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The Trans-Pacific Flight Project and the Re-examination of Aeronautical Standards

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1. Introduction

There are six volumes of old albums preserved in the library of the Research Center for Advanced Science and Technology (RCAST) of the University of Tokyo.[1] They are collections of newspaper clips whose dates ran from November 1, 1923 to April 6, 1928. The albums were apparently made by a professional company at the request of the Aeronautical Research Institute (A.R.I.), the predecessor of RCAST, and all the thousands of newspaper clips contained in them concerned with various aspects of aviation, especially adventurous and record-making flights all over the world.

Among other topics domestic and abroad filling the pages of these albums, there was a project which dominated Japanese journalists' attention in the years of 1927 and 1928. It was a project organized by the Imperial Aeronautic Association to make a non-stop flight across the Pacific Ocean. The plan of this project was conceived immediately after Charles Lindbergh's successful trans-Atlantic flight in May 1927. Lindbergh's flight is so famous in the world that everyone

1. *Zenkoku Shimbun Kirinuki* (*Kōkū*) (*Clips from National Newspapers* (*Aviation*)), 6 vols. (1923–28), preserved at the Research Center for Advanced Science and Technology, the University of Tokyo. The dates stamped on clips starts on 1 November 1923 and ends, abruptly, on 6 April 1928. The albums were professionally made by the Tokyo Kirinuki Tsūshinsha (Tokyo Clipping Communication Company), apparently at the request from the Aeronautical Research Institute, and all newspaper clips are neatly arranged in each page of album. I appreciate Takashi Tachibana for drawing my attention to these albums.

knows his historic event today. But how about the flight across the Pacific? Here we encounter a question: while Lindbergh first flew across the Atlantic, who first flew across the Pacific? Most people, do not know its answer nor have ever thought about such a question. But considering the enthusiasm generated by Lindbergh, we wonder why the first trans-Pacific flight did not generate such enthusiasm nor was remembered in history in countries like Japan adjacent to the Pacific.

Though forgotten from our collective memory, there certainly were many attempts to fly across the Pacific in the 1920s and the early 1930s, and they did attract nationwide attention in Japan. And as the existence of the albums testifies, such adventurous attempts also caught the attention of A.R.I. engineers. Indeed, some of its members were deeply involved with the trans-Pacific project of the Imperial Aeronautic Association. Although the story of the trans-Pacific project was usually not referred to in a history of the A.R.I., the frustrated experience with the project had an important influence on its following activities, especially the development of a long-range monoplane called Kōkenki.

This chapter concerns with this forgotten episode of the trans-Pacific project and the involvement of A.R.I. engineers with the project. The most controversial issue arising from this project was over the applicability of the aeronautical standard to different types of airplanes. The chapter will discuss a process in which an aeronautical standard was constructed through their involvement with the project. It will particularly discuss the work of the young A.R.I. researcher Hidemasa Kimura who investigated the engineering foundation of aeronautical standards.

2. The Origin and Early Activities of the Aeronautical Research Institute

The organized effort of aeronautical research and development in Japan originated at the establishment of the Special Research Committee on Military Balloons (臨時軍用気球研究会) in 1909, a year after the Wright brothers' flight demonstration in Europe. Despite its name, it aimed at broader investigation on aeronautics, and consisted of civilian and military experts on aeronautics, including the physicist Aikitsu Tanakadate, the mechanical engineer Ariya Iguchi, and the meteorologist Seio Nakamura. Tanakadate and Iguchi were professors at the Schools of Science and Engineering of Tokyo Imperial University, and their early involvement with aeronautical matters worked in a sense as a seed for the later expansive growth of aeronautical research at the university.

In response to the rapid development of aviation, Tokyo Imperial University set up in 1916 a Committee for the Investigation of Aeronautics to explore the possibility of establishing an engineering department as well as a research institute solely devoted to the research and development of aeronautics. Its seven members gathered from Departments of Physics, Chemistry, Mechanical Engineering, and others, and they proposed a plan to establish such a department as well as a research institute. Not only making a plan, they also initiated aeronautical researches such as the one by Iguchi's team who carried up an engine to the top of Mt. Fuji to test its performance at high altitude.

In 1918, the university established the Aeronautics Department at the School of Engineering, and the Aeronautical Research Institute in Ecchūjima adjacent to Tokyo Bay.[2] They selected this location for the convenience to test seaplanes. The construction of its whole facilities including a wind tunnel and several factories was completed by 1920. In 1921, the Institute became an "attached institute" which had a more independent institutional status inside the university than the former adjacent institute. However, owing to the demolition of the new Ecchūjima facilities by the great Kanto Earthquake in 1923, the university had to rebuild the facilities, and decided to relocate the Institute to Komaba, about 10 km west from downtown. The facilities of the renewed Institute were substantially expanded from the original institute at Ecchūjima. It now included several factories,

2. For an institutional history of the Aeronautical Research Institute, see Nihon Kōkū Gakujutsushi Henshū Iinkai (the Editorial Committee of the History of Aeronautical Research in Japan), ed., *Nihon Kōkū Gakujutsushi* (*The History of Aeronautical Research in Japan*), *1910–1945* (Tokyo: Maruzen, 1990), pp. 259–290.

some with most advanced machine tools, and consisted of the following eight research divisions: physics, chemistry, metallurgy, material, wind tunnel, engines, aeroplane, and instruments. But their construction was not completed until 1931, and until then, most members either worked at Ecchūjima or the university campus in Hongō without good experimental facilities.

In 1921, the year when the A.R.I. acquired a new institutional status, an Aeronautical Council (航空評議会) was established at the Ministry of Education as an advisory body to "discuss important issues relating to basic researches on aircraft and advise relevant Ministries."[3] It may be comparable to the Advisory Committee for Aeronautics in Britain or the National Advisory Committee for Aeronautics in the United States, but it seemingly had more limited functions than those foreign committees. The A.R.I. did not function to work under the Aeronautical Council, but many of its members served at the Council's committees and were naturally engaged in related work back at the A.R.I. There remain no archival records of minutes of Council meetings. The Annals of the Ministry of Education in those years only recorded the list of topical issues discussed at the Council from 1921 to 1925.[4] Most of the topics discussed at the Council concerned with the standardization of various aspects of the development and production of aircraft: units and instruments of aeronautical measurement, nomenclature of Japanese technical terms, measurements at wind tunnel, methods of testing materials to be used aircraft construction, and so forth.

