

RESEARCH ARTICLE

The Transnational Origins of China's Aviation Infrastructure

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Abstract

This article investigates the role of foreign technical experts in developing China's aviation infrastructure from the 1980s to the present. Focusing on a series of training and technical aid programmes, it traces the influx of critical know-how from Europe, Japan and North America during the period of reform and opening up. Through fieldwork conducted at airports in Beijing, Hong Kong and Shanghai – and expert interviews with architects, planners and engineers – the article sheds light on the instrumental role played by foreign technical experts. By establishing a leading-edge set of airport planning practices, these aviation professionals accelerated the modernization of China's transport infrastructure and its reintegration into the world economy. Moreover, by positioning China as a global leader in infrastructure development, they laid the technical foundations for Chinese foreign policy endeavours that seek to export an infrastructure-led model of economic development to Africa, Asia and the former Soviet sphere.

摘要

本文考察了 20 世纪 80 年代至今，境外技术专家在中国航空基础设施发展中所扮演的角色。通过关注改革开放期间一系列培训和技术援助项目，它追溯了来自欧洲、日本以及北美的关键技术涌入。通过对北京、香港和上海机场的田野调查，以及对建筑师、规划师和工程师的专家访谈，本文揭示了境外技术专家的重要影响。通过具有前沿性的机场规划，这些航空专家加速了中国交通基础设施的现代化及其与世界经济的融合。此外，通过将中国定位为全球基础设施建设的领导者，他们为中国对外政策的推行奠定了技术基础，以向非洲、亚洲和前苏联区域输出由基础设施建设所主导的经济发展模式。

Keywords: airports; aviation; infrastructure; urban planning; expertise

关键词: 机场; 航空; 基础设施; 城市规划; 专业技术

Recent scholarly work on China has devoted much attention to foreign policy initiatives that aim to export an infrastructure-led model of spatial and economic development to emerging and middle-income countries in Africa, Asia and the former Soviet sphere.¹ As Alessandro Rippa and Timothy Oakes note in the introduction to this special section, the government of the People's Republic of China (PRC) has promoted this so-called “China model” (*Zhongguo moshi* 中国模式) as a pragmatic, non-ideological form of investment in much needed infrastructures that are the foundation for rapid modernization, market expansion and mutually beneficial trade relations. At the same time, Rippa and Oakes argue that this export-oriented model of infrastructure provision is fundamentally informed by – and may even be viewed as an extension of – a process of infrastructure development that has emerged within China itself over the past several decades.²

1 See, for example, Arase 2015; Chan 2018; Godehardt 2014; Kaczmarek 2017; Lim et al. 2016; Miller 2019; Murton and Lord 2020; Oh 2018; Sidaway and Woon 2017; Sternber, Ahearn and McConnell 2017; Summers 2016; Yu 2017.

2 Rippa and Oakes, this issue.

This “China model” represents the conceptual backbone of the Belt and Road Initiative (BRI), whose very name emphasizes Chinese policy-makers’ infrastructural ambitions. Under the aegis of the BRI, China has directed considerable manpower, technical expertise and financing towards the overseas construction of roads, rails, pipelines, seaports, airports and power plants. These projects aim to drive urban development, economic growth and regional integration in more than 40 emerging and middle-income economies, while at the same time cementing diplomatic ties with China. The scale, speed and overt geopolitical objectives of these projects have captured the attention of the public, as well as that of policy-makers and scholars around the world. They have also aroused the suspicion of China’s critics and geopolitical rivals, who perceive the China model underlying these projects as a recipe for authoritarian capitalism and neo-colonialism.³

Less attention, however, has been paid to the intellectual origins of China’s infrastructure-led development approach, and to the planning and engineering know-how upon which it is predicated. This article addresses that gap by studying the development of an especially prominent domain of Chinese infrastructure – aviation – from the 1980s to the present. In so doing, I posit airports as an insightful lens for tracing the influx of infrastructural expertise from Europe, Japan and North America during the post-Mao period of reform and opening up.

Through fieldwork conducted at airports in mainland China, Hong Kong, France and the United States – as well as expert interviews with architects, planners and engineers – the article sheds light on the instrumental role played by foreign technical experts.⁴ By establishing a leading-edge set of airport planning practices, these aviation professionals accelerated the modernization of China’s transport infrastructure and its reintegration into the world economy. Moreover, by positioning China as a global leader in infrastructure development, they laid the technical foundations for infrastructure-led foreign policy endeavours such as the BRI. As such, these foreign experts represent a crucial – and thus far overlooked – source of data for both infrastructure scholars and scholars of China.

With that goal in mind, the article focuses on a series of cooperative research, training and development programmes – organized jointly by Chinese, European and American transport agencies, airport operators and engineering firms – that have fuelled the co-production of airport architecture and aviation technology on a global scale. By revealing untapped sources of empirical evidence, I ask: What are the actual spatial, aesthetic, and managerial outcomes of that process? How does it challenge received notions about the pathways of transnational knowledge exchange? And finally, how can these insights advance this special issue’s overarching objective: that is, to stimulate new conceptual approaches to the study of Chinese infrastructure?

A note on methodology is in order at the outset. The article draws inspiration from historians of technology who devote equal attention to infrastructure’s material, social and regulatory components – none of which could effectively operate without the others.⁵ I am particularly indebted to Thomas Misa’s analysis of infrastructure’s social organization – the people behind the projects – which he divides into a macro scale (top-level decision-makers), a micro scale (local actors “on the ground”), and a meso scale, made up of experts and institutions who influence infrastructural outcomes by setting design standards and enforcing technical norms.⁶ I draw on ethnographic fieldwork in order to give voice to those experts and institutions – that is, the architects, planners and engineers who build large-scale transportation projects.

