

## Aviation infrastructures in the Republic of China, 1920–37

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### Abstract

This essay investigates technical aspects of the history of aviation in the Republic of China, focusing on the period between 1920 and 1937. It suggests that Chinese authors and administrators came to see the establishment of technical infrastructure as dependent on the education of personnel who could assume responsibility for maintaining and expanding Chinese aviation ventures, rather than on specific technologies or practices. Magazines and journals in the 1920s reflected concerns with the establishment of weather observation and reporting, radio communications, and technical education in service of aviation; the last of these was critical for the first two. Provisions for technical work and training were reflected in contracts that were drawn up in the years around 1930 to establish three aviation projects in the Republic: the China National Aviation Corporation (CNAC), the Eurasia Aviation Corporation, and Southwest Airlines. Subsequent contracts and reports for CNAC and Eurasia in the years before the 1937 outbreak of war with Japan suggested a particular emphasis on the technical education of personnel as an important step in building Chinese aviation infrastructures.

### Keywords

China, aviation, technology, infrastructures, airplanes, aeronautics

### Introduction

In this special issue, several case studies in the history of transportation technologies have suggested the maintenance and repair of vehicles as a key site of knowledge production. Taken together, studies of the coexistence of automobiles and bullock carts in twentieth-century India, the travails of the British Navy's men-of-war in the South Pacific, and the

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rise of West African centers of shipworks to meet European demand for canoes in the nineteenth century demonstrate that the establishment of infrastructures for maintenance and repair contributed crucially to the historical significance of transportation technologies. The Introduction to this issue notes that traditional historiographies of transport have generally not focused on issues of maintenance and repair. Yet these studies suggest the centrality of such infrastructures for narratives of knowledge production and cross-cultural exchange in the history of science, and that attending to the actual means by which people, texts, and objects moved around the world can help articulate and explain the movement of knowledge more broadly.<sup>1</sup>

This piece adds to these cases a study of civil aviation in the early twentieth-century Republic of China, a time and place when many new technologies of transportation were transforming modern life. The essay draws on published archival documents and print cultures to suggest that magazines and journals in the 1920s reflected a growing awareness of the need to establish technical infrastructures to support aviation, and that these concerns were reflected in plans drawn up in the years around 1930 to establish aviation projects in the Republic, as well as in the actual work of two of these projects before the 1937 outbreak of war with Japan. First, I suggest that aviation-themed periodicals published in the 1920s gave significant attention to the technical requirements of aviation in terms of establishing weather observation and reporting systems across large areas, radio communications in the form of broadcasting stations at airfields and airports, and education in mechanical engineering, aeronautics, pilotage, and associated disciplines. Of these, the last was most significant, because knowledge and skills gained through training were considered necessary for both meteorological and radio work. Then, I discuss the degree to which the initial establishment of three aviation ventures in the early 1930s – the China National Aviation Corporation (Zhongguo hangkong gongsi, hereafter CNAC), the Eurasia Aviation Corporation (Ouya hangkong gongsi, hereafter Eurasia), and Southwestern Airlines (Xinan hangkong gongsi, hereafter Southwestern) – incorporated plans to support technical requirements, especially in terms of commitments to training. Finally, plans and reports for CNAC and Eurasia after their establishment and before 1937 suggested a particular concern for technical education of Chinese pilots, mechanics, and radio operators.

I argue that this emphasis on training suggested that in the case of aviation, Chinese authors and administrators came to see the establishment of technical infrastructure as a process that depended most critically not on specific technologies or practices, but rather on the education of engineers and mechanics who could assume responsibility for maintaining and expanding Chinese aviation ventures. In some cases, technical education

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1. Stefan Tetzlaff, “Materialities and Knowledge Systems: Infrastructure Making between Modernizing Agents and Peasant Households in Central and Western India, c. 1919–1939,” *History of Science*, forthcoming; Sara Caputo, “**Exploration and Mortification: Fragile Infrastructures, Imperial Narratives, and the Self-Sufficiency of British Naval ‘Discovery’ Vessels, 1760–1815,**” *History of Science*, forthcoming (published online 6 November 2020), 1–20; Bronwen Everill, “‘For the Services of Shipwrights, Coopers, and Grumettas’: Freetown’s Ship Repair Cluster in Nineteenth-Century Sierra Leone,” *History of Science*, forthcoming (published online 13 August 2020), 1–17.

offered a means of demarcating aviation as an enterprise to be established and run by members of China's professional classes. Rather than valorizing individual pilot-heroes, the literature considered here prioritized the cultivation of a cohort proficient in the maintenance and expansion of weather observing stations, radio communications networks, and other necessary components of such infrastructures. In considering questions of infrastructure, this piece does not seek to give a comprehensive list of every aviation-related institution, factory, or workshop that existed in Republican China.<sup>2</sup> It does suggest some ways in which published literature in the 1920s and private agreements in the 1930s both reflected a growing need to incorporate infrastructure into the establishment of aviation projects, especially in terms of technical training of personnel. In doing so, it contributes a perspective from the history of science and technology to a field that has been largely occupied by business histories.<sup>3</sup> In science studies, histories of maintenance and repair are often also histories of the labor associated with those activities; in China, plans and expectations for technical labor were mediated by transnational partnerships with Germany and the United States. Unlike European countries, in which technical training found early support in military initiatives and institutional footing in engineering programs established at technical institutes and universities,<sup>4</sup> Republican China lacked the large-scale military and educational structures to follow these precedents, making transnational relationships valuable points of access to such resources. These cooperations provided technical knowledge and materials, as well as a means for Chinese administrators to exert agency and define their terms of engagement in a key realm of technology transfer.

## Historiographies of flight in China

Historians of China have generally accepted the existence of a strong connection between aviation and modern transformation. The argument that the adoption of aviation resulted in the "making of modern China" is a narrative that Chinese intellectuals of the early twentieth century themselves endorsed. The revolutionary leader Sun Yatsen coined the phrase *hangkong jiuguo*, or "aviation will save the nation." The nascent Republic of China invested in military air power on this premise, and the phrase spread

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2. For excellent overviews, see Queming Meng, *Zhongguo jindai hangkong gongye shi (1909–1949)* [History of the modern Chinese aviation industry, 1909–1949] (Beijing: Hangkong gongye chubanshe, 2014), and Lennart Andersson, *A History of Chinese Aviation: Encyclopedia of Aircraft and Aviation in China until 1949* (Taipei: AHS of ROC, 2008), esp. pp.224–34.
  3. Mark Dougan, *A Political Economy Analysis of China's Civil Aviation Industry* (New York and London: Routledge, 2002); Karl Morgenstern and Dietmar Plath, *Eurasia Aviation Corporation: Junkers and Lufthansa in China, 1931–1943* (Munich: GeraMond Verlag, 2006); William M. Leary, Jr., *The Dragon's Wings: The China National Aviation Corporation and the Development of Commercial Aviation in China* (Athens, GA: University of Georgia Press, 1976).
  4. Peter Lundgreen, "Engineering education in Europe and the U.S.A., 1750–1930: The rise to dominance of school culture and the engineering professions," *Annals of Science* 47 (1990): 33–75.