The standardization of wind tunnel experiments, for instance, was a research item discussed at the Council in 1923 and 1924. The Annals in 1928 recorded that the Subcommittee on the Standardization of Wind Tunnel Experiments held seven meetings in the year to discuss the matter.[5] The topic was in fact a hot issue among aeronau-

3. See Takehiko Hashimoto, "Kōkūkenkyūjo to Kōkūhyōgikai (The Aeronautical Research Institute and the Aeronautical Council)," in Sentanken Tankendan, *The Third Report* (Tokyo: Sentanken Tankendan, 1997): 22–26.

4. *Nihon Teikoku Monbushō Nenpō* (*The Annals of the Ministry of Education of Imperial Japan*), 50(1921–22), p. 315, 51(1922–23), pp. 366–367, 52(1923–24), p. 388, 53(1924–25), p. 392, 54(1925–26), p. 403.

5. *The Annals of the Ministry of Education*, 57(1928–29), p. 489.

tical engineers around the world. By then each country constructed numerous wind tunnels which generated indispensable aerodynamic data for aircraft design. But the structure and performance of wind tunnels were widely varied, and it was strongly hoped that test results at one wind tunnel could be consistently compared with those at another tunnel. For that, the standardization of wind tunnel testing was necessary. The above mentioned British Advisory Committee for Aeronautics consequently organized an international project of comparing the performance of major wind tunnels of all leading countries using one and the same experimental wing model.[6] The work required theoretical and experimental knowledge to perform exactly the designated measurement. The A.R.I. in Japan was a suitable institution to perform such a project and did conduct the experiments.

The Council also discussed the standardization of licensing the airworthiness of aircraft in 1925. The examination of the airworthiness of aircraft required to tackle with complex problems. It had to consider the structural strength of aircraft body and wings, aerodynamic forces, and meteorological conditions. For this complex problem which required theoretical and practical considerations, A.R.I. members were involved with the work to examine its standardization. And the standard of airworthiness became a controversial issue in the project aiming at trans-Pacific flight.

3. The Project of a Trans-Pacific Flight

After the First World War, aviators attempted to fly farther from Europe and America to conquest skies around the world. The atmosphere of the age is well expressed in the title of the book by the aviation historian C.R. Roseberry, "The Challenging Skies: The Colorful Story of Aviation's Most Exciting Years, 1919–39."[7] Aside from

6. On this project, see Takehiko Hashimoto, "The Wind Tunnel and the Emergence of Aeronautical Research in Britain," in Peter Galison and Alex Roland, eds., *Atmospheric Flight in the Twentieth Century* (London: Kluwer Academic Publishers, 2000): 223–239.
7. C.R. Roseberry, *The Challenging Skies: The Colorful Story of Aviation Most Exciting Years, 1919–39* (Garden City: Doubleday, 1966), Chapter 18 "Wide Rolls the Pacific."

the non-stop trans-Atlantic flight of Charles Lindbergh, there were many stories of adventurers in the sky, most of which are now forgotten from our memory. *Challenging Skies* as well as the albums of the A.R.I. are filled with such episodes of successes and failures of pilots who attempted to make long-distance flights over continents and oceans.

Of these challenging flights, Charles Lindbergh's trans-Atlantic flight was certainly a highlight. Two weeks after the failed attempt by French aviators in early May in 1927, Lindbergh flew across the Atlantic, and accomplished the first non-stop flight over the ocean on May 21, 1927. This success at the opposite side of the world spurred enthusiasm of the whole Japanese nation and the event turned their nationwide attention to the possibility of the flight over the Pacific Ocean, as *Tokyo Asahi Newspaper* put it: "What remains Is Pacific! Who Flies First? Now Center of Attention."[8] Immediately after Lindbergh's flight, an Aeronautical Social Meeting (航空懇談会) was organized in Japan, calling in aeronautical leaders from the Army, the Navy, the Aeronautical Bureau (航空局), the Imperial Aeronautic Association (帝国飛行協会), and the A.R.I.[9] The primary purpose of the meeting was to discuss the possibility of the flight across the Pacific. And at its second meeting, the members agreed on the possibility and decided to conduct the project at the initiative of the Imperial Aeronautic Association.

The Imperial Aeronautic Association, the key player of this project, had been established in 1913, three years after the first Japanese flight of an airplane at Yoyogi, Tokyo. Its financial basis relied on the original donation from the Imperial family, and subsequent donations from private individuals and institutions. Its primary function was to promote every aspect of aeronautical activities in Japan, organizing events of flight and representing Japan at the International Aeronautic Federation. And three years before this 1927 project was launched, it

Yūsuke Edo, *Misu Bidoru wa Tonda: Nihon kara Tonda Taiheiyo Muchakuriku Ōdanhikō* (*Miss Beadle has flown: Non stop Trans-Pacific Flight from Japan*) (Tokyo: Kenyukan, 2000).

8. *Tokyo Asahi Shimbun*, May 27, 1927.

9. *Tokyo Asahi Shimbun* and other newspapers, on May 28 and May 29, 1927.

had already raised the fund of two million yen to promote various aeronautical projects including the flight across the Pacific.

The Association publicly announced in June 1927 its plan of the trans-Pacific project. To plan and prepare the project, it set up an Investigative Committee which included as its member, A.R.I. Professor Shūhei Iwamoto, an expert in structural analysis. At this moment, a sense of optimism prevailed among members of the Committee. A naval officer associated with the project theoretically calculated the distance of a possible route and the performance of best available airplanes, and concluded that it was not difficult to accomplish the flight of the route.[10] Based on this preliminary consideration, the Association officially decided to proceed the project in August, and established an Executive Committee for the project. Its member included Iwamoto and another A.R.I. professor, Toyotarō Suhara. Under this Executive Committee, it set up an Engineering Committee, where Iwamoto and Suhara respectively took charge of the airplane's body and its engine.[11] Soon afterwards, the Imperial Aeronautic Association announced its more specific plan to make the flight by a Japanese airplane with four Japanese pilots, and finally designated the Kawanishi Machinery Manufacturing Company as a company to design and construct the airplane.