3 Lee 2017.

4 This article is based on interviews with more than 50 airport directors, planners, architects and engineers. I would like to thank Daniel Bircher, Elizabeth Boshier, Vivian Cheung, Cai Haiyan, Cai Lingyu, Cao Yunchun, Curt Fentress, Doug Goldberg, Hsieh Huai-Hui, Agatha Kessler, Alexander Kirby, Kjell Kloosterzijl, Elisabeth Le Masson, Michaël Leymarie, Luo Boming, René Marey, François Tamisier, Jeff Thomas, Sheila Thomas, Tim van Vrijaldenhoven, Margaret Yan and Carol Zhang for sharing their professional insights.

5 Edwards 2003.

6 Misa 1994.

In the existing literature on Chinese infrastructure, their perspective is conspicuously absent. That omission can be attributed to the relative invisibility of the specialist firms in which these technical experts are employed. While corporate architects and state-owned enterprises manage the public face of mega-projects, they rarely come up with the specific planning, design and engineering guidelines upon which they are based. Meanwhile, the niche companies that perform these tasks typically maintain a low public profile and are not widely known outside industry circles.⁷ These professionals played a crucial role in the transfer of infrastructural expertise during the post-Mao era. By planning the vast majority of Chinese airports, they guided the development of a cross-border aviation system that critically underpins China's regional integration – and the integration of its goods and people into the global economy.

The article thus investigates the genesis of China's airport infrastructure through an ethnography of its producers. I begin by charting the activities of one French engineering firm in order to highlight the multiple ways by which infrastructural expertise entered China during the period of reform and opening up. I expand on this theme by focusing on two specific pathways of technical exchange: development aid and professional training. Finally, a case study of Shanghai Pudong International Airport demonstrates how different sources of design and technical expertise from France, the United States, Japan and China coalesced in one very influential project. In the conclusion, I consider how these findings can stimulate new conceptual approaches to the study of infrastructure.

Building the Chinese Riviera

In 1989, the French airport authority *Aéroports de Paris* – better known as ADP – hosted a delegation from Hainan at its headquarters in Paris.⁸ Previously an administrative region of Guangdong, Hainan had recently been elevated to province status by the central government, who also designated the entire island as an SEZ, or special economic zone.⁹ Like other SEZs in southern China, Hainan's output goals focused on export-oriented industrial and agricultural activities, such as mining iron ore and cultivating rubber, pepper and coffee. But the Hainan SEZ was also established to stimulate China's nascent tourism industry. As Pál Nyiri has noted, in Maoist China, tourism was seen as evidence of a bourgeois lifestyle and therefore taboo.¹⁰ But in the 1980s the government reversed that position through a series of policies that promoted the development of "scenic spots" and actively encouraged both overseas visitors and Chinese citizens to engage in leisure trips. With its tropical climate and sandy beaches, Hainan appeared to be an ideal place to start. During the Spring Festival of 1987, the provincial government announced its intention to develop Hainan's Yalong Bay 亚龙湾 into a "tropical international tourist area," and to allocate considerable resources towards the construction of a new airport in Sanya 三亚.¹¹

The Hainanese delegation was assigned the undoubtedly pleasant task of traveling abroad to study examples of successful tourism regions. Their tour led them to two conclusions. First, all destinations that they visited relied on aviation to attract large numbers of leisure travellers. Second, they identified the French Riviera as the gold standard of seaside tourism. They were particularly impressed by Nice Côte d'Azur Airport, which had opened a second terminal in 1987, designed by ADP. Developing a Chinese Riviera in Hainan, modelled on the French precedent and anchored by a modern airport hub similar to the one in Nice, became the delegation's top priority.

Hence the visit to ADP, and the meeting with two of the firm's architects, one a leading figure in French design culture, the other a recent hire in his mid-30s. Paul Andreu is perhaps best known as

7 Hirsh 2011; 2016.

8 Elisabeth Le Masson, interview with the author, Paris, 20 January 2017; François Tamisier, interview with the author, Paris, 20 January 2017.

9 Yang 1988.

10 Nyiri 2010.

11 Hu 2012.

the architect of Paris Charles de Gaulle Airport (1974), and for his role in designing the Grande Arche (1989), the striking centrepiece of Paris's La Défense business district. His younger counterpart was François Tamisier, a graduate of the École des Beaux-Arts who began his training as a sculptor before transitioning to architecture. Tamisier joined ADP in 1987 to work on the Grande Arche. Unlike Andreu, Tamisier had no previous experience in airport design. And while ADP had successfully won a contract to build Jakarta's Soekarno-Hatta International Airport, completed in 1985, the company's footprint in Asia remained small. When Hainanese officials invited ADP to submit a proposal for an international airport in Sanya, Andreu and Tamisier leapt at the opportunity.

The goal of the project was to build a modern airport that could welcome international guests and establish Hainan as an attractive vacation destination. The airport was planned concurrently with and sited adjacent to the first Chinese location of Club Méditerranée (Club Med), the French resort hotel chain. (In 2015, Club Med was purchased by the Chinese conglomerate Fosun. Its headquarters remains in Paris.) Construction for Sanya Phoenix International Airport broke ground in 1990. When it opened four years later, it became the first Chinese airport dedicated to leisure travel.¹²

The successful inauguration led to a string of Sino-French aviation projects. Over the past thirty years, ADP has participated in the design and planning of many of China's largest hubs, including Guangzhou Baiyun, Shanghai Pudong, Chengdu Shuangliu, Chongqing Jiangbei and Nanjing Lukou international airports. Most recently, ADP partnered with Zaha Hadid Architects on the design of Beijing Daxing International Airport – Beijing's second hub – whose opening in 2019 was timed to coincide with the 70th anniversary of the founding of the PRC.