quickly through media during the 1920s, reflecting desires to project an image of China as a strong, powerful, technologically advanced nation.<sup>5</sup> Technologies of transportation offered rich symbols of modernization and progress, if not always for the benefit of national projects. Elisabeth Köll has shown that railway networks achieved considerable local autonomy in the 1910s and 1920s, only being enlisted to support national political order after the Nationalist Party (Guomindang) consolidated power in 1928.<sup>6</sup> Xu Tao suggests that the bicycle occupied an ambivalent social position in the Republican period; in the 1920s and 1930s, it became a popular means of transport for public and corporate agencies, but ultimately provided a social indicator for China's urban middle classes, better off than the "rickshaw class" but not wealthy enough to purchase automobiles.<sup>7</sup>

Airplanes stood apart from trains, cars, or bicycles in collectively providing a symbol of national achievement on a global geopolitical stage. Alan Baumler writes, for example, that "just as Europeans were using aviation to express their dominance, Asians were using it to express their modernity."<sup>8</sup> During China's war with Japan, mobilization for air defense was connected to international definitions of "air-mindedness," a belief that aviation would transform humanity, which reflected Euro-American notions of modernism and man's ability to master nature.<sup>9</sup> Peter Fritzsche has suggested that air-mindedness offered grounds for national, authoritarian reinvention in interwar Germany because it invoked fears of "technological vulnerability."<sup>10</sup> In Republican China, a similar concern with national weakness found expression in developments like the May Fourth and New Culture Movements of the 1920s, which promoted scientism and the adoption of Western science and technology for national benefit.<sup>11</sup>

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5. Amy O'Keefe, "Stars in the Nation's Skies: The Ascent and Trajectory of the Chinese Aviation Celebrity in the Prewar Decade," in Paul Pickowicz, Kuiyi Shen, and Yingjin Zhang (eds.), *Liangyou: Kaleidoscopic Modernity and the Shanghai Global Metropolis, 1926–1945* (Leiden: Brill, 2013), pp. 135–60, 136.
  6. Elisabeth Köll, *Railroads and the Transformation of China* (Cambridge, MA: Harvard University Press, 2019), pp.13–14.
  7. Tao Xu, "Ta che er fei: zixingche yu Zhongguo qi che ren (1868–1949 nian)" [A history of the bicycle and Chinese cyclists, 1868–1949], *Cross-Currents* e-journal (2012): 48–79, 58. See also Tao Xu, *Zixingche yu jindai Zhongguo* [The bicycle and modern China] (Shanghai: Shanghai renmin chubanshe, 2015). <https://cross-currents.berkeley.edu/e-journal/issue-3/history-bicycle-and-chinese-cyclist-1868-1949>
  8. Alan Baumler, "Aviation and Asian Modernity, 1900–1950," *Oxford Research Encyclopedia of Asian History*, 2017, <<https://oxfordre.com/asianhistory/view/10.1093/acrefore/9780190277727.001.0001/acrefore-9780190277727-e-177>> (1 May 2019), p.1.
  9. Alan Baumler, "Keep Calm and Carry On: Airmindedness and Mass Mobilization during the War of Resistance," *Journal of Chinese Military History* 5 (2016): 1–36, 2–4.
  10. Peter Fritzsche, "Machine Dreams: Airmindedness and the Reinvention of Germany," *The American Historical Review* 98 (1993): 685–709, 688. See also Peter Fritzsche, *A Nation of Fliers: German Aviation and the Popular Imagination* (Cambridge, MA: Harvard University Press, 1992).
  11. Fa-ti Fan, "How did the Chinese Become Native?: Science and the Search for National Origins in the May Fourth Era," in Kai-Wing Chow, Tze-ki Hon, Hung-yok Ip, and Don C. Price (eds.) *Beyond the May Fourth Paradigm: In Search of Chinese Modernity*, (Lanham, MD: Lexington Books, 2008), 183–208.

Such anxieties motivated efforts to achieve rapid transnational transfers – not just of airplanes themselves, but of the technological systems supporting aviation. As David Edgerton notes, “although the aeroplane was often associated with freedom, its operation was characterised by exceptional attention to discipline, routine and maintenance.”<sup>12</sup> Aviation has traditionally required high investments in construction and maintenance, not only of airplanes, but also of supportive systems of meteorological observation, communications equipment, airports, and airfields: in short, of infrastructure.<sup>13</sup> Following this and Paul Edwards’ work on the coconstruction of infrastructure and modernity, the modernity that aviation offered China was not only articulated in the making of an air-minded population or new military capabilities to travel quickly over great distances, but also was constituted in supportive technological systems.<sup>14</sup> The example of Japan demonstrated the importance of importing materials and knowledge from abroad in the establishment of such systems; Jürgen Melzer has shown that the establishment of aviation there in the early twentieth century relied upon the selective adoption of aircraft production, organizational formation, and training of manpower from a range of foreign countries in order to establish structures to support technological creativity and the independent design of aircraft.<sup>15</sup> Elsewhere in East and Southeast Asia, European imperial powers dominated aviation infrastructure in French Indochina and the Dutch East Indies.<sup>16</sup> Unlike these, in the case of Chinese aviation, foreign interests were involved in unique configurations of finance and authority, seeking means of establishing transcontinental routes between Asia, Europe, and North America even as Chinese partners sought to develop the capacity for independent domestic operation.

During the period of Nationalist power in China from 1928 to 1937, ambitious state-building projects sought to place highly educated elites in administrative and corporate positions of authority over projects that took as their explicit goal the transfer of technologies from foreign countries. William Kirby has suggested that in aviation, such joint ventures “failed as instruments of planned technology transfer” because they did not succeed in training enough Chinese personnel to operate without foreign support.<sup>17</sup> This

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12. David Edgerton, *The Shock of the Old: Technology and Global History since 1900* (Oxford: Oxford University Press, 2007), p.87.

13. *Ibid.*, p.87.

14. Paul N. Edwards, “Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems,” in Thomas J. Misa, Andrew Feenburg, and Philip Brey (eds.), *Modernity and Technology* (Cambridge, MA: MIT Press, 2003), pp. 185–225, 186. See also Thomas Hughes, “The Evolution of Large Technological Systems,” in Wiebe Bijker, Thomas Hughes, and Trevor Pinch (eds.), *The Social Construction of Technological Systems* (Cambridge, MA: MIT Press, 1987), pp.51–82.

15. Jürgen Melzer, *Wings for the Rising Sun: A Transnational History of Japanese Aviation* (Cambridge, MA: Harvard University Press, 2020), pp.2–4, 96, 266.

16. Marc Dierikx, “Routes versus Revenue: Pioneering Commercial Aviation in Holland 1919–1940,” *Revue belge de Philologie et d’Histoire* 78 (2000): 889–911, 907–8; Gregory Seltzer, “The Hopes and the Realities of Aviation in French Indochina, 1919–1940,” PhD diss., University of Kentucky, 2017.

