition that found the myth so attractive was undermining the comparative advantage of Silicon Valley in high technology [33]. The myth flourished while the reality floundered. And because the Silicon Valley myth was detached from reality, it was unscathed by revelations that uncertain water and electricity supplies, smog, overcrowding, traffic congestion, chemical pollution, poverty and social exclusion were the lot of many of the Valley's high technology workers [34]. Indeed, high technology seemed to be most prosperous in those parts of Silicon Valley outstanding for their high pollution, high housing costs and shortage of cultural amenities [35].

Re-interpreting reality

The innovation of high technology, the innovation fundamental to increased competitiveness and wealth, is as much the product of serendipity as of system. What those who seek to replicate Silicon Valley seem to forget is that neither it nor that other primary centre of high technology enterprise, Route 128 around Boston, was planned. Just as the uncertainty of innovation has been re-interpreted, so has the reality of Silicon Valley. Whatever made Silicon Valley, it was not Stanford University. Stanford was founded by one Leland Stanford, a railway magnate of ill repute, and endowed with surrounding land – the Farm. The bequest required the Farm to remain in agricultural use, and so it did until the massive industrialization of the surrounding area during World War II pushed up property taxes. The University was forced to sell large parts of the Farm simply to pay its taxes, and had little interest in what was done on the sold land [36]. Yet, this has become the model for the science park.

Such re-interpretation denies the role of accident in history and is profoundly

ahistorical in that it perverts understanding to serve modern ends. The modern organisation is, at least in theory, a streamlined affair favouring efficiency over flexibility, and inimical to mavericks and heretics likely to disrupt existing systems. If there is to be change, it must come from the top, from a leader empowered to be inspired. Such individuals acquire – and require – heroic status, and this is easily afforded past leaders. Drescher, for example, conveniently attributes the Research Triangle Park of North Carolina to the efforts of a university professor and a state governor [37]. Frederick Terman, Dean of Engineering at Stanford University from 1946 and Provost from 1955, conventionally stars as the creator of Silicon Valley, declaring that Stanford should have a science park and prescient in his certainty that University information would flow out onto the park to create thriving high technology industry [38]. Singular explanations of major events should always be suspect. It would be as justified to attribute Silicon Valley to William Shockley, co-inventor of the transistor, moving there in 1954 to set up one of the first firms to exploit the new technology. In fact, Palo Alto was his home town, Shockley proved to be no entrepreneur, and his semiconductor firm rapidly foundered. Shockley's interests soon transferred from semiconductors to eugenics and establishing a superior race through sperm banks, and his own contribution to them [39]. Larsen and Rogers, in perceiving Silicon Valley's overall attribute to be entrepreneurialism, lean towards this heroic explanation [40]. Had not Shockley come home to Palo Alto, had not Terman sold part of the Farm, there would have been no Silicon Valley. The same logic leads to speculation that the emergence of Silicon Valley was dependent on garages: much is made of Steve Jobs and Steven Wozniak of Apple, and of William Hewlett and David Packard of Hewlett Packard starting their businesses in garages.

This wholesale reinterpretation is possible because so much of what does make Silicon Valley tick is an invisible reality. Whatever its origins – and it really is not very important what they are – Silicon Valley works because it has exploited what the geographers call agglomeration economies, the economists externalities, the sociologists and anthropologists – and a great many others – networking [41], and

management types clustering [42]. The perspective on what makes Silicon Valley so vibrant may differ, but there is multi-disciplinary consensus that information is the primary resource of high technology industry, that information flow occurs among the actors in Silicon Valley, and that the means by which this information flows are largely informal. The trouble is that this agreement is clearly at odds with the highly-planned and regulated environment of the science park. All Silicon Valley and the science park really have in common is the proximity of firms. Even here, survey evidence is that firms in science parks tend to have little contact with each other [43]. Geographical proximity is not a sufficient condition for contact and network dynamics, especially when it is regulated by an institution.

The successor to Silicon Valley is not the science park, but such concentrations of economic activity as the motor racing firms of South East England.