This brief foray into the history of one French infrastructure firm demonstrates two key points. First, Hainan is an unlikely point of entry into the Chinese market. Most discussions of cross-border infrastructural investments focus on how they are used to manage urban growth in first-tier cities or, alternatively, how they are deployed to increase industrial production and the extraction of raw materials. With airports, that perspective is problematized by the fact that much of China's initial infrastructural know-how entered the country via Sanya – an airport whose goal was to jumpstart a new branch of the economy predicated on consumption and leisure.

Second, Sanya sheds light on a much broader phenomenon. In the post-Mao era, China has made staggering investments in transport infrastructure: developing highways, high-speed rail stations, seaports and airports at a pace and on a scale that has captivated the imagination of observers both at home and abroad. Some scholars have pointed to the prevalence of engineers among China's ruling elite as one explanation for this infrastructure-oriented approach to economic development.¹³ Yet few have bothered to ask where the necessary infrastructural expertise that undergirds these projects actually originated.

When Deng Xiaoping came to power in 1978, China had astonishingly few airfields. They remained under the direct command of the People's Liberation Army until 1980 when, in an effort to introduce a market-driven approach to air travel, the central government separated the Civil Aviation Administration of China (CAAC) from the military. The CAAC subsequently transferred the responsibility for airport operation to local governments, broke up the national airline into several smaller entities, and encouraged the development of private regional carriers to compete with state-run ones.¹⁴ Despite these policy changes, civil aviation was slow to develop. China's airlines had little experience with commercial operations, and airport operators lacked basic knowledge about how to build airports and manage air traffic. In contrast to major hubs in Japan and the

¹² Sanya Daily 2018.

¹³ Andreas 2009.

¹⁴ Hirsh 2017.

West, Chinese airports relied on a single airstrip – except for Beijing, which had two – as Chinese aviation planners did not know how to design a multi-runway system.

Fast-forward to the 21st century, when China routinely inaugurates four- and five-runway hubs capable of handling upwards of 100 million passengers a year. These airports are equipped with the latest biometric technologies, integrated with high-speed rail networks, and are rolled out at a speed unthinkable in Western countries. During the 2016 United States presidential election, Donald Trump drew a comparison between “incredible” Chinese airports and “Third World” American ones to illustrate the growing trade imbalance and technological gulf between the two countries. How did China acquire the necessary technical expertise in such a short period of time?

Technical Aid and Training: Two Pathways of Exchange

An analysis of the aviation industry reveals two processes by which infrastructural know-how was imported into China during the post-Mao reform era. The first was a coordinated effort by foreign governments to promote their countries’ technical expertise, equipment and services in China. We can read those endeavours as an attempt to export a particular set of industrial norms, standards and specifications, using large-scale transport and telecommunications projects as a vehicle for establishing those norms in the PRC.

An American planner, for example, based on his or her own professional experience, is likely to be most familiar with US design and technical standards, and will incorporate those standards into an airport’s master plan. In effect, the introduction of these standards is a form of upstream business development for a range of service providers who produce hardware and software used at airports – everything from elevators, escalators, self-check-in terminals and biometric devices to aircraft, airbridges and air navigation systems. Establishing these norms in emerging economies is essential for the economic survival of developed nations, where voting publics grow both weary and wary of major infrastructure investments, and building new airports from scratch has become rare. Amid stagnating domestic markets, advanced industrial countries depend heavily on the export of infrastructural goods and services in order to maintain growth. The macroeconomic impact of introducing specific norms and standards early in the design process is tremendous, and governmental agencies go to significant lengths to do so.¹⁵

The technopolitics of infrastructural standards, and their use as tools of bilateral diplomacy, should not be underestimated.¹⁶ Introducing these standards during the start-up phase of an emerging industry presents opportunities to influence that industry’s long-term development, while at the same time sowing the seeds of intertwined political and financial interests between the sending and receiving nations. In the domain of aviation, Western European nations, along with South Korea and Japan, stand out as the most active participants in that battle. In the Chinese context, France, Japan, the Netherlands and the United Kingdom have arguably been the most prolific. They deploy a complex constellation of diplomatic entreaties, technical assistance programmes and cultural exchanges in order to advance the financial interests of their countries’ planning and engineering firms, airplane manufacturers and airport and airline operators. These firms, in turn, act as a foothold into China for homegrown products and services from related industries, such as construction, hospitality and food and beverage.¹⁷

The development of airport infrastructure thus serves as a useful lens for studying China’s broader reintegration into the global economy in the post-Mao era, and its reengagement with its historical enemies. As Deborah Brautigam notes, beginning in the late 1970s, the Japanese,

¹⁵ Bradford 2020.

¹⁶ Barry 2001; Mitchell 2002.

¹⁷ These insights are based on five interviews with engineers in the Netherlands and France in January and December 2017. Due to the sensitive nature of the topic, the interviewees’ names have been omitted.

American and European governments supplied the PRC with advanced technical equipment and training programmes, paid for by loans with attractive terms.¹⁸ These financial packages were often disguised as “technical aid,” with the understanding that that assistance would be used to purchase products and services from the sending country. The regular signing of memoranda of understanding and the professional gatherings that take place to mark those occasions represent the glue that hold these bilateral relationships together.