17. William C. Kirby, “Joint Ventures, Technology Transfer and Technocratic Organization in Nationalist China, 1928–1949,” *Republican China* 12 (1987): 3–21, 5–6.

article attempts to trace how technical training became so significant as to provide a metric of the success or failure of such transmissions. Although technology transfer is often treated as a straightforward, unidirectional process, the history of science has suggested a more complex view of this dynamic, one in which cross-cultural movements of scientific knowledge are mediated by socio-political contexts and marked by local modification, appropriation, and reinvention.<sup>18</sup> By the 1930s, Chinese authors and administrators identified a key site for the development of aviation infrastructures: the training of a middle-class corps in disciplines that would allow them to assume independent responsibility for domestic ventures. An important aspect of modern aviation infrastructure, and the technology transfer involved in building it, was thus understood to be embodied in the knowledge and skills of its personnel.<sup>19</sup>

### The rise of print cultures of aviation

In the 1920s and 1930s, the establishment of a number of journals and magazines dedicated to aviation reflected growing popular interest in aviation and created a space for discussion of the requirements and potential benefits of this transportation technology among educated urban readerships. These publications also articulated the need for technical infrastructures to support aviation in China, discussing many different issues but paying significant attention to reliable weather prediction, wireless radio communications, and technical education. The rise of this print culture accompanied formal planning for the establishment of aviation. In 1918, the Beiyang government, maintaining nominal authority over the Republic of China between 1912 and 1928, had established an “Office to make preparations for matters concerning aviation” (Chouban hangkong kongshi yi chu); two years later, it was renamed the Bureau of Aviation (Hangkong shu), and under this more official title planned aerial routes from Beijing to Shanghai, Guangzhou, Chengdu, Harbin, and Ulan Bator.<sup>20</sup> A number of aviation-related factories, repair shops, and schools were established in cities across the nation during this period.<sup>21</sup>

18. James A. Secord, “Knowledge in Transit,” *Isis* 95 (2004): 654–72; Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900* (Houndmills and New York: Palgrave Macmillan, 2007); Sujit Sivasundaram, “Sciences and the Global: On Methods, Questions, and Theory,” *Isis* 101 (2010): 146–58; Liliaine Hilaire-Perez and Catherine Verna, “Dissemination of Technical Knowledge in the Middle Ages and the Early Modern Era: New Approaches and Methodological Issues,” *Technology and Culture* 47 (2006): 536–65, and Jonathan Zeitlin, “Introduction,” in Jonathan Zeitlin and Gary Herrigel (eds.), *Americanization and its Limits: Reworking US Technology and Management in Post-war Europe and Japan* (Oxford: Oxford University Press, 2000), pp. 1–50.

19. See Harry M. Collins, *Tacit and Explicit Knowledge* (Chicago: University of Chicago Press, 2010), pp. 2–3.

20. Chen Yaohuan, *Yinyi chuchu: Zhongguo dalu, Taiwan sheng ji Xianggang minhang shilüe* [Silver wings everywhere: A brief history of aviation in mainland China, Taiwan, and Hong Kong] (Beijing: Zhongguo huaqiao chuban gongsi, 1990), p.4.

21. Meng, *Zhongguo jindai hangkong gongye shi*, pp.20–38 (on factories and workshops), 44–8 (on schools) (note 2).

Aviation was one of many disciplines that benefited from the rise of print culture in the Republican era. Early twentieth-century China experienced a rapid expansion in its periodical press, centered in Shanghai; new magazines and journals disseminated information about a variety of special interests to literate audiences.<sup>22</sup> By 1930, a range of publications offered access to news and features about technologies of aviation. Just to give a sense of the titles on offer, *Journal of Flight* (*Feixing zazhi*) was first printed in Beijing and Nanjing in March 1921 and ceased publication in March 1931. *Aviation Monthly* (*Hangkong yuekan*) began life as *Aviation* (*Hangkong*) and ran from May 1920 to at least 1927. *Aviation Magazine* (*Hangkong zazhi*) was published in Nanjing, Hangzhou, Nanchang, Hankou, and Chengdu from March 1929 to March 1944.<sup>23</sup> Although records of circulation and readership are difficult to access, judging from content and style, the readers these publications' authors envisioned were likely middle- and upper-class city-dwellers who might belong to an organization for the promotion of aviation, or simply have an interest in the subject. Although issues typically included sections with printed translations of foreign lectures and texts, they also featured original articles by Chinese authors and reported on domestic and international news relating to aviation. *Aviation Monthly*, for instance, translated and reprinted lectures from MIT on aeronautical engineering, as well as introductions to technical topics in the operation of gravitational compasses or the means by which high-altitude flight could provide opportunities for astronomical research.<sup>24</sup> Three issues emerged in these journals' discussions of the infrastructural requirements of aviation: reliable weather prediction, wireless radio networks, and technical education of Chinese students.

First, establishing viable aviation ventures required reckoning with the problems that bad weather posed for vessels in flight. After the coastal weather reporting networks of the Imperial China Maritime Customs Service fragmented following the 1911 collapse of the Qing dynasty, meteorology underwent rapid disciplinary transformation and professionalization.<sup>25</sup> The importance of weather observations to the successful operation of aircraft quickly became apparent to advocates of aviation. A 1920 piece in *Eastern*

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22. Joan Judge, Barbara Mittler, and Michel Hockx, "Introduction: Women's Journals as Multigeneric Artifacts," in Michel Hockx, Joan Judge, and Barbara Mittler (eds.) *Women and the Periodical Press in China's Long Twentieth Century: A Space of Their Own?* (Cambridge: Cambridge University Press, 2018), pp.1–18, 2–3; see also Christopher Reed, *Gutenberg in Shanghai: Chinese Print Capitalism, 1876–1937* (Vancouver: UBC Press, 2004), and Michel Hockx, *Questions of Style: Literary Societies and Literary Journals in Modern China, 1911–1937* (Leiden: Brill, 2003).
  23. Meng, *Zhongguo jindai hangkong gongye shi*, p.134 (note 2).
  24. "Hangkong zatan: yinli luojing" [Aviation Discussion: Gravitational Compass], trans. into English by Shuling Zheng, *Hangkong yuekan*, 1 June 1928: 97–99; Yude Li (ed.), "Hangkong tianwenxue" [Aviation Astronomy], *Hangkong yuekan*, 1 June 1928, 100–103; Yude Li, "Hangkong xue jiao fan" [Aeronautical Education], *Hangkong yuekan*, 1 November 1927, 8–9.
  25. Robert Bickers, "'Throwing light on natural laws': Meteorology on the China coast, 1869–1912," in Robert Bickers and Isabella Jackson (eds.), *Treaty Ports in Modern China: Law, Land, and Power* (London: Routledge, 2016), pp. 179–200, 180, 191; Jie Fei, "Meteorological History and Historical Climate of China," *Oxford Research Encyclopedia of Climate Science* (2018), <<https://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-594>> (17 July 2020), pp. 1–20, 6.