Kawanishi Machinery Manufacturing Company (川西機械製作所) was established in 1920 as a spin-off company from Nihon Airplane Manufacturing Company (日本飛行機製作所) which had been established by Chikuhei Nakajima three years earlier. After the conflict between Nakajima and the cofounder Ryūzō Kawanishi, the company split and both entrepreneurs established independent companies. Since its foundation, Kawanishi produced excellent K series airplanes designed by its chief aircraft designer, Eiji Sekiguchi. Of them, K-6 and K-8B succeeded in their flight all around Japan in 1924, which

10. *Tokyo Nichinichi Shimbun*, July 8, 1927.

11. Mineo Yamamoto, "Taiheiyo Ōdan no Omoide (A Recollection of the Trans-Pacific Project)," in *Kawanishi Ryūzō Tsuikairoku* (*Recollections on Ryūzō Kawanishi*) edited and published by Shin Meiwa Kōgyō Company in 1956. Shin Meiwa Kōgyō Company is the successor of Kawanishi Machinery Manufacturing Company, and Kawanishi Ryūzō was the founder and longtime president of this original company.

was a small-scale version of the previous successful flight around the world by American aviators.

Kawanishi Company also had been establishing its close relationship with the A.R.I. The A.R.I. member Masami Ono joined Kawanishi by the time when Kawanishi initiated the design work of the trans-Pacific airplane, and even after he had left A.R.I., kept in touch with the Institute frequently contributing papers to its journal.[12] Students of Aeronautics Department at Tokyo, too, visited Kawanishi to receive apprentice training from its practicing engineers. Kawanishi also invited the world-famous aeronautical engineer Theodore von Kármán in 1927 and 1928. Born and educated in Hungary, Kármán had investigated aerodynamics at the Göttingen University under Ludwig Prandtl and was widely known for the concept of "Kármán vortex street."[13] Kármán was then a professor at the Technical Institute of Aachen, and, just after his acceptance to visit Japan, received an invitation from California Institute of Technology, where he would be settled several years later. Kawanishi invited him to design and construct its new wind tunnel. For its construction, he needed his assistant and called, Erich Kayser, from Aachen.[14]

Kármán was not directly involved with the trans-Pacific project, but assisted the design of the propeller of the airplane. The airplane was mainly designed by Kawanishi's chief designer Sekiguchi. It was Kawanishi's twelfth plane, therefore designated as K-12, and later named as Sakura. It was a two seater monoplane whose structural design was based on K-9. Its cantilever wings were wooden structure covered with cloth and plates, while its body was made of riveted

12. *Jiji Shimpō*, September 27, 1927, reports Ono as a Kawanishi engineer who participated the design work together with Sekiguchi and Theodore von Kármán. Masami Ono contributed numerous papers to Journal of the Aeronautical Research Institute as its faculty member until 1925, and as a Kawanishi engineer from 1928. He measured aerodynamic performance of the model of Kawanishi, K-7 for instance, at a wind tunnel. Masami Ono, "Huto-Zikken no Hokoku (A Report on Wind Tunnel Experiment)," *Miscellaneous Works of the Aeronautical Research Institute*, no 16 (1925): 395–410.

13. Paul Hanle, *Bringing Aerodynamics to America* (Cambridge, Mass.: MIT Press, 1982).

14. Theodore von Kármán and Lee Edson, *The Wind and Beyond: Theodore von Kármán, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown and Company, 1964), p. 131.

metal tubes and covered by cloth. And it had a large fuel tank inside its body around its center of weight.[15] The proposed design of the airplane was displayed at the Examination Committee of the Imperial Aeronautic Association. A few days later, the design was approved by the members of the Engineering Committee of the Association,[16] and Kawanishi proceeded to receive an approval from the Aeronautical Bureau.[17]

Receiving the official approval, the project started with full steam from November 1927. But it needed money. According to its preliminary estimation, the cost of the project including the award would amount to seven hundred thousand yen.[18] Because it was a private association and did not receive the fund from the government, the Association had to make a nationwide fund-raising campaign. And the campaign should be vigorous considering the amount of the cost. Accordingly, it founded an association of supporters for the project and attempted to collect donations from the public.[19] Newspapers functioned as useful media for this campaign. They frequently reported about donations from a variety of people, wealthy and poor, old and young. Even a criminal in prison sent one and a half yen to the Association, a newspaper reported, assuring the Association that the money was not foul because it was from his ill mother to have him buy bread.[20] Children spared their stipends and sent them, while the Imperial family, municipal governments, and aristocrats donated a large amount of money.[21] As a part of this campaign, an exhibition on this trans-Pacific flight was held at a department store, and attracted

15. *Nihon Kōkūki Sōtokushū* (*All Japanese Aircraft*), vol. 3 Kawanishi Hiroshō Hen (Kawanishi and Hiroshima Arsenal) (Tokyo: Shuppan Kyodo Sha, 1982), pp. 30–33, 71–73; *Nihon Kessakuki Kaihatsu Dokyumento: Sekkeishano Shōgen* (*Documents of the Development of Excellent Airplanes in Japan: Testimony of Designers*), (Tokyo: Kantōsha, 1994): 81–82.

16. *Jiji Shimpō,* September 27 and 28, 1927.

17. *Osaka Mainichi Shimbun*, October 1, 1927.

18. *Chuo Shimbun*, June 14, 1927. The Board of Trustees of the Imperial Flight Society officially sanctioned the project in August 1927. *Tokyo Asahi Shimbun*, August 5, 1927.

19. *Kokumin Shimbun*, September 21, 1927.

20. *Osaka Asahi Shimbun*, November 1, 1927.

21. E.g. *Osaka Mainichi Shimbun*, November 27, 1927, and *Hochi Shimbun*, November 29, 1927.

hundreds of people as well as donation.[22] It was a national event, or it was to be.