One example is the Sustainable Airport Areas International Seminar, a conference that I participated in seven times from 2012 to 2021. Organized and largely financed by French government agencies and state-owned enterprises, the conference was initially founded to strengthen international relations and promote knowledge exchange between three of the world’s largest airports: Paris Charles de Gaulle, Hartsfield–Jackson Atlanta International Airport and Shanghai Pudong. The choice of cities was not coincidental: these three airports are hubs for Air France, Delta Air Lines and China Eastern Airlines, respectively – all members of SkyTeam, one of the aviation industry’s “big three” airline alliances. Beyond the stated purpose of promoting the international exchange of ideas, the conference is a platform for Chinese clients to network with foreign service providers.

While the event is ostensibly international in nature, typically half of the attendees are French. They include aviation professionals from Air France, ADP and ADP’s overseas planning and engineering subsidiary, ADPI, along with aviation-related start-ups and economic development boards seeking foreign investment in France. Rotating between Paris, Atlanta, Beijing and Shanghai, the seminar has proven crucial for building and maintaining Sino-French relations in the sphere of aviation, while at the same time contributing to the coproduction of airport infrastructure and airport-area economic development in all three countries.

American architects, planners and engineers often view Chinese projects as an uneven playing field, seeing themselves at a disadvantage compared to their European and Asian competitors. Much to their consternation, the US government has hewn closely to a “let the market decide” mentality, and has not provided a comparable level of financial and diplomatic support for American firms attempting to enter the Chinese market. Reflecting on his experience working on design competitions in Beijing and Shanghai in the 1990s, one American airport planner recalled:

We faced an uphill battle competing against the Europeans. They got into China before the US. The US first got in after the doors opened with Nixon in 1972. The Europeans were already in there then. They were much more aggressive in going forward and entrenching themselves.¹⁹

Another American airport planner expressed a more pointed critique:

The French go in there and just buy the project. How the hell are we supposed to compete? They cover the design fee and pass the work on to their own companies. It’s corruption, pure and simple. No US administration will ever do that.²⁰

The extent to which bilateral relations influence infrastructural outcomes in China – and in Asia more broadly – can be inferred from a story that was related to me by a prominent American architect:

¹⁸ Brautigam 2009.

¹⁹ Jeff Thomas, interview with the author, Culver City, California, 10 November 2017.

²⁰ “Interviewee A,” interview with the author, Amsterdam, 15 March 2017. Due to the sensitive nature of the topic, the interviewee’s name has been omitted.

The day after we won [a major airport project], I was summoned to the US ambassador's office. I was expecting him to congratulate us on winning a big competition, maybe offer me a glass of champagne. Instead he was livid. "Who did you bribe?" he demanded. I was taken aback. "Uh, I didn't bribe anyone." "Don't play dumb with me," the ambassador shot back. "That airport was supposed to go to the French. I know everything that goes on here. Now who the fuck did you bribe?" The ambassador asked me three more times before he stormed out of the office. He just couldn't believe that we had won the competition based on our design proposal.²¹

The purpose of reproducing these anecdotes in an academic journal is not to assess their veracity. Instead, my objective is to shed light on a common perception among US aviation professionals that they face unfair disadvantages in China relative to their European competitors. Yet by focusing exclusively on the subject of "aid," these American architects and planners neglect to mention the influential role played by government-backed bilateral training programmes – which represent a second significant pathway for the transfer of standards and norms.

The most notable of these is the US–China Aviation Cooperation Program (ACP), under which Chinese airport engineers and administrators are invited to the United States for technical training and study tours. Although the ACP is funded by the Federal Aviation Administration and the US Trade and Development Agency, the organization is chaired by the president of Boeing China, and day-to-day operations are delegated to private firms like Boeing, FedEx, American Airlines, General Electric and the Cincinnati-based aviation planning firm Landrum & Brown (L&B), who organize visits to their own factories and run training programmes out of their company offices.²² In effect, these training programmes are an opportunity for American corporations to introduce their goods and services to a Chinese audience – a free "pitch meeting," if you will, funded with taxpayer money.

Since ACP was established in 2004, these courses have also enabled US firms to overcome yet another competitive disadvantage: the inability to pay bribes. Several European interviewees described the creative accounting methods that their companies had devised for giving gifts – an essential aspect of doing business in China. By contrast, my US-based interlocutors claimed that stringent federal anti-bribery legislation prevented them from giving gifts to their Chinese business partners. The ACP programme offered a legal alternative by providing Chinese aviation professionals with all-expenses-paid study tours to the United States – which frequently doubled as extended shopping trips.²³ One senior American airport planner who had hosted numerous ACP delegations, for example, confided that it was essential to schedule visits to high-end shopping centres as well as more mundane runs to Costco, in order to keep the Chinese participants happy and receptive to doing business.²⁴

The start of this century likewise saw a flourishing of American and European aviation education initiatives on Chinese soil, with a French state institution – the *École Nationale de l'Aviation Civile* (ENAC) – once again playing a leading role. Since its founding in 1949, ENAC's primary mission has been to train aeronautical engineers and administrators, and to prepare them for a career working for France's airports, airlines and aircraft manufacturers. Beginning in the 1990s, however, the elite *grande école* took on an additional role: to train Chinese students and, in so doing, to bring up-and-coming aviation professionals into contact with French companies like Airbus and ADPI. While some Chinese students come to ENAC's home campus in Toulouse, the majority

21 "Interviewee B," interview with the author, Amsterdam, 15 March 2017. Due to the sensitive nature of the topic, the interviewee's name has been omitted.

22 Sheila Thomas, interview with the author, Hong Kong, 8 November 2016.

23 "Interviewee C," interview with the author, Amsterdam, 15 March 2017. Due to the sensitive nature of the topic, the interviewee's name has been omitted.