*Miscellany (Dongfang zazhi)*, the nation's "principal organ for educated public opinion,"<sup>26</sup> described American progress in using aircraft to support meteorological research. "The future progress of aviation depends upon the progress of meteorology," explained the author, stressing the symbiotic relationship of aerial navigation and weather forecasting. "Because meteorologists can accurately show us changes in the weather for a few days or as many as ten days ahead, pilots can make preparations in advance, and avoid every kind of difficulty."<sup>27</sup> In 1921, renowned meteorologist Jiang Bingran wrote in the professional journal *Observatory Reports (Guanxiang congbao)*, "The so-called good weather of the airman is completely different from that of gardeners and travellers." Summarizing the various problems that could manifest in the skies for aerial navigation, Jiang continued, "The key point is that [the airman] seeks to know whether or not it is possible to fly, that he will not be hindered by wind or vapour, whether he can make a flight before rain falls, [and] whether there will be any sort of turbulence, which could prevent his ascent or descent."<sup>28</sup>

Although it was readily apparent that meteorology was a necessary part of aviation infrastructures, establishing weather reporting networks was a different matter. Adequately skilled observers scattered across large distances on the ground were an important part of this endeavor. A 1920 translation of an article on meteorology in *Beijing Aviation (Hangkong [Beijing])*, likely originally written by F.V. Holt, British colonel and adviser to the Beiyang government, described the kinds of observations that were important for supplementing aerial navigation. Some measurements, such as those of humidity or air pressure, relied on instrumentation, but others required trained personnel to make specific and complex interpretations of phenomena.<sup>29</sup> In both cases, perception was fallible. Trained observers could miss important signs, and meteorological instruments in the 1920s and 1930s were not always reliable. One 1923 article by Jiang in the aviation magazine *Riding the Wind (Yu Feng)* described the faults of the latter in vivid detail. Observing a balloon while using a theodolite to calculate wind direction and speed at high altitude, Jiang explained, worked – until the balloon entered a cloud and could not be observed. Alternatives to this method existed, but none were foolproof. Jiang stressed the need for rapid transmission of meteorological information in the context of aviation, where forecasts were only effective within six or at most twelve hours. "The expansion of meteorological observation must complement the development of aviation routes with progress on both sides," he concluded.<sup>30</sup> To build such an infrastructure, it was necessary to institute a network of stations and rapid communications systems. It was also

26. Theodore Hutters, *Bringing the World Home: Appropriating the West in Late Qing and Early Republican China* (Honolulu, HI: University of Hawai'i, 2005), p.210.

27. Y (pseud.), "Feiji shang zhi qihou yuce" [Predicting the weather on an airplane], *Dongfang zazhi* 17 (1920): 81–82.

28. Bingran Jiang, "Hangkong yingyong qixiang xue fu bian" [Aviation should use meteorology: supplement], *Guanxiang congbao* 6 (1921): 1–8, 1.

29. He'erde (F.V. Holt), "Qixiang yu hangkong zhi guanxi" [The relationship between meteorology and aviation], *Hangkong (Beijing)* 1 (1920): 17–19.

30. Bingran Jiang, "Hangkong qixiang yingyou zhi shebei" [Aeronautical meteorological equipment], *Yu Feng* (1923): 9–10, 10.



important to purchase instruments and train specialists to use these tools and to make qualitative observations about the weather. Holt called for the establishment of meteorological stations in “every major centre,” so that the distance between any given station would not exceed 500 miles, and for the establishment of wireless radio networks that would allow meteorological stations to broadcast weather information four times a day.<sup>31</sup>

Wireless radio thus became another recurrent topic in aviation literature, and here again, competent operators with necessary skills were required. Each airport or landing field along a given route required radio receivers and transmitters in order to facilitate transmission of meteorological data, as Jiang pointed out, but the significance of communications infrastructure for aviation was hardly confined to weather reporting. In 1925, an *Aviation Monthly* article identified navigation as one of the two major “problems” facing the development of aviation, the other being the establishment of adequate airfields. Pilots could use magnetic compasses to navigate in conditions of poor visibility, but without any other aids they faced the problem of magnetic declination, in which the difference between magnetic north and true north made compasses unreliable indicators of direction. Therefore, wireless radios were vital tools to use in conjunction with compasses in order to navigate and identify directions correctly.<sup>32</sup>

Wireless radio was not only necessary for aerial navigation; it was strategically vital. A 1926 issue of *Aviation Monthly* printed an illustration that emphasized the military significance of the rapid transmission of information via radio from the air. The image depicted a Guomindang military camp in which a soldier with his back to the reader speaks to an officer, who is pointing to a gramophone-like device that has the words “news of victory” (*jiebao*) pouring out of it. A plane flying far in the distance emits a series of lines arranged in concentric arcs, gradually increasing in width, to look like radio waves aimed at the soldiers; these lines resolve into characters reading “The enemy is completely defeated [and] our army has won.” The caption of the image reads, “Nothing is as fast for investigating and reporting the military situation as an airplane and a wireless radio set.”<sup>33</sup> Despite this explicit recognition of strategic value, the paucity of extant radio infrastructure was a concern for commentators promoting the establishment of aviation. A 1927 *Aviation Monthly* article, entitled “China Urgently Needs to Develop Aviation Transport,” noted as part of a litany of Chinese deficiencies in transportation and communications networks that “there are only about ten wireless radio stations” in the country.<sup>34</sup> Wireless radio, like meteorological observation, ultimately depended on yet another strand of infrastructure that emerged over the early twentieth century to support aviation: the training of and support for adequate personnel who could staff a network of supportive stations.

Education and human resources played a crucial role in emerging infrastructures of aviation. China had opened its first flight school in 1913 at Beijing’s Nanyuan Airport. Other schools offering instructing in aviation technology and flight skills were

31. He’erde, “Qixiang yu hangkong zhi guanxi,” pp. 18–19 (note 29).

32. “Hangkong de liangge zhongyao wenti” [Two important problems of aviation], *Hangkong yuekan*, 15 November 1925: 9–12, 11–12.

33. Shuyu Xiao, “Women yao zai feixing shang he diguo zhuyi jue sheng suan” [We must fight for victory against imperialism in flight], *Hangkong yuekan*, 1 May 1926: 3–4, 4.

34. Tingrui Yu, “Zhongguo jiyao fazhan jiaotong hangkong” [China Urgently Needs to Develop Aviation Transport], *Hangkong yuekan*, 1 June 1927: 8–11, 9.

established in Guangzhou, Hangzhou, and Liuzhou (Guangxi) over the 1920s and 1930s; during these decades, schools of aviation in the United States and the Philippines were also established for Chinese students.<sup>35</sup> The disciplines required to successfully build a working airplane and fly it from one place to another were manifold: fluid dynamics, organic chemistry, material science, and physiology had all contributed to the development of aeronautical engineering.<sup>36</sup> Establishing a viable system of education in the technologies and disciplines of flight was therefore understood as essential to the success of Chinese aviation in printed materials of the 1920s. “Aviation is a specialized technology, which lies beyond the abilities of ordinary people; it is necessary to have personnel with such expertise,” claimed one 1925 article in *Aviation Monthly*.<sup>37</sup> A key goal of any endeavor must therefore be the successful establishment of Chinese educational ventures: “Aviation schools are the mothers of aviation talent, so aviation schools provide a fundamental program for developing aviation itself; this cannot be lacking.”<sup>38</sup>

In this context, “aviation talent” did not refer to individual geniuses or heroes, but rather cohorts of engineers, pilots, and mechanics who had been trained in shared knowledge and skills relating to the use of aviation-related technologies. A 1927 article in *Aviation Monthly* expanded upon the interdependence of skilled personnel and infrastructural development in aviation. Author Ma Yiyun decried the underdevelopment of China’s aviation industry, offering a list of reasons for its parlous state – one of which was a “lack of qualified personnel.” “I would like to ask,” he wrote pointedly, “given the lack of advancement of the aviation industry, whether it does not follow that those people with knowledge of aviation (*hangkong xueshi*) have nowhere to display their talents.”<sup>39</sup> Ma explained that such individuals would naturally be drawn to career paths in other industries that more easily provided for their professional advancements, resulting in a paucity of students being attracted to the study of the disciplines that contributed to aviation. Without sufficient industrial networks to provide employment in large numbers for those who chose to study the disciplines affiliated with aviation, talented individuals would consider it a “perilous undertaking.”<sup>40</sup> Ma’s critique thus stressed the importance of establishing aviation and aeronautics as fields where work should be done by a select group with exceptional skills.