> "… Motor Sport Valley shows few overt signs of institutional thickness in the form of 'financial institutions, local chambers of commerce, training agencies, clerical bodies, unions, government agencies providing premises, land and infrastructure, business service organizations, marketing boards and so on'." [44]

No matter how unofficial and impromptu such concentrations of economic activity, there is always a temptation to present them as planned. To this, the multitude of Silicon Glens, Corridors, Gulches, Cities, Bayous, Freeways, Alleys, Fens and Bogs around the world are eloquent testimony.

Science parks in China

The first Chinese science park, and now the largest, was launched in 1988 at Zhongguancun, within the Beijing Experimental Zone. As ever, Silicon Valley was the guide:

> "Since the first science park was created on the campus of Stanford University more than 40 years ago, Science Parks have been founded in many parts of the world. … Zhongguancun is the name of a place in the Haidan District, northwest

> of Beijing, but currently the name connotes a high-tech Science Park similar to the Silicon Valley in the US." [45]

Even the United States Embassy in Beijing describes Zhongguancun science park as "a large-scale attempt to recreate Silicon Valley in China" [46].

By 1995, there were 52 Chinese national science parks, and another 31 regional innovation centers [47]. There are now 53 national science parks, and more than 50 provincial science parks. Chinese science parks have been actively encouraged by foreign science parks interests. Take a single example: in a sort of technological imperialism, the British Council and Nigel Halford, the manager of Newlands Science Park at the University of Hull in the UK and Treasurer of the United Kingdom Science Park Association, have been helping to develop Chinese science parks since 1997.

> "Any visitor to the Technology Parks in Wuxi, Changzhou, Nanjing or Suzhou will be told about 'Mr Nigel' and, as part of the three-year programme, a series of training programmes for Science Park managers has been started." [48]

The *Annual Report* of the Chinese Torch Program for 1999 claims that there were 2.21 million people working in 17,498 high technology firms on the 53 national science parks. Of these, 670,000 were researchers and engineers, 5,300 with Ph.D.s and 38,000 with masters degrees. The annual value of goods and services produced on these science parks was nearly 600 billion RMB, and the export income about $US12 billion.

Amidst several developments in Shanghai that might be termed science parks are the Shanghai-Caohejing Hi-Tech Park, close to Hongqiao Airport, and Zhangjiang Hi-Tech Park in Pudong. The former was founded in 1988, the latter in 1992. Zhangjiang is absolutely vast, covering over 500 square kilometers in total. The

purpose of these parks is quite simply to “attract high tech manufacturing firms for the purpose of jump-starting economic development” [49]. There is very little criticism of science parks in China. It is widely accepted that they do whatever it is they should do, but there is little consideration of just what that might be and just how it is to be achieved.

While assessing the success of science parks in China meets the same obstacles as the exercise encounters elsewhere, it may be worth considering Chinese science parks in the light of what has been uncovered in other parts of the world. After all, the stimulus for Chinese science parks came from those very parts of the world that now seem to be experiencing some trouble with their science parks. Table 1 compares the activities of high technology companies on and off six Shanghai science parks in 1999. It would seem that such firms fare little better on science parks than they do off science parks. The value of production per firm is about the same, as is export income. The only real difference is that high technology firms off science parks are considerably bigger.

Table 1. Performance of High Technology Firms On and Off Shanghai Science Parks, 1999

	On Science Parks	**Off Science Parks**
number of firms	219	368
number of employees	47,000	157,000
employees per firm	215	427
annual production (m RMB)	20,100	32,500
annual production per firm (m RMB)	92	88
export income (m $US)	390	670
export income per firm (m $US)	1.78	1.82

Source: from Walcott, S. and Xiao, W-B., ‘High-tech parks and development zones in metropolitan Shanghai: from the industrial to the information age’, *Asian Geographer*, 19, 1-2, 2000, pp.157-79 (p.165).

It is possible to conduct a similar exercise for high technology firms nationally in the same year. The result is presented in Table 2. The national picture resembles the Shanghai situation in that high technology firms are considerably bigger off science parks than on. This is, perhaps, to be expected if science parks are nurturing small firms. What requires more explanation, though, is just why the off-park firms are so very much more economically active, and so much more profitable, than their counterparts on science parks. It may be that the available data are unreliable and misleading, but it seems worth noting the similarity between these findings and those that have emerged elsewhere.