24 "Interviewee D," interview with the author, Amsterdam, 15 March 2017. Due to the sensitive nature of the topic, the interviewee's name has been omitted.

are enrolled in degree programmes jointly offered by ENAC and partner universities in Beijing, Hong Kong and Tianjin. Together with the Civil Aviation University of China, in 2007 ENAC co-founded the Institut Sino-Européen d'Ingénierie de l'Aviation in Tianjin; a larger Sino-French aviation university, based in Hangzhou, is scheduled to open in the early 2020s.²⁵

ENAC's initiatives are part of a top-down effort to inculcate French planning practices and to integrate French companies and state institutions into all dimensions of airport production in China, including tertiary education. In effect, hundreds of employees of ADP, ADPI, ENAC and Airbus operate in a coordinated fashion, each seeking to drive mutually beneficial business opportunities for the entire French aviation sector. By contrast, American forays into Chinese higher education were driven by individuals working on behalf of a single company: L&B. As L&B's former CEO Jeff Thomas recalls, these efforts advanced primarily through entrepreneurial happenstance:

L&B had a big office in Chicago. A friend of mine introduced me to a Chinese gentleman there. He was living in Chicago, but the family was out of Canton and they were well connected. He didn't know much about airports, but he wanted to do things, you know? He kind of took us by the hand and tried to help me get into China. He got me in with all the officials in Guangzhou, and through that I met a bunch of people in [Shanghai] Pudong. But we were too late to the party: they'd already made all their choice of the planners and designers [in Guangzhou], and we lost the competition [in Shanghai]. Then at some point he introduced us to the civil aviation university in Tianjin. We put a scholarship programme together for next to nothing, and it's one of the best investments in anything I ever made. It was like five or six thousand dollars a year, and it was giving three or four kids a scholarship, later they divided it up into partial scholarships for ten to twelve kids. But it's created an enormous sense of goodwill, these people are now in middle management at half the airports in China. And L&B helped pay for their education, so there's so much goodwill there. The first guy who got the scholarship was the first mainland employee we hired.²⁶

This example highlights the variety of approaches that foreign firms (and governments) have taken to developing business in the PRC and engaging with Chinese clients. In effect, in contrast to the top-down forces and bilateral initiatives that drive European technical aid and professional training programmes, the reliance on a well-connected Chinese middleman as described above reveals a much more informal and entrepreneurial approach to the transfer of infrastructural expertise.

Building Shanghai Pudong International Airport

A case study illustrates where these different actors and knowledge exchange pathways intersect: Completed in three stages between 1999 and 2008, Shanghai Pudong International Airport was developed by Chinese state planning and aviation authorities who relied heavily on technical, financial and managerial expertise imported from France, Japan and the United States. Studying Pudong enables us to better understand the division of labour between them. It also highlights the influential role that Shanghainese models of urban and regional development played during the reform era. Many of my interlocutors emphasized the city's vanguard status: once Shanghai builds something, the conventional wisdom among infrastructure planners goes, all other airports in China will follow.²⁷ In particular, Pudong helped to introduce a broad range of technical and design standards in the field of Chinese infrastructure planning, while at the same time establishing the terms by which Chinese airport authorities and local design institutes work together with foreign engineering

²⁵ Cooke 2019.

²⁶ Jeff Thomas, interview with the author.

²⁷ Doug Goldberg, interview with the author, Chicago O'Hare International Airport, 18 September 2017.

and design firms. The collaborative model that Chinese and overseas planners pioneered at Pudong thus had powerful implications for China's aviation infrastructure as a whole.

Before proceeding, it is essential to point out two critical elements of Chinese planning that fundamentally determine the financing, siting and timing of infrastructure development: the Five-Year Plan and the National Development and Reform Commission (NDRC). Imported by Soviet advisors in the early 1950s, the Five-Year Plan remains the basic building block of China's state-led economy.²⁸ Each plan includes a chapter on transport infrastructure that summarizes the central government's main objectives for its road, rail, air and sea networks, and which announces any major changes in the policies that govern the movement of goods and people to, from and within mainland China.

The critical element that determines how, when and where aviation infrastructure is planned, built and delivered is the NDRC. China's airports are primarily owned and operated by municipal governments, who delegate the detailed planning work to their city's local design institute. Local officials – particularly mayors and Party secretaries – are thus important decision-makers who influence both the process and outcome of airport development. Yet the real power to develop aviation infrastructure lies with the NDRC, thanks to its ability to designate a given infrastructure project as a national-level priority, and to marshal substantial financial and political capital in the process.

It is within this organizational framework that Pudong's development needs to be understood. In 1996, the Chinese government published the Ninth Five-Year Plan. Anticipating a doubling of China's aviation volume – from 51 million passengers and a million tonnes of cargo annually in 1995 to nearly twice that amount by the year 2000 – the plan called for the development of 41 major airports across the country.²⁹ Along with Beijing and Guangzhou, the plan prioritized Shanghai as one of China's three international hubs, and authorized the construction of a new airport to support economic growth in Pudong New Area, arguably China's most prominent showcase for urban development. Shanghai Pudong, as the new airport became known, aimed to enhance the city's international connectivity, while the expansion of Shanghai's existing airfield at Hongqiao sought to accommodate the increase in domestic flights.

Bearing those goals in mind, in 1996 the Chinese government commissioned the Japan International Cooperation Agency (JICA) to prepare a master plan and detailed design study for the new airport, which was to be built on reclaimed land along Pudong's rural coastline. JICA, in turn, assigned that task to Nippon Koei, Japan's largest engineering and construction consultancy, and to the architecture and planning firm Nikken Sekkei.³⁰ Both companies could offer expert knowledge about airport-led land reclamation that they had recently gained while building New Kansai Airport on an artificial island in Japan's Seto Inland Sea.³¹ Upon the study's completion in September 1997, the Chinese Ministry of Foreign Trade and Economic Cooperation and the Shanghai municipal government entered into an Official Development Assistance Loan agreement with the Japanese government, administered by JICA. Under the terms of the loan, Japan lent China 40 billion yen to fund the construction of a four-kilometre runway, a 200,000-square-metre passenger terminal and a 65,000-square-metre cargo terminal. Crucially, the loan covered the project's foreign currency costs, thereby overcoming the perennial challenge of moving money between China and the outside world.