In summary, a burgeoning print culture in the 1920s gave significant space to articles that discussed the technical requirements for aviation infrastructures. These pieces focused on the need for accurate weather observations and adequate radio communications systems to relay this and other information useful for aerial navigation. Yet in these and other aeronautical disciplines, the effective use of such technologies

35. Meng, *Zhongguo jindai hangkong gongye shi*, pp.45–53, 72 (note 2).

36. Yanru Wu, “Rizhu yunxiao: Gao Lu yu 《Kongzhong hangxing shu》” [Triumph in the Skies: Kao Lu’s ‘Aeronautics’], *Kexue shi tongxun* 39 (2015): 111–48, 111.

37. Jiwu Yu, “Yao nuli shixing fazhan hangkong de genben tiaojian” [Fundamental conditions for efforts to develop aviation], *Hangkong yuekan*, 1 November 1927: 3–4, 4.

38. *Ibid.*, p.4.

39. Yiyun Ma, “Zhongguo hangkong shiye weineng fazhan de yuanyin” [The reasons for the Chinese aviation industry’s lack of development], *Hangkong yuekan*, 1 July 1927: 5–10, 7.

40. *Ibid.*, p.7.

required adequate training. Already apparent, and fundamental, was a belief that specific expertise was required for aviation, and that such expertise must be specially cultivated. This issue would find its way into new aviation contracts and initiatives in the early 1930s.

## The establishment of new aviation ventures

After the Nationalist Party consolidated power across much of central and southern China in 1927 under Chiang Kaishek, the Nationalist state signed agreements, first with the United States and then Germany, to establish aviation companies and capacities in China through transnational partnerships. CNAC was established in 1930 as a joint enterprise between the Republic and American airplane manufacturer Curtiss-Wright to support domestic airmail routes. In 1933, Curtiss-Wright sold its shares to Pan-American Airways, after which CNAC established a trans-Pacific route to North America via Hong Kong.<sup>41</sup> For much of its existence, CNAC coexisted with Eurasia, which formed in February 1931 as a joint enterprise of the Ministry of Communications of the Republic of China and Deutsche Lufthansa.<sup>42</sup> In addition to these transnational projects, a domestic corporation, Southwestern Airlines, was established in 1933 with the aim of providing a means for China's southwestern provinces to compete with north and central China, which had enjoyed the benefits of early agreements with CNAC and Eurasia, and to connect to shipping routes established in French Indochina.<sup>43</sup> These corporations were not the first or the only aviation ventures in China – for instance, in 1933, the Sino-Italian National Aviation Works were initiated and eventually established in the central city of Nanchang as a major military-industrial project – but they were among the most prominent.<sup>44</sup> In this section, I suggest that CNAC, Eurasia, and Southwestern all incorporated provisions for building technical infrastructures in their establishment. Featured in these plans was the training of Chinese employees in technical knowledge and skills, supported by foreign partners where possible.

For CNAC, infrastructure included not only making plans to invest in equipment, but also obtaining the rights to use it. This point supports a broader contribution of the special issue – that repair and maintenance require access to infrastructure that frequently

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41. Dougan, *China's Civil Aviation Industry*, pp.39–41 (note 3); Leary, *Dragon's Wings*, pp.13, 22–3, 41–8, 79–95 (note 3).

42. For more on German influence, see William C. Kirby, *Germany and Republican China* (Stanford, CA: Stanford University Press, 1984); Gang Tan, “1931–1937 nian ouya hangkong gongsi de jingying guanli yu yexu fenxi” [Operational management and performance analysis of the Eurasia Aviation Corporation, 1931–1937], *Xinan daxue xuebao (shehui kexue ban)* 39 (2013):166–72, 166.

43. “001, Xinan hangkong gongsi chou wei hui jiang xinan hangkong gongsi zhangcheng deng cheng jiaotong bu bei'an” [Document 1, Southwestern Aviation Corporation Preparatory Committee submission of the company charter to the Ministry of Communications for the record], in *Zhonghua minguo jiaotong shiliao (er): hangkong shiliao* [Republic of China Historical Materials on Transportation, Vol. 2: Historical materials on aviation] (Taipei: Guoshiguan yinxing, 1991), pp.170–72.

has to be negotiated through complex legal contracts – and the legal right to repair and maintain airplanes was foundational to the success of transnational corporations here as elsewhere. At its founding, CNAC established as part of its purview “any business related to the . . . manufacturing, construction, repair, import, export, etc. of aviation-related goods, including radio equipment and other materials used in aviation.”<sup>45</sup> The aircraft division was a major part of the organization, and its duties included maintenance of airports, procurement of materials and parts, and equipment repair and inspection.<sup>46</sup> The 1930 contract to establish the corporation included an article that established the right to “install, maintain and use suitable transceivers and telephones,” as well as a provision that the Chinese government would provide a certain number of radio wavelengths for dedicated use by CNAC “exclusively for the company to transfer messages between stations and aircraft.”<sup>47</sup> The contract further stipulated that the American partners at Curtiss-Wright would “provide Chinese people in China and in the United States with sufficient opportunities to receive training in pilotage, and at the same time provide Chinese people with sufficient opportunities for instruction by mechanics, and technical training in wireless radio management,” and that as a matter of policy, CNAC would employ Chinese staffers, pilots, and mechanics.<sup>48</sup>

The establishment of Eurasia brought similar commitments on behalf of the German government to support the establishment of aviation-related infrastructure in China, including specific provisions to educate Chinese technical personnel at home and abroad. A contract to establish the company in February 1930 stipulated that Lufthansa would “manage and supervise the technical matters” of the air routes, including such matters as radio transceiver and telephone installation, and that Lufthansa would make arrangements for “the training of qualified Chinese pilots and mechanics in Germany and China, and to support the research and practice of air transport routes, operations, and factory administration, as well as aircraft repair.”<sup>49</sup> Once the agreement to establish Eurasia had

44. Ovidio Ferrante, “Missione aeronautica italiana in Cina,” *Informazioni della Difesa* 3 (2008): 45–50.

45. “Zhongguo hangkong gongsi zhangcheng” [Constitution, China National Aviation Corporation], 27 July 1930, record group 493, file 67, China No. 2 Historical Archives, Nanjing, People’s Republic of China, transcribed in Liu Yuanxiong and Hu Ping, *Zhongguo hangkong gongsi, ouya—zhongyang hangkong gongsi shiliao huibian* [Compilation of historical materials on the China National Aviation Corporation and Eurasian/Central Aviation Corporation] (Beijing: Minhang zongju shizhi bianji bu, 1997), pp.55–64, 55.