4. The Battle over the Standard: the Association vs. the Bureau

A grave problem emerged over the project in early February of 1928.

The Aeronautical Bureau of the Ministry of Communications, which was in charge of various aeronautical standards, claimed that the Kawanishi airplane was too weak to meet the standard of airworthiness set by the Bureau in the previous year.[23] The representative of the Bureau and leading members of the Committee for this project, including the two A.R.I. professors, discussed the matter. According to newspapers, the Bureau side concluded that its wings and body were not strong enough to satisfy the new official requirement; the Kawanishi side, on the other hand, counter-argued that the constructed plane aimed only at the single purpose of flying across the Pacific, and therefore argued that it did not necessarily have to satisfy the official standard set by the Bureau for general airplanes.

The Rule of Testing Aircraft established in 1927 required that the wings of the airplane should withstand the force represented by the following load factors.[24] Here the airplane was divided into three categories: the first for ordinary transportation, the second for record making, and the third for acrobatic flight. And the rule covered three different cases in which the center of pressure on the wings is forward, central, and rear, respectively. The report of *Chūgai Shōgyō Newspaper* on February 14, 1928, referred to more technical details of the problems of the Kawanishi airplane in that it was below the standard at all

22. *Jiji Shimpō,* November 15, 1927.

23. *Chuo Shimbun, Miyako Shimbun*, on February 3, 1928; *Hochi Shimbun, Tokyo Asahi Shimbun, Kokumin Shimbun, Chūgai Shōgyō, Jiji Shimpō*, on February 4, 1928; *Osaka Mainichi Shimbun*, on February 5, 1928.

24. "Kōkūki Kensa Kisoku (The Rule of Testing Aircraft)," Ordinance No. 9 of the Ministry of Communications in 1927, in *Hōrei Zensho* (*The Collection of Ordinance*) (1927), no. 4, pp. 40–70.

the three cases. As shown in Table 7.1, the load factors required for the airplane of the second category were 4, 3, 1.2 for those over 5 tons. But the strength of K-12 were lower than these limits. In the third extraordinary case, in which the plane dropped vertically, the standard coefficiency for the airplane of the second category was 1.2, while that of the Kawanishi plane was 0.45.[25] Kawanishi engineers reportedly argued against these judgement, claiming that the standards which the administration relied upon was the decade-old international standard, and further proclaimed that Kawanishi based their calculation on the new theory especially through the assistance of a German aeronautical engineer named Rennetz whom they recently invited.[26]

Table 7.1: The designaed load factor to calculate the strength of wings [From Aricle 16 of "Kōkūki Kensa Kisoku (The Rule of Testing Aircraft)," Ordinance No. 9 of Ministry of Communication in 1927, in *Horei Zensho* (The Collection of Ordinance) (1927), no. 4, p. 42.]

1. The case in which air pressure exerts on the front part of the wings

	weight < 1t	1t ≤ weight < 5t	5t ≤ weight
Category 1	7	7 to 5	5
Category 2	5	5 to 4	4
Category 3	9	9 to 7	7

2. The case in which air pressure exerts on the central part of the wings

	weight < 1t	1t ≤ weight < 5t	5t ≤ weight
Category 1	5.25	5.25 to 3.75	3.75
Category 2	3.75	3.75 to 3.00	3.00
Category 3	6.75	6.75 to 5.25	5.25

3. The case in which air pressure exerts on the rear part of the wings

Category 1	1.5
Category 2	1.2
Category 3	2.5

25. Measured results in the other two cases varied from position to position of the wings, but all results were below the standard. For the first case, they were 2.5, 2.25, 2.9, which were below 4, and for the second case, 2.5, 1.45, and 1.95, which were below 3.
26. *Yamato Shimbun,* February 17, 1927.

Representing the Executive Committee, Iwamoto visited the Kawanishi factory informing them of the Committee's tentative conclusion and investigating himself the conditions of the airplane and its construction. On his return to Tokyo, they held another meeting where they had a seven-hour long heated debate.[27] Having admitted that the plane under construction had structural weakness, Iwamoto proposed that it should be used for destruction test, a test through deforming its components, and that two more planes should be constructed for the experimental flight and for the trans-Pacific flight. After the debate, the Committee concluded that another plane should be constructed and if the Kawanishi insisted, the second plane could attempt the trans-Pacific flight. A few days later, the Committee discussed with Kawanishi, which finally answered to redesign and construct the second airplane in cooperation with Suhara and Iwamoto and other Committee members, and to attempt to make the flight with this second plane.[28]

In the meantime, one of the four selected pilots training for the trans-Pacific flight was killed by an accident during a flight near a hill in a foggy weather.[29] The death of the pilot led to the compromise of the Aeronautical Bureau to permit the construction of the second plane only with minor modifications from the original design. Kawanishi also agreed to redesign the plane and to make it meet the Bureau standard.[30] The structural problem was temporarily solved and other problems on the engine and other components were to be checked at the A.R.I. They also started to consider shortening the distance of the flight course. The original route from Tokyo to Seattle was now changed to the new one from Hanasaki, the eastern end of Hokkaido, to Sitka, the southern end of Alaska, which substantially reduced the flight distance.[31]

Iwamoto and Suhara kept close contact with Kawanishi to modify the design. They intensively worked on calculation to modify the

27. *Tokyo Nichinichi Shimbun*, February 18, 1928.

28. *Osaka Mainichi Shimbun*, *Osaka Asahi Shimbun*, February 28, 1928.

29. *Osaka Mainichi Shimbun, Hochi Shimbun, Tokyo Nichinichi*, March 1, 1928.

30. *Osaka Asahi Shimbun*, March 18, 1928.

31. *Kokumin Shimbun*, March 21, 1928..

design, frequently visiting Kobe with Iwamoto's assistant Hidemasa Kimura.[32] The reports at newspapers became confounding during this month. As Iwamoto told reporters, some essential matters were kept secret. The prospect of the project reported in articles at newspapers oscillated between optimism and pessimism. While they were working on the redesigning calculation, Kawanishi had already accelerated the construction increasing the number of its staff mechanics and the amount of payment for them. And it turned out that the process of construction of the plane was so advanced that it was no longer possible to adjust its design to the new specification resulted from the calculation of the two professors.[33] To solve this problem, it was suggested that the plane should fly with the speed not as high as the two professors assumed in their calculation, consequently making it stand the required structural strength, but the reduction of the speed caused the decrease of the cruising range.