Pudong's planners thus relied heavily on Japanese financial assistance and on Japanese engineering expertise. Yet when it came to architecture and landscape design, they turned to a different source: France. In 1997, Aéroports de Paris won an international competition to design Pudong's

28 Xue and Ding 2018.

29 JICA 2001.

30 JICA 1997.

31 Hirsh 2019.

passenger terminal building, or T1, whose inauguration in 1999 would fall on the 50th anniversary of the founding of the PRC. Planned by a team led by Paul Andreu, T1 rehearses the basic design elements of Charles de Gaulle's Terminal 2F, which Andreu's team was constructing concurrently in Paris. ADP was also tasked with developing a conceptual approach for the entire airport. As the architect François Tamisier recalls:

When we went on the site for the first time there was nothing: rice fields with water and the sea. The plan was to silt up the land in order to create it. We decided to design a very large pond, with the main ideas as the water and the sky. In this way, we tried to bring in Chinese artistic elements. It is a large pond, four hundred metres by four hundred metres, and we used this as drainage. And we brought in the road coming from Shanghai across the water, to give the experience of taking flight. So the first image of the airport is: it was water, it will always be water. The second theme is architecture as a garden. We used these two elements for urban scenography. We followed the Suzhou gardens, with a yard, walls and a square. We spoke of Pudong as a very large Suzhou garden. We thought that it was important to work with knowledge of Chinese culture, painting and landscape arts. In China there are a lot of possibilities to create big areas starting from a small, specific site: for example, in Suzhou, or in the Forbidden City in Beijing. At the time Shanghai was the biggest airport in China. Our proposal had to be of an international standard and totally based on Chinese culture, so we considered the landscape as a very important system. Of course, we provided the standard master plan, but with a mark: we are in China, and we have to express this. The main idea we used was the garden as a possibility to organize a very large amount of land following the Chinese system of building a plan around the void.³²

ADP's role in the construction of Pudong points to both the economic and aesthetic commonalities that connect Chinese infrastructure planners to their French counterparts. As Fligstein and Zhang have argued, China's form of "organized capitalism" bears a strong resemblance to France's model of a coordinated market economy, wherein the private sector is dominated by state-controlled enterprises.³³

Discussions with my interlocutors at ADP appear to support that thesis: several drew comparisons between China's socialist market economy and France's dirigiste approach to capitalism. One executive told me that the Chinese "understand our way of thinking. For us, the airport is not just about aviation, it is also about promoting our national interests. There are many similarities between Chinese state-owned enterprises and our own companies. We understand the mentality."³⁴ This attitude helps to explain the willingness of the French diplomatic corps to intervene on behalf of French companies, as well as their ability to provide financial incentives – beyond that of most other nations – to favour the outcome of airport design competitions.

But beyond the level of economic policy, Sino-French infrastructural cooperation is bound together by palpable aesthetic affinities, in particular a fondness for large-scale territorial planning based on abstract metaphors. Formalist design concepts, predicated on dubious references to feng shui and purported Chinese design traditions, forge an epistemological connection between the objectives of Chinese government officials and of French planners and engineers.

This is evident in ADP's conceptual approach to Pudong, and in the rhetoric commonly deployed by Chinese government officials to justify major infrastructure investments. The recourse to abstract formalism was evident at a Sino-French aviation conference held in Beijing in 2018.

³² Tamisier 2017.

³³ Fligstein and Zhang 2010.

³⁴ "Interviewee E," interview with the author, Paris, 9 May 2016. Due to the sensitive nature of the topic, the interviewee's name has been omitted.

The event marked the one-year countdown to the opening of Beijing Daxing. In one of the opening speeches, a senior airport executive discussed the formal similarities between the older Beijing Capital International Airport and a dragon. That airport's presence on the eastern periphery, he explained, had thrown Beijing's urban development out of joint. The inauspicious state would be remedied through the construction of the new airport at Daxing; occupying a site shaped like a phoenix, Daxing would restore balance to the Chinese capital and guarantee the harmonious development of the greater Jing–Jin–Ji region.³⁵

Metaphorical formalism is likewise a common facet of the many follow-up projects that ADP has won as a result of their work at Pudong. One French architect, for example, framed ADP's development plan for Nanjing Lukou as a "modern airport city inspired by the traditional Chinese city."³⁶ Its network of gridded streets, bookended by triumphal gates, echoed the "square frame" and sequence of "doors and thresholds" characteristics of pre-modern Chinese urbanism, while a rectangular water feature, studded with two islands connected via four bridges, referenced the interplay between water and energy, the real and the reflection, of Nanjing's Xuanwu Lake. A series of circular office towers – set along an axis that one might be forgiven for interpreting as a paean to Ludwig Hilberseimer's vertical city – was in fact a nod to the *tanggu* 堂鼓, the traditional Chinese drum, whose rhythm marked the flow of time and bound the past to the future.