46. “Zhongguo hangkong gongsi zuzhi dagang ji banshi xize” [China National Aviation Corporation Outline of Organization and Detailed Work Regulations], 1930, record group 493, file 25, China No. 2 Historical Archives, Nanjing, People’s Republic of China, transcribed in Liu and Hu, *Zhongguo hangkong gongsi* (note 45), pp.65–70, 68.

47. “001, Jiaotong bu cheng xingzhengyuan gai bu yu mei feiyun gongsi xieshang xiuzheng zhong mei hangkong hetong qing zhunyu bei’an” [Document 1, Ministry of Communications submission to the Executive Yuan of the Sino-American aviation contract this Ministry has negotiated with the American Air Transport Company and requests approval and filing], *Hangkong shiliao* (note 43), pp. 205–218, 213–14.

48. *Ibid.*, p.213.

49. “Zhonghua minguo guomin zhengfu jiaotong bu yu Deguo hansha hangkong gongsi dingli ouya hangkong youyun hetong” [Government of the Republic of China Ministry of

been settled, arrangements were made to ship thirty-nine boxes of equipment for repairs and maintenance to Nanyuan, where Eurasia planned to set up its primary workshop.<sup>50</sup> The reliance on railways for this workshop's establishment reflected the dependence of aviation infrastructures on other technologies of transportation.

As a domestic corporation, Southwestern Airlines lacked the foreign investment and support that characterized projects of transnational technology transfer for CNAC and Eurasia, but the former did make provisions for building technical capacities for aviation in southern China. The majority stakeholder was the Guangdong Provincial Government, and the local governments of Guangxi, Fujian, Yunnan, and Guizhou shared equal minority stakes. The company's 1934 articles of incorporation stated that its business included the purchase and sale of all equipment related to aviation, as well as manufacturing and site repair, the training of pilots and mechanics, "surveying fields, roads, and urban land," and "all matters relating to the purchase, installation, leasing, and loaning of sites needed for aviation routes."<sup>51</sup> In their initial prospectus, the directors of Southwestern planned six months to complete technical preparations, including acquiring the necessary radios and other equipment, establishing seaplane bases, borrowing existing airport terminals from cities and provinces where possible, and hiring mechanics and staff.<sup>52</sup>

This was an optimistic estimate, albeit one in keeping with the sunny tones of a business prospectus. In 1933, the national Minister of Communications, Zhu Jiahua, wrote more candidly to Chen Jitang, the governor of Guangdong, about the troubles Southwestern might face. "In terms of technology," Zhu wrote,

pilots must have deep experience without having met with a mishap; then, and only then, can they, at a time of urgency, adapt to change as the occasion requires. Moreover, the difficulty of radio dispatch and airborne communication – compared to that on the ground – is several orders of magnitude greater, and the mechanical adjustments and repairs are also most exacting [in their requirements]. So there are some deficiencies, which then produce obstacles.<sup>53</sup>

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Communications and Germany's Lufthansa Aviation Corporation Contract Establishing Eurasia Aviation Airmail], February 21, 1930, record group 493, file 88, China No. 2 Historical Archives, Nanjing, People's Republic of China, transcribed in Liu and Hu, *Zhongguo hangkong gongsi* (note 45), pp.249–56, 254.

50. Boqun Wang, "Han: Jiaotong bu han: di si jiu jiu hao" [Letter: Ministry of Communications: Number 499], *Jiaotong gongbao* 242 (1931): 30.
51. "Si, xingzhengyuan mishuchu han jiaotong bu jiu xinan hangkong gongsi chengli shi he yi ju fu (minguo ershan nian yi yue shiliu ri), fujian san: xinan hangkong gufen youxian gongsi zhangcheng" [Document 4, Letter of the Secretariat of the Executive Yuan to the Ministry of Communications to approve the review of the establishment of Southwestern Airlines (16 January 1934), appendix 3: Southwestern Airlines Articles of Incorporation], in *Hangkong shiliao* (note 43), pp. 177–80, 178.
52. "Si, xingzhengyuan mishuchu han jiaotong bu jiu xinan hangkong gongsi chengli shi he yi ju fu (minguo ershan nian yi yue shiliu ri), fujian si: xinan hangkong gongsi jihua shu" [Document 4, Letter of the Secretariat of the Executive Yuan to the Ministry of Communications to approve the review of the establishment of Southwestern Airlines (16 January 1934), appendix 4: Southwestern Airlines Prospectus], in *Hangkong shiliao* (note 43), pp. 180–8, 186.
53. "San, jiaotongbu Zhu bu zhang han Guangzhou Chen zong siling he qu tingzhang chen shu xinan hangkong gongsi jiang zaoyu zhi kunnan (Minguo er shi er nian shi er yue er shi wu

Zhu's letter demonstrated awareness of the myriad technical challenges of establishing aviation, and the importance of training personnel in the kinds of "deep experience" and knowledge that made it possible to resolve complex mechanical problems and cope with fast-moving crises.

These obstacles, along with a lack of foreign assistance, ultimately posed insurmountable challenges for Southwestern. As the company launched routes from Guangzhou to Nanning, Haikou, Guilin, Longzhou, and Hanoi between 1933 and 1938, technical problems resulted in calamity. In one case, a mechanic's alleged carelessness led to the destruction by fire of an aircraft; in another, efforts to renovate an old engine led to the same outcome. These crises suggested the serious consequences resulting from a lack of sufficient mechanical training. In 1937, war with Japan broke out, and Southwest folded a year later, in June 1938.<sup>54</sup> Likewise, the Second World War brought an end to the normal operations of both Eurasia and CNAC, forcing the dissolution of Eurasia on 1 June 1943; after 1941 CNAC was integrated into American-led systems of wartime aviation.<sup>55</sup> Yet before these dramatic transformations, CNAC and Eurasia devoted significant attention to technical concerns over the course of their operations, especially the training of personnel.

## Infrastructure building in the 1930s

As aviation ventures developed over the early and mid-1930s, subsequent contracts and reports reflected a continuing concern with the construction of technical infrastructures. This concern manifested primarily in terms of the explicit responsibility to train Chinese pilots, radio operators, and mechanics. Although the aviation press discussed in the first section articulated concerns with weather observation as well as radio operation and technical training of personnel, meteorological work did not appear very prominently in available reports of CNAC and Eurasia after 1930, possibly because the successful establishment of weather observing stations across China had supported the consolidation of meteorology as a distinct discipline. For example, CNAC established a station at Guiyang in 1935, while in 1934 Eurasia transformed those at Yinchuan, Baotou, and Zhengzhou from "irregular sites of weather observation" to full-fledged research stations.<sup>56</sup>

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ri)" [Document 3, Letter from Minister of Communications Zhu to Guangzhou Commander-in-chief Chen and District Director discussing the difficulties Southwestern Airlines will encounter (25 December 1933)], in *Hangkong shiliao* (note 43), pp. 173–4, 173.