Table 2. Performance of High Technology Firms On and Off Chinese Science Parks, 1999

	On Science Parks	**Off Science Parks**
number of firms	17,498	4,566
number of employees	2,197,323	1,973,540
employees per firm	126	432
annual production (m RMB)	594,360	5,767,500
annual production per firm (m RMB)	34	1,263
net profit (m RMB)	39,870	386,400
net profit per firm (m RMB)	2.3	85
tax paid (m RMB)	33,860	520,700
tax paid per company (m RMB)	2	114
export income (m $US)	11,900	110,200
export income per firm (m $US)	0.7	24

Source: from Chinese Torch Program, *Annual Report*, 1999

Concluding thoughts

The assumption supporting science parks is wrong. The mythic status of the model underlying this assumption protects it from critical assessment. Myth allows nonsense to pass unchallenged.

> "The research findings from UK science parks, together with the discussion of current understanding of the innovation process, suggests that the science park concept is fundamentally flawed in its premise that universities and polytechnics are reservoirs of knowledge to be tapped merely by siting property developments nearby." [50]

This is not to say that science parks bring no benefits. They do; they bring benefits to property developers, to the host institutions, the vice-chancellors, to the scientists and engineers who are shown to play a seminal part in innovation; benefits to those who need a handy tool for regional development; and benefits to those who are pleased to see innovation as a process, linear, manageable and, above all, controllable. Even those who write about science parks are beneficiaries in a sense [51]

But there are also costs, costs that are generally overlooked in the general assumption of universal benefits [52]. High technology firms seem to gain little from their location on technology parks apart from enhanced status, which seems to be sought on science parks everywhere, including China [53]. Beyond that, there is nothing; even the basic agglomeration economies that high technology firms find so important in nature are devalued by the regulation of the science park [54]. If science parks fail to achieve their stated objectives, they impose an opportunity cost. Once again, the supposition that science parks work as they are said to work is based on unchallenged assumptions.

> "[These assumptions] range from the linear conception of the model of scientific production and industrial innovation, to the spatial organization and spatial symbolism of parks. They are founding assumptions which, together with the other essential characteristics of science parks, tend towards the reproduction of social inequality, the exacerbation of geographical uneven development, and – most important of all from the point of view of the stated aims of science parks themselves – are likely to vitiate the objectives of industrial regeneration." [55]

The science park is based squarely on the Silicon Valley model of high technology innovation, but the Silicon Valley model is far from being the only model available [56]:

> "From the radical ideas produced during the Cultural Revolution in China, to the involvement of workers and trade unionists in technological innovation and implementation in Sweden, to the greater integration of shop-floor worker, scientist and engineers in (West) Germany (and the much higher levels of training of shop-floor workers), and the systematic incremental productivity initiatives in Japanese industry, there is a wide range of possible variants on, and alternatives to, the linear model." [57]

The problem is that adoption of these other models might unsettle the existing system and threaten its beneficiaries. Hence the interest in reinforcing the Silicon Valley model, and in encouraging its diffusion. Science parks are touted round the world in defiance of the evidence and in deference to the myth [58]. And the more science parks created, the greater the precedent for more still to be created [59].

> "The UK science park phenomenon, itself drawing on an unrealistic interpretation of US post-war industrial history, is now being seen as a model for other countries, in southern and eastern Europe, and in the developing nations of the south." [60]

It is, of course, quite pointless confronting myth with logic. It may be logical to assert, as Qian does in the Chinese context, that Silicon Valley cannot be re-created in the science park [61]. But it is also quite out of tune with the myth, and therefore an irrelevant observation. This paper has sought to explain the importance of myth in the understanding of science parks. What it has not done, and could not do, is challenge the myth. Beliefs are not altered by mere logic, in China or anywhere else.

"Science parks provide an ideal interface between university and industry, not only for developed countries, but also for developing countries. " [62]

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