French designers evinced a talent for engaging with two countervailing tendencies typical of the late-20th-century Chinese client: a hunger for foreign designs as a way to demonstrate China's modernization and ascendance coupled with patriotic homages to tradition that deliver that modern infrastructure in a Chinese register. Firms like ADP proved less adept, however, at adapting their design schemes to the practical needs of the burgeoning Chinese aviation market. They underestimated, in particular, the rapid growth in air traffic that quickly rendered their initial designs incapable of accommodating the sheer volume of passengers at one of China's largest hubs. Between 2001 and 2006, the number of passengers flying in and out of Pudong more than quadrupled.³⁷ Halfway through the 10th Five-Year Plan, ADP's original scheme for four small terminals and two runways already appeared quaint. Rather than commit to the second phase of the French master plan, the Shanghai Airport Authority decided to look for other approaches by using two tried and tested techniques: the international design competition and the overseas study tour.

At the height of the reform era, international design competitions played a key role in the modernization of China's cities and urban infrastructure. They were a relatively quick and cheap way to amass vast amounts of knowledge and ideas, sourced from top global thought leaders. As Thomas explains,

The Chinese process...is an intelligent way of dealing with airport design. By law they have to bring in a foreign expert into any of these big infrastructure projects. That's weakening now, but when we first arrived you couldn't get anything built without it. So the competition process was the way they brought the ideas of lots of people together. And the Chinese are good at sucking people's minds, and it was a way of picking people's brains. So if you brought in world-renowned experts into the room, and asked them to put their ideas onto the wall, you're buying all their ideas – basically when you give them a fee for competing, you can pick and choose what you like and learn a lot.³⁸

35 Yue Kong, presentation at Pullman Hotel Beijing South, 24 October 2018. Jing–Jin–Ji 京津冀 refers to a state planning policy that seeks to create an integrated mega-region encompassing Beijing, Tianjin and Hebei province.

36 Michaël Leymarie, presentation at Pullman Hotel Beijing South, 24 October 2018.

37 JICA 2001; CAAC 2007.

38 Jeff Thomas, interview with the author.

In 2004 the Shanghai Airport Authority (SAA) commissioned a competition for a new terminal area master plan, and for a conceptual design for a second terminal. At the midpoint of the competition, the authority sent an overseas delegation to the Cincinnati headquarters of L&B. Hundreds of airports around the world have been planned out of L&B's headquarters. Li Dirun, the delegation's leader and chairman of the SAA, was keen to meet with Thomas. Although he had failed to win any Chinese competitions, Thomas had established a reputation in mainland aviation circles as an entrepreneurial enfant terrible. Through an interpreter, Thomas and Li discussed alternative arrangements for Pudong's future. Thomas briefed the delegation on L&B's experience in transforming Chicago O'Hare, which had undergone a major expansion in the 1980s following the deregulation of the US aviation industry. He argued that the Midwestern behemoth – which served a massive domestic market, while at the same time functioning as a critical intercontinental gateway – was a more appropriate reference than European hubs like Paris Charles de Gaulle, where domestic traffic was negligible. Moreover, he contended that O'Hare's Midwestern sense of scale – with its generous proportions and ample runways – should be transferred to Pudong in order to meet the demands of a Chinese aviation market that was growing at breakneck speed. L&B subsequently won the competition. In place of ADP's four smaller terminals, the L&B plan envisioned a “concentrated terminal complex” nearly triple the size of the existing one. Along with a third runway, the new terminal was completed in 2008.

Pudong's genesis illuminates the strategies and processes by which Chinese planners developed aviation infrastructure in the post-Mao era. In particular, an analysis of the Shanghaiese hub reveals how Chinese clients deployed three tools to achieve their development goals: bilateral aid, international design competitions and overseas study tours. Mainland infrastructure planners eschewed dependence on a single source of knowledge, talent or capital, choosing instead to pick the brains of expert engineers, planners and architects trained in Japan, Western Europe and the United States. In the 1990s, these three world regions represented the most advanced aviation markets in the world. By learning about the evolution of Tokyo Narita International Airport, Paris Charles de Gaulle and Chicago O'Hare from the experts who built them, Pudong's leadership amalgamated the best practices of mature airports, accrued over decades, and used that collective global wisdom to create a leading-edge air hub for Shanghai.

The China Model in a Global Context

Transport megaprojects have been analysed in a variety of academic disciplines through the prism of infrastructure's symbolic value and its use as a political tool. And not without reason: particularly in developing countries, transport infrastructure is an easily decipherable index of technical progress and economic development, and of effective stewardship by political elites.³⁹ It also operates as a shorthand to explain complex geopolitical relationships, as governments deploy transport infrastructure both as physical manifestation of bilateral ties and as confirmation of its socioeconomic benefit. As Cole Roskam has noted, Maoist cadres positioned infrastructure projects as material demonstrations of the PRC's solidarity with developing nations in the Third World, in contrast to the exploitative practices of the capitalist West.⁴⁰ Echoes of that infrastructural diplomacy reverberate outwards from China in the present day, as the construction of rail and port facilities manifests intensified economic and diplomatic ties with countries across Africa, Asia and the former Soviet sphere.

Less apparent, however, is the influx of infrastructural knowledge and design standards into China over the past half-century. While Chinese leaders are eager to promote the export value of China's infrastructure-led development model, they are less forthcoming about the foreign origins –

39 Khan 2006.

40 Roskam 2015.

from Europe, North America and Japan – of the expertise that underpins it. For better or worse, the China model represents a globalized, state-of-the-art snapshot of how infrastructure is designed, built and financed today. As such, it cannot accurately be described as a homegrown product so much as a hybridization of foreign expertise from multiple sources.