54. Zonghua Kan and Houbang Zheng, "Xinan hangkong gongsi de xingshuai" [The rise and fall of Southwestern Airlines], in Quanguo zhengxie wenshi ziliao weiyuanhui (ed.), *Zhonghua wenshi ziliao wenku, di 13 juan, jingji gongshang bian: shangye, jiaotong, youdian, luyou, qita* [Library of Chinese historical accounts, Vol. 13, economics, industry, and commerce: business, communications, post and telecommunications, tourism, etc.] (Beijing: Zhongguo wenshi chubanshe, 1996), pp.707–12.
55. Morgenstern and Plath, *Eurasia Aviation Corporation*, p. 107 (note 3). The most famous period in the anglophone history of CNAC was its wartime work flying military supplies over the Himalayas; see Dougan, *China's Civil Aviation Industry*, pp.39–41 (note 3); Leary, *Dragon's Wings*, pp. 125–92 (note 3).

Nonetheless, during the 1930s, discussions of technical infrastructure at CNAC and Eurasia focused on the training of Chinese personnel in specialist topics necessary for aviation, suggesting a growing emphasis on this work as central to the enterprise of establishing aviation. Baumler and O'Keefe have demonstrated the significance attached to pilots as heroes symbolizing Chinese modernity and technological proficiency.<sup>57</sup> This section suggests that the work of mechanics and other kinds of technical workers also contributed to constructions of Chinese modernity. In developing educational plans and articulating class identities for technical personnel that precluded those of lower status, administrators sought to professionalize this labor.

Early reports on the progress of CNAC stressed the importance of building technical infrastructure. Shortly after its establishment, a 1931 booklet commemorating the corporation's opening of new air routes set forth extensive plans for future development. An article titled "The Future of CNAC" stated,

When the contract with the United States began, its vision was to focus on the training of specialists. The intention was [for the corporation] to manage on its own without having to ask for materials from outside, and the hope was to produce and improve aircraft without having to buy them externally. The purpose of those who are "catching up," so to speak, is to be able to quickly use their own materials in order to improve their equipment and manufacturing.<sup>58</sup>

In placing CNAC in the role of playing "catch-up," the unnamed author stressed the continued need to adopt foreign technologies. The article went on to outline the chief plans for improving the technical side of CNAC operations: to increase the number of aircraft factories and repair workshops and better equip them, as well as train personnel. The tone was optimistic: "It is not difficult to expand repair workshops and factories and to manufacture aircraft, and it is even easier to gradually increase their equipment. In addition the company has already made preparations for cultivating talent."<sup>59</sup> Airports and airfields were major sites for planned improvements; the article specified plans to establish repair workshops at every stop along a route and equip them with appropriate spare parts, as well as ensuring that each airport had sufficient signage, lighting, and

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56. Zengxiang Wu, *Zhongguo jindai qixiang tai zhan* [Modern Chinese meteorological stations] (Beijing: Qixiang chubanshe, 2007), pp.112–13. Between 1912 and 1937, over one hundred meteorological stations were established in China. Jie, "Meteorological History and Historical Climate of China" (note 25), p. 6; Dong Wang and Yuping Ding, "Zhu Kezhen yu woguo qixiang taizhan de jianshe" [Chu Coching and the Construction of Meteorological Stations], *Qixiang keji jinzhan* 4 (2014): 67–73, 72.

57. O'Keefe, "Stars in the Nation's Sky" (note 5); Alan Baumler, "Masculinity, Femininity, Sacrifice, and Celebrity during China's War of Resistance: Telling the Lives of the Aviators Yan Haiwan (1916–37) and Lee Ya-Ching," *Nan Nü* 22 (2020): 70–115.

58. "Zhongguo hangkong gongsi zhi jianglai [The future of CNAC]," in *Zhongguo hangkong gongsi jing ping han yi er xian kaihang jinian tekan* [CNAC Commemorative Volume on the Opening of Two Air Routes from Nanjing to Beijing and from Hankou to Yichang] (Shanghai: CNAC, 1931), pp.58–62, 61.

59. *Ibid.*, p.61.

meteorological instruments.<sup>60</sup> A concern with supporting infrastructural maintenance and repair thus emerged very quickly after the establishment of CNAC.

A few years later, the issue of “cultivating talent” came to the forefront of questions of technology transfer in CNAC. In a 1933 report on the corporation’s technical progress, Dai Enji, the corporation’s managing director, stressed the training programs it had established for Chinese personnel. Dai wrote, “When the company first began operations, it mostly hired foreign personnel. Yet today, there are qualified personnel in our own country, in areas such as wireless radio, which is already totally staffed by Chinese people. And now Chinese personnel also take responsibility for repair of aircraft.”<sup>61</sup> Yet despite this unsurprisingly glowing review of his corporation’s work, Dai portrayed it as only incremental progress in meeting an urgent need: “The Sino-American contract’s period of validity is only ten years, and three and a half years have already elapsed; the remaining six and a half years will go by in a flash, so the cultivation of talent can’t be delayed, not even a little bit.”<sup>62</sup> Thus, the training of qualified personnel was directly linked to the purpose and function of this transnational venture. In autumn 1934, CNAC dispatched an unspecified number of Chinese personnel to the United States to undertake a survey of aviation there, sending one employee specifically to study radio engineering. Upon their return, all radio operators employed by CNAC were Chinese and a 1936 report noted that “wireless radio, mechanical engineering, and management no longer need to hire foreign personnel.”<sup>63</sup> Administrators presented the training of Chinese personnel in technical administration, even in small numbers, as a substantial achievement. A 1939 Ministry of Communications document advocated for extending the arrangement that had established CNAC for another five years, saying that the corporation had successfully “opened routes and trained Chinese technical personnel, resulting in considerable achievements in developing civil aviation transport and establishing a business foundation,” and thereby fulfilling its original purpose of “making use of foreign capital and technology in order to develop national aviation.”<sup>64</sup>

Like CNAC, Eurasia administrators celebrated their progress in establishing technical infrastructure, especially radio communications, and described their training of Chinese technical personnel as a fulfillment of the terms and principles of the corporation’s establishment. A 1935 volume celebrating the fourth anniversary of Eurasia’s establishment delved extensively into questions of technical infrastructure, especially the need to identify and prepare the right class of individual to receive technical

60. Ibid., p. 61–62.

61. Enji Dai, “Minguo er shi er nian Zhongguo hangkong gongsi zhi gaikuang yu jianglai fazhan zhi jihua” [The general state of CNAC in 1933 and plans for its future development], *Zhongguo jianshe* 9 (1934): 1.

62. Ibid.

63. “Zhongguo hangkong gongsi” [China National Aviation Corporation], *Shenbao nianji*, 1936, pp.1043–45, 1045. Leary notes that communications and weather reporting were operated by Chinese employees by 1933. Leary, *Dragon’s Wings*, p.75 (note 3).