On April 4, the Engineering Subcommittee held a six-hour-long meeting on the problem, and Executive Committee Chairman Yamada announced a statement on the conclusion of their discussion.[34] According to the calculation by its members, the cruising range of the strengthened second airplane would be 5,500km. But this calculation was based on the condition that the airplane was examined as the first type of the airplane categorized in the standardization of airworthiness by the Aeronautical Bureau. Although the Kawanishi plane evidently should be categorized as the second type, the Subcommittee conjectured that if it was approved as a second type airplane, it could not be put into practical test of flight performance. Therefore, they decided that they first made and tested the plane as the first type, and that they would later modify it as the second type so that it will increase its cruising range. According to their calculation, whereas its range would be only 5,500km when it was the first type, its range would increase up to 8,150km if modified to the second type. Hav-

32. *Osaka Asahi Shimbun, Chuo Shimbun*, March 20, 1928. Iwamoto did not state explicitly the condition of the work to the newspaper reporters, but he stated that he may have to come to Kobe every week to solve technical problems piece by piece.

33. *Chūgai Shōgyō Shimbun*, March 31, 1928.

34. *Jiji Shimpō, Chūgai Shōgyō Shimpō, Tokyo Asahi Shimbun*, April 5, 1928.

ing adopted this expediential policy, they decided to postpone the final conclusion until the actual flight test of the first airplane would be performed. At the same time, the airplane was named as "Sakura" meaning cherry.[35]

The construction of the first plane was completed by mid April 1928, and its components were transported to Kagamigahara Airfield in Gifu prefecture, where the reassembled no. 1 airplane started its flight test from May 18.[36] Its preliminary tests did not bring about good results, however. It occasionally damaged its parts during the test, and its performance was not so good as Kawanishi had claimed.[37] Because of the poor performance of the first plane, they came to infer that the second plane would also have the flight range as short as 5,700km, though its construction was just completed.[38] Because of this conclusion based on the official flight test of the first plane, the Committee concluded that the original plan of the trans-Pacific flight should be changed so that the second plane with the shorter cruising range could attain a new goal.[39]

The construction of the second plane was almost completed in June, but its flight test was postponed until August for unknown reasons, thereby generating a suspicion among journalists that a grave problem was recognized and discussed hidden behind the official statements of the Committee.[40] Its flight performance was tested during August.[41] On September 5, the Executive Committee held a meeting to discuss the test results and the prospect of the project. Their publicly announced conclusion was to continue its performance test increasing its weight up to 5 ton, and to receive the certificate of airworthiness from the Aeronautical Bureau.[42] However, no news was informed on the matter for more than a month. On October 30, newspapers reported a sudden news on the resignation of

35. *Jiji Shimpō, Chūgai Shōgyō Shimpō,* April 6, 1928.

36. *Tokyo Asahi Shimbun*, May 18, 1928.

37. *Tokyo Asahi Shimbun*, May 18, 19, 20, 23 and June 1, 9, 15, 17, 29, 30.

38. *Tokyo Asahi Shimbun*, July 2, 3, 4, 1928.

39. *Tokyo Asahi Shimbun,* July 8, 1928.

40. *Tokyo Asahi Shimbun*, June 16, 1928.

41. *Tokyo Asahi Shimbun*, August 4, 10, 16, 28, 1928.

42. *Tokyo Asahi Shimbun*, September 6, 1928.

the trustee members of the Imperial Aeronautic Association.[43] Because of the failure of the project, the members of its Board of Trustees once resigned and gathered again to restart the board. On November 8, the council of the Imperial Aeronautic Association held a meeting, and concluded that it entirely reset the project.[44] Although they stated that they decided to continue, the new plane should be redesigned holding the design competition. The date and course were not set, but *Tokyo Asahi Newspaper* speculated that the flight would be postponed until the year after next. As the original project failed, the Executive Committee was disbanded, the remaining pilots dismissed, and the ill fated Sakura dismantled.

The Association also stated in 1929 to plan to make the flight by the next summer or fall, but it was never done.[45] Despite its determination to make another attempt, the Association gave up the second-round project as well by December 1929. It had considered the possibility to use a modification of a German airplane which had been offered to the Association. It was told to have a flight range over 6,000km, and the Association expected it to fly over 8,000km through some improvements. But all approached manufacturing companies responded that such an improvement was impossible. The problem derived from its structural strength. Its flight test showed that it would withstand against the required load factor only for the first fourteen to fifteen hours. The representative of the Association thus stated to reporters that if the administration modified the safety coefficients, they would venture to fly, but he commented that such a chance was improbable.[46] The final complaining words from the Association pointed to the crucial point of the problem—the legitimacy and appropriateness of the standard.

43. *Tokyo Asahi Shimbun*, October 30, 1928.
44. *Tokyo Asahi Shimbun*, November 9, 1928.
45. *Tokyo Asahi Shimbun*, March 1, April 12, and August 6, 1929.
46. *Tokyo Asahi Shimbun*, December 13, 1928.

5. Hidemasa Kimura on the Essence of Standardization

Through the personal involvement of its, the A.R.I. had close relationship with the project of the trans-Pacific flight. Iwamoto and Suhara were responsible members of the project, and had to tackle with engineering problems deriving from the project. Iwamoto, in particular, was involved with the crucial analysis of structural strength of the airplane. In September 1928, Iwamoto gave a lecture on the trans-Pacific project at a lecture hall of Tokyo Imperial University.[47] It attracted more than seventy people for its audience which was twice as many as its ordinary attendants. Although only the title and not the content of his lecture was recorded in the *A.R.I. Journal*, he probably explained about the present difficult situation of the project as well as technical details of the calculation on structural strength and of the theoretical estimate of the cruising range of the airplane.

Besides Iwamoto, several faculty members and students at Tokyo Imperial University were also engaged in related engineering work. According to the recollection of Mineo Yamamoto who graduated Aeronautics Department at Tokyo in 1928, Ogawa at A.R.I.'s Aircraft Body Department made loading tests of components of the K-12 airplane, and Shigenao Kaneko at Aeronautics Department assisted the calculation of its strength.[48] Hidemasa Kimura, a fresh graduate from Aeronautics Department, also worked under Iwamoto on the structural calculation and experiment. Whereas his classmates, including the future Zero designer Jirō Horikoshi, went to private aircraft companies and administration after their graduation, Kimura continued his scholarly study at the graduate school and became a research associate at the A.R.I. The first job given to him was the examination of the strength of the components of Sakura.[49] He was engaged in the problem of calculating the strength of the modified version of Sakura, and if necessary made experiments of the strength of materials.

47. *Journal of the Aeronautical Research Institute,* no. 62(1929), p. 552.

48. Yamamoto, op.cit., p. 147. Yamamoto refers to the name Agawa, but this must be Ogawa.

49. Hidemasa Kimura, *Waga Hikōki Jinsei* (*My Life Devoted to Airplanes*) (Tokyo: Nihon Keizai Shimbunsha, 1973), p. 90.

Born in 1904, Kimura spent his entire life devoted to design and construct airplanes, as is explicitly shown in the title of his autobiography, *My Airplane Life*.[50] Since when he had witnessed at his childhood historic flights near his home in Tokyo, he had been fascinated with the airplanes and had determined to become an aeronautical engineer. When he finally entered Aeronautics Department of Tokyo Imperial University, he recalls in his autobiography, he was too glad to sleep staying up whole night to build an airplane model. This young airplane enthusiast privately subscribed the German journal *Flugsport,* and read it while commuting in train every morning and evening. The scene caught the attention of an A.R.I. Professor Taichirō Ogawa, who encouraged Kimura to visit his laboratory in Ecchūjima in 1921, two years before the Kantō Earthquake. Ogawa was then engaged in the investigation of the structure and strength of various types of captured German and Austrian airplanes sent to Japan.[51] While assisting Ogawa, he noticed specific structural characteristics of supportive wing planes of a German airplane, on which he wrote an article in *Journal of the A.R.I.*[52] During this period, Kimura and his classmate were introduced through Ogawa to Kawanishi Company and was sent to work under the airplane designer Eiji Sekiguchi. They visited its factory at Kizugawa in Osaka, and tried to redesign the Kawanishi K-3 airplane so that they could switch its engine from a German to an English one. Kimura recalls that although the supervisor Sekiguchi "corrected many points and severely criticized" the results of the students, they managed to pass his strict check.[53] Kimura thus received invaluable practical instructions

50. Ibid.

51. Ibid., pp. 71–73. Taichirō Ogawa, et al., "Doku Ō Ōshū Hikōki Chōsa, Dai Ippō (The Investigation on German and Austrian Captured Airplanes, Part 1)," *Journal of the Aeronautical Research Institute*, no. 14(1925): 329–358; Part 2, ibid., no. 21(1926): 176–201; Part 4, ibid., no. 24(1926): 334–370.

52. Hidemasa Kimura, " Doku Ō Ōshū Hikōki Chōsa, Dai Sanpō, Eruron no Sekkeini Tsuite (The Investigation on German and Austrian Captured Airplanes, Part 1, On the Design of the Aileron)," *Journal of the Aeronautical Research Institute*, no. 23(1926): 286–298; "Dai Gohō (Part 5)," Ibid., no. 25(1926): 421–438.

53. Hidemasa Kimura, *Waga Hikōki Jinsei* (*My Life Devoted to Airplanes*) (Tokyo: Nihon Keizai Shimbunsha, 1973), pp. 73–74.

from the future designer of Sakura.

Involved with the trans-Pacific project under Iwamoto, Kimura was now in a position to assist the examination of the airplane designed by his former instructor at Kawanishi. Because the main wings of Sakura were made of wood, he tested the strength of the wood material with Iwamoto. As Kimura recalls, Iwamoto even suggested that Kimura continue his research on structural analysis of wood as his dissertation topic, but he did not follow this suggestion because the problem was so complicated.[54] Years later, Kimura published with his collaborator an article on the results of his research on the strength of wood and its standardization which he had initiated for the trans-Pacific project.[55] The table of the results of his experiment appears to be so usefully and frequently consulted that its pages are entirely worn out in the copy preserved at the RCAST library. For his experiment, he used for this experiment a Canadian spruce of 2.6m diameter and 2.1m length, cut it methodically into one-hundred-and-four pieces, and measured its shrinkage when pressed. In part based on Kimura's such structural investigation, the second version of Sakura passed the test of the Aeronautical Bureau. During this work, he also recalls that he frequently commuted between Tokyo and Kobe with Kawanishi engineers to discuss the problem.[56]

The trans-Pacific project ended up with the failure. The two planes were constructed, modified to pass the official test of airworthiness, but did not obtain the expected cruising ability. The project was over, but it left a fundamental and complex problem to concerned engineers: the reconsideration of the aeronautical standard so that it be applied more appropriately and efficiently to the actual practice of aviation. The work required the substantial reexamination of the presupposition of the existing standards. After the failure of the project,

54. Kimura, *Hikōki Jinsei,* op.cit., p. 93.

55. Hidemasa Kimura and Yoshiro Udo, "Hikōkino Sekkeini Hitsuyōna Mokuzaino Seishitsu (Characteristics of Wooden Materials Necessary for the Design of Airplanes)," *Journal of the Aeronautical Research Institute*, no. 101(1933): 1–54.

56. Kimura, *Hikōki Jinsei*, op.cit., pp. 93–94. As has been stated above, the assistant of Iwamoto referred to on newspapers when he visited Kawanishi in April 1928 was most probably Kimura.

Kimura proceeded from the specific investigation of the structural strength to this fundamental problem of the standardization of the strength of the airplane. For that purpose, he initially examined various national and international standards of the strength of the airplane and reached the conclusion that the German standard established as recent as in 1929 was most advanced of all.[57]

Iwamoto and Kimura published an article on the newly established standards on the strength of the airplane body.[58] Iwamoto was chairman of the committee on the airplane body of the Aeronautical Council under the Ministry of Education. As was mentioned earlier, the Aeronautical Council's basic function was to investigate various aeronautical standards and related works on standardization, and the A.R.I. played an important role to assist its work which was critically important at the early stage of aeronautical development in Japan. Its work naturally included the standardization of strength of airplanes which some professors like Iwamoto had been engaged in before the fiasco of the trans-Pacific project. According to the opening statement of the article coauthored by Iwamoto and Kimura, Iwamoto took the initiative to reformulate again the standard, and the Council held more than one hundred meetings to reach an agreement on its final form. To do it, they relied on foreign aeronautical standards as well as opinions of notable designers and manufacturers actively working in Japan, to which Kimura certainly contributed an important service. The outcome of this long discussion, the new Regulation of the Strength of the Airplane Body, first explained about the division of the five categories of the airplane with different degrees of strength. And it gave an additional comment on the relationship between these five categories and the uses of the airplane. The first weakest category was only permitted for those planes intended for making record or

57. Hidemasa Kimura, "Doitsu Hikōki Kikaku Kyōdo no Kenkyū, Sono 1 (A Research on the German Standard of the Strength of the Airplanes, Part 1)," *Journal of Aeronautical Research Institute*, no. 77(1931): 58–74; idem, "Sono 2 (Part 2)," Ibid.: 173–197. Kimura consulted French, English, American, Italian, Japanese, German, and International standards of the strength of the airplanes.

58. Shuhei Iwamoto and Hidemasa Kimura, "Kōkū Hyōgikai Hikōki Kitai Kyōdo Kitei Kaisetsu (Explanation on the Air Council Standard for the Strength of Airplanes)," *Journal of Aeronautical Research Institute*, no. 97(1932): 695–760.

research. The second for the cargo and postal planes. The third for passenger and practice planes, and the fourth and fifth for acrobatic planes. To make this standard, they based their discussion on several recent investigations including those done at the A.R.I. such as Taichiro Ogawa's research on the strength of wing parts.

After his involvement with the reformulation of the standard of airworthiness, Kimura wrote two short articles in which he discussed the "essential points" of the standardization of the strength of airplane body, in a sense, a philosophical aspect involved in this engineering problem. In the first article "The Rationalization of Load Factor," he first emphasized that the standard strength necessarily derived from the compromise between safety and economy, and the standard only determined the minimum required strength of the airplane.[59] He continued to explain about the actual procedure to determine the minimum standard of the strength. He discussed how to estimate the amount of load on the airplane body and its components and the structural condition of these components to withstand the load estimated. The minimum possible standard was to be determined as the maximum value of these loads among all possible cases.

In so doing, Kimura emphasized the contingent factors inherent in this quantitative estimation of the load factors. He divided various contingent factors into three categories: the specific characteristics of an individual airplane, of an individual pilot, and of weather at each day and location. As to the characteristics of the maneuvering operation of an individual pilot, he referred to the experiment of Richard V. Rhode at the National Advisory Committee for Aeronautics in the United States, which made several pilots fly three types of airplanes, and which concluded that each pilot having distinctly different sensitivity to maneuvering. Each pilot flew three airplanes and operated the same maneuver to pull them up to large angle of attack. Rhode's experiment showed that the deviation of the acceleration over different pilots exceeded that over different airplane. In addition, the same pilot

59. Hidemasa Kimura, "Fuka Jōken no Ichibu: Hikōki Kyōdokikaku Honshitsuron no Ichibu (The Rationalization of Load Factor: A Part of the Essential Discussion of the Standard of the Strength of the Airplane)," *Journal of Aeronautical Research Institute*, no. 99(1932): 814–20.

would maneuver differently under different circumstances, most notably under different meteorological conditions. Although engineers could develop the airplane design to standardize the characteristics of the airplane, it could be difficult to standardize the pilot's performance and the meteorological conditions. It was therefore inevitable to make the standards more and more complicated. Kimura suggested that after the load coefficient had been decided, pilots should keep the acceleration within the limit of that decided value. For that purpose, he suggested that the instrument to indicate the acceleration of the plane would help a pilot to keep it within the safe limit of acceleration.

After he wrote this article, Kimura received a question from an engineer at Aichi Tokei Company on the inevitability to complicate the aeronautical standard. In response, he wrote a second article on what he conceived as the essential point of the standard.[60] In it, he first contrasted the standard of the strength of the airplane in the United States and Germany. Whereas the German standard tended to be more complicated since it considered load factors as close as possible to reality, the American standard tended to be simpler even though it made the airplane heavier and stronger. In the American standard, the load factor of diving, for instance, was determined and applied to all categories of airplanes. But Kimura commented that this uniform application of the standard would necessarily cause some redundancy for certain types of airplanes. He thus regarded the American standard inferior to the German one, despite its simplicity. In conclusion, he stated that before the standard reach an ideal simplicity, it should first be rationalized in the sense that it should take into account different conditions of various cases more appropriately and efficiently, even though such rationalization necessarily led to the complexity of the standard.

Kimura's paper on the strength of wood shows the ways in which he analyzed structural strength and perceived the function of the standardization. Following the new German standard, the new Japanese standard determined the minimum strength of the materials basically

60. Hidemasa Kimura, "Fuka Jōken no Kan-yaku: Hikōki Kyōdokikaku Honshitsuron no Ichibu (The Simplification of the Condition of Load Factor: A Part of the Essential Discussion of the Standard of the Strength of the Airplane)," *Journal of Aeronautical Research Institute*, no. 103(1933): 143–145.

by the limit of elasticity of the materials. Metals and woods have elasticity, and conform to the Hooke's law up to some point called the limit of proportionality. There were, however, another method to determine the limit of elasticity. It was to measure the remaining deformation, the amount of deformation which did not disappear even after the applied force was returned to zero. The new German standard designated that the strength of all materials be the force causing a remaining deformation to be 0.02 percent of the total length of the tested material. The Japanese standard established in July 1932 designated, in a slightly different way, that the strength be the force causing the remaining deformation to be 2 percent of the total deformation of the material. Referring to the possibility of other candidates for the definition of the elastic limit, Kimura concluded from this investigation that it was difficult to determine which point was to be defined as the elastic limit, and that they should check whether these candidate definitions could work well in actual design practice. The standards were after all decided by the convention of the authoritative committee. Kimura considered that engineers should take into account this conventionality of standards in applying them to actual design practice.

6. Kōkenki and A26 as the A.R.I.'s Follow-up Projects

In 1932, the A.R.I. decided to be engaged in the project of the design and construction of an airplane to make a world record of longest distance. The story of the development of this airplane named "Kōkenki," meaning the airplane of A.R.I., has been recounted in the recently published book by one of the then A.R.I. members, Kiyoshi Tomizuka.[61] Tomizuka states that the origin of the Kōkenki project

61. Kiyoshi Tomizuka, *Kōkenki: Sekai Kiroku Juritsu eno Michi* (*The Airplane of the Aeronautical Research Institute*) (Tokyo: Miki Shobō, 1998). The book is based on the manuscript of Tomizuka Kiyoshi and its content is edited by Seiichi Awano who worked with Tomizuka at A.R.I. in prewar years. Nihon Kōku Gakujutsushi Iinkai, ed., *Tōdai Kōkūkenkyūjo Shisaku Chōkyoriki, Kōkenki* (*The Long Range Airplane of the Aeronautical Research Institute of Tokyo Imperial University, the Airplane of the A.R.I.*) (Tokyo:

derived from these two professors Iwamoto and Suhara. Both professors were involved with the previous trans-Pacific project by the Imperial Aeronautic Association, but Tomizuka does not mention the specific connection between the two project. A recollection of Mineo Yamamoto, another A.R.I. member, more explicitly states the motivational link between the two projects:

> A.R.I. Professors Iwamoto and Suhara, who had worked as members of the Executive Committee of the Imperial Aeronautic Association for this trans-Pacific project, felt strongly their responsibility after the failure of Sakura, and, triggered by this, planned the development of a long range airplane. Together with A.R.I. Director Chuzaburo Shiba, they proposed the experimental construction of a long range airplane to the Ministry of Education. This became motivation for later developing Kōkenki and making the world record of the longest flight distance.[62]

As is recounted in this recollection, it is natural to assume that Iwamoto and Suhara became eager to construct a long range airplane and that they persuaded Shiba to pursue the project.

For the project of the development of a long range monoplane, the A.R.I. received 500,000 yen from the Ministry of Education. Kimura now as a formal associate of the A.R.I. was engaged in the project. In his autobiography, he refers to some criticisms raised on the project by university scholars and military officers: some stated that scholars without practical experiences could not construct such an airplane, and other that university professors should devote their energy to scholarly research. Whereas Kimura does not concretely describe such criticisms, Tomizuka provides a substantial account of the inside story. Tomizuka confesses in his book that younger members including himself in fact were opposed to this project. They even made a plea to new Director Koroku Wada that the project was illegitimate and difficult to be realized without modifications. Despite their criti-

Maruzen, 1999), reproduces technical documents with some historical accounts.

62. Yamamoto, "Recollection of Trans-Pacific Project," op.cit., p. 153.

cisms, the project started in the spring of 1934. Tomizuka briefly mentions about the process of the selection of the basic design of the airplane. Sakura made by Kawanishi was one of them, but the idea was rejected, because its performance was not as good as expected, and because Kawanishi was on the side of Navy whereas the A.R.I. had closer relationship with Army. A company which emerged at this selection process was Tokyo Gas Electric Company, which was making such products as automobile and airplane engines, and it agreed to manufacture the airplane designed by the A.R.I. The chief designer at the Tokyo Gas Electric was a former engineer at the French airplane manufacturing company, DeWoitine. Accordingly, the basic design of the planned airplane closely followed its monoplane, D33. The only notable difference between the two was to make the new airplane's gears retractable. The retractable gears became widely used during the 1930s. But when the A.R.I. plane was planned, they were not popular and the modeled DeWoitine D33 was without retractable gears, because its wings were too thin to hold them. Banri Hirotsu, who was in charge of the design and construction of this retractable gears, consulted American aeronautical journals, and adopted the design which used ropes to retract the gears. But this work turned out the bottleneck of the whole project. The retraction necessitated the complex mechanism owing to the already fixed design of the wing construction. Tomizuka discusses retrospectively that designers of other parts should have compromised for the sake of the gear designer so that the wing would have a enough space for the appropriate position. However, the work of the wing design had been already finished, and director Wada decided to do with the problem of gear design with minor modification without changing the already fixed wing design.

Tomizuka provides an adequate institutional analysis on the cause of this technological problem. For a large engineering project, it is necessary that the project leader should take an initiative to judge the total efficiency of the project as a system. The leader thus should have to order the decrease of efficiency of some components so as to increase the efficiency of other parts. However, the A.R.I. consisted of fairly independent departments, and the role of the director was no more than a reconciliator when it came to the details of the component design. The problem of the retractable gears delayed the whole project one year. The initial construction of the airplane was completed and tested in April of 1937, but the retractable gears were immediately damaged. To redesign it, Tomizuka was called in and successfully redesigned. The complete airplane was thus made in December that year. Its flight was waited until May 1938 following advice of meteorologists. And on May 15, it attained the record of 11,651 km after its 63 hour flight.[63]

The success of Kōkenki was followed up, by the project of A26. In his autobiography, Kimura recalls that during the process of the performance test of the Kōkenki, he came up with many new ideas about further improvement of the design of this plane.[64] A few years later, Kimura's dream became realized. In 1940, the A.R.I. was approached by the Asahi Newspaper Company which proposed to develop and construct a long range airplane.[65] The A.R.I. responded affirmatively, and many of its members started to be involved with the new project. At the first meeting, President of the Asahi Newspaper Company stated that the proposed airplane, later named as A26 standing for Asahi and the first two digits of the year in the new century of the Japanese calendar, should have a cruising range of 15,000 km to fly from Tokyo to New York with 3 to 5 crew members.

Thirty five year old Kimura was responsible for designing important parts of the