The case of Shanghai Pudong – like the many Chinese airport projects that followed – sheds light on the relative strengths of each planning culture’s design approaches. Through international design competitions and overseas study trips, China’s aviation planners cherry-picked what they perceived to be the best attributes of the world’s top aviation markets: airfield planning, structural engineering and long-term infrastructural aid packages in the case of Japan; a no-nonsense approach to terminal design from the US that emphasizes the demands of a mass domestic flying public; and an aesthetic sensibility that privileges national traditions and abstract formalism from the French.

That division of labour – wherein the French provide the artistic vision, the Americans offer a cost-effective customer experience and the Japanese deliver the engineering and the financing – is undeniably stereotypical. Whether it was borne of Chinese preconceptions, or instead confirms them, is up for debate. Either way, that decidedly multilateral approach is how Chinese decision-makers imported the most redeeming qualities of different cultures, and combined them into a “China model” of infrastructure development that is adapted to the temporal framework of the Five-Year Plan and to the organizational structure of the PRC’s urban planning institutions. This approach exemplifies the broader process of “policy collaging” that guided China’s post-Mao economic reforms.⁴¹

That conclusion leads us inevitably to a rather delicate question: what, then, is uniquely Chinese about the China model? A review of China’s recent aviation history offers a few clues. In contrast to the overseas precedents upon which they are based, airports built in China in the 21st century distinguish themselves in three critical areas: speed, scale and subsidies. If they are able to win the support of the NDRC, the mayor and the local Party secretary, Chinese aviation authorities can execute large-scale infrastructure projects at an unparalleled pace, because they can dispense with consulting and placating local stakeholders. They also face little pressure to demonstrate a credible return on investment, and when a new airport fails to attract interest from airlines because they don’t consider potential routes to be commercially viable, local officials can quickly offer financial incentives, for example by waiving aeronautical charges.⁴² Chinese cities are hungry for international connectivity, and they’re willing to pay for it. Stakeholder engagement, profitability and route development: at most of the world’s airports, these processes are both essential and time-consuming. In China their absence, or relative insignificance, helps to explain China’s advantage.

China’s municipally owned airports likewise distinguish themselves through their scale, thanks to local governments’ ability to commandeer vast amounts of land. Over the past decade, airports in China have been progressively reconceptualized as multifunctional “airport economic development zones,” some spanning more than a hundred square kilometres.⁴³ In effect, local governments no longer simply build new airports, but rather entire “airport cities.” Chinese infrastructure planners take these temporal and spatial conditions for granted, but they are difficult to replicate outside China – perhaps even impossible.

Conclusion

Let us revisit two questions that I posed at the outset. First, how does the production of China’s airport infrastructure challenge received notions about the pathways of transnational knowledge

⁴¹ Leutert 2021.

⁴² Henri Hié, interview with the author, Hong Kong, 21 February 2017.

⁴³ Cao 1999.

exchange? And second, how can this investigation stimulate new conceptual approaches to the study of Chinese infrastructure?

First and foremost, more research is needed that links multilateral economic development policies to their spatial and material outcomes in the built environment. Infrastructure can serve as an insightful vehicle for investigating how multilateral relations thrive, both in periods that valorize open markets and open borders – as was the case in the late 20th century, when China re-emerged as a global power – and in times marked by resurgent nativism and protectionism, such as our current era.

I have emphasized the previously overlooked role of mid-level experts as agents of transnational exchange. In so doing, this article contributes to emerging research into transnational influences on China's market reforms: highlighting the importance of overseas fact-finding missions and subsequent "policy collaging" during the period of reform and opening up.⁴⁴ These architects, planners and engineers collectively design infrastructural systems that enable the movement of goods and people between cities and across continents. Yet they are also crucial actors in the transfer of ideas and information. Modest by nature, they possess a diplomatic acumen that enables them to collaborate across cultural, linguistic and ideological divides. The engineering historian Martin Reuss has pointed to engineers' negotiating skills, rather than their technical proficiency, as the key driver of successful infrastructure projects.⁴⁵ That is doubly true for projects where engineers must reconcile imported norms, standards and values with indigenous ones. Attempting to strike a balance between "cultural preferences, economic requirements, environmental protection, and various sociopolitical issues at all levels of government," engineers must effectively "mediate the incommensurable."

My study of Chinese airports expands on Reuss's understanding of engineers as negotiators by drawing attention to their role as stealth diplomats and agents of multilateral exchange. Many of my interlocutors first visited China at a time when few foreigners had either the desire or the permission to do so. As we enter a new period of great-power confrontation and isolationism, those same planners and engineers continue to work on Chinese projects, acting as crucial intermediaries at a time when voting publics, and many world leaders, are questioning the benefits of international cooperation.

Most studies focus either on how infrastructure projects fulfil the aims of governments and economic systems, or, alternatively, how those projects are received by local constituents on the ground. These two vectors of analysis correspond, respectively, to what Thomas Misa has termed the macro and micro scales of infrastructure's social organization.⁴⁶ By contrast, this article has focused on what Misa calls the meso scale: institutions whose influence derives from their ability to establish technical standards, and whose impact on infrastructural outcomes is neither as ephemeral as that of micro-level users, nor as enduring as macro-level power structures.

Moving forwards, scholars of Chinese infrastructure should be encouraged to devote more attention to those meso-scale institutions and the individuals who populate them, for they possess enormous amounts of untapped data that can help us to better understand how, in fact, infrastructure is produced. In particular, whereas this article has focused on foreign technical experts, more research is needed into the priorities and practices of their Chinese counterparts. Attending to that meso scale of influence presents a welcome opportunity to escape the confrontation between top-down and bottom-up modes of inquiry – an unhelpful duality that has divided infrastructure scholars into two competing camps who often struggle to engage with, or learn from, one another.

44 Gewirtz 2017; Leutert 2021.

45 Reuss 2008.

46 Misa 1994.

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