64. “005. Jiaotong bu cheng xingzhengyuan guanyu yu Meiguo feiyun gongsi yanchang hetong shi qi jianhe shizun (Minguo er shi ba nian yi yue shiqi ri)” [Document 5. Ministry of Communications request to the Executive Yuan, relating to the extension of the contract with the American Air Transport Corporation (17 January 1939)], in *Hangkong shiliao* (note 43), pp.221–2.



instruction from the corporation's German partners. It devoted an entire chapter to the establishment of wireless radio networks, and another to the training of Chinese personnel. The chapter on radio described the transmitter and antenna equipment with which each Eurasia aircraft was equipped and provided an overview of the network of eighteen radio stations that had been established across China.<sup>65</sup> The author concluded the chapter by noting how much room there was for improvement.

Although one can still hope for much progress, for instance (1) to increase short-wave radio power, (2) to change the short-wave transmitter from self-oscillation to main oscillation, in order to stabilize the wavelength, (3) to add more accurate directional equipment, (4) to make each set radio equipment more consistent, (5) to place short-wave radios on aircraft, (6) to make every effort to use cities' radio waves and use a rectifier [an electrical device that converts alternating current to direct current] to charge [radios], and (7) to increase the repair workshop's wireless radio testing equipment, and gradually try to supplement it for the sake of completeness, in terms of current needs and economic capabilities, the radios used in the company nowadays are sufficiently fast and have satisfactory performance.<sup>66</sup>

This rather lengthy wish list seriously undermined the concluding words of praise. Nonetheless, a 1936 Eurasia report described subsequent successes in equipping airplanes and stations in north China with short-wave radio sets and, in some cases, radio direction finders.<sup>67</sup>

The 1935 volume included a detailed chapter on the training of Chinese employees, one which pointed to a problem for Eurasia: it was lower-class mechanics, a group that did not fit ideals of intellectual or social background, who were industriously acquiring technical skills from German colleagues. Author Cha Zhenhu claimed, "According to the provisions of the original contract for the Sino-German Eurasia Aviation Corporation, this company's German personnel would not only take responsibility for technical matters, but also should assume responsibility for training Chinese technicians."<sup>68</sup> Cha went on to explain that fulfilling this obligation while also running a business venture was a logistically impossible task. Furthermore, it was important to find the right kind of person to train – and this question revealed biases against those of lower class among Eurasia's administrators, who suggested that technical workers in aviation, like pilots,

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65. Changxian Shen, "Ouya hangkong gongsi zhi wuxiandian shebei gaikuang" [A survey of Eurasia Aviation Corporation's wireless radio equipment], in Ouya hangkong gongsi (ed.), *Ouya hangkong gongsi kaihang sizhou nianji tekan* [Eurasia Aviation Corporation Four Year Commemorative Volume] (Shanghai: Ouya hangkong gongsi, 1935), pp.67–78, 68.

66. *Ibid.*, p.78.

67. *Ouya hangkong gongsi er shi wu nian yingye gaikuang (ying han duizhao)* [Eurasia Aviation Corporation Report on Business for 1936 (English–Chinese bilingual version)], pp. 7–8.

68. Zhenhu Cha, "Ouya hangkong gongsi duiyu guoji jishu renyuan zhi xunlian qingxing" [Description of Eurasia Aviation Corporation's training of Chinese technical personnel], in *Ouya hangkong gongsi kaihang sizhou nianji tekan* (note 65), pp.79–81, 79.

should be drawn from an educated elite.<sup>69</sup> “Previously,” Cha wrote, “those in domestic aviation who took on technical work were mostly from the craftsmen class [*gongjiang jieji*], and in terms of flying, this company had no way of finding suitable and experienced talents.”<sup>70</sup> Cha was blunt: craftsmen were not the right kind of people to become aviation technicians because of their social class. In fact, the artisans recruited to help German mechanics and pilots actually posed a threat to the cause of Chinese aviation *because* of their limited success, in Cha’s view. “The accomplishments in factory service of these artisans, who underwent training by German personnel, are really considerable,” he acknowledged. “Although [the artisans’ success] is genuine, to hope that they could continue and pursue advanced studies, and could alone carry responsibility for the work, or study the technical skills of flying, is really hard to expect, because of a lack of fundamental knowledge.” Most importantly, “the Germans cannot be given to believe that in doing this, they are fulfilling the training obligations stipulated in the contract.” *Ibid.* For Cha, then, a major problem for Eurasia was the social status of the personnel who managed much of its technical infrastructure.

After Li Jingcong took office as general manager of Eurasia in 1932, he overturned this status quo. Li set up an operating budget for training Chinese personnel in technical disciplines, stipulating that those who could take part had to have qualifications from a technical college, or combined a high school degree with experience in radio operation or piloting. Successful candidates began as apprentices in Eurasia’s repair workshops, assisting in the repair and assemblage of aircraft and engines, then moved on to radio stations, where they assisted in the repair and assembly of radio equipment; only after these stages were completed could personnel then move on to assist with mechanics and telecommunications in flight, and a Junkers W33 was specially designated for flight training at Longhua Airport in Shanghai. Some candidates were to travel to Germany for further study and training in pilotage. At the time of the report’s publication, thirty-one personnel were enrolled in this program in China, and five Chinese nationals were studying aviation engineering and flight in Germany at Lufthansa’s expense.<sup>71</sup> Eurasia’s efforts to establish training programs for Chinese technicians, like those articulated by CNAC, thus represented a specific vision of the means by which China would establish aviation infrastructure: one in which a select group of candidates with adequate preparation attained a series of technical qualifications that in turn might qualify them for the ultimate goal of study abroad.

This essay has suggested that in the 1920s, print cultures of aviation articulated the need to establish comprehensive infrastructures for air transport. Subsequent agreements by the Republican government to establish aviation ventures addressed this call, accounting for technical needs. The history of these organizations’ establishment and operations in the 1930s suggests the growing importance placed on technical training in building such systems. The education of Chinese students provided a means by which technology would not simply be passively transferred in material form from other countries, but

69. The definition of such an elite appears to have been somewhat flexible; for Cha, as a subsequent quote indicates, it required a basic level of higher education.

70. Cha, “Ouya hangkong gongsi duiyu guoji jishu ren yuan,” p.79 (note 68).

71. *Ibid.*, pp. 79–81.

instead could be actively appropriated by Chinese historical actors who acquired the technological understanding necessary to construct and operate aviation infrastructures. Although this strategy is considered to have failed in accomplishing technology transfer,<sup>72</sup> this essay suggests that it did provide a means for the Republican state to exert agency and reap some technical benefits from such transnational exchanges. Moreover, it reveals the assumption that a certain kind of knowledge, access to which was defined in some cases by social class, preparation, and experience, should constitute such a transfer.

In this respect, the essay suggests that for Republican administrators, technology transfer was most effectively achieved not through exchanges of materials or texts, but through training programs that both depended on and helped reinforce middle-class identities. The case of aviation in Republican China therefore offers an example of technology transfer that was contingent on a variety of infrastructural adaptations with significant social meanings. Dániel Margócsy notes in the Introduction to this special issue that that questions of infrastructure, maintenance, and repair provide drivers for new narratives in the history of technology. Here, consideration of these issues has shown that the establishment of technical infrastructure in Republican China contributed to the plans and policies of prominent aviation ventures, and that humans played crucial roles in that infrastructure.

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72. Kirby, “Joint Ventures,” pp.5–6 (note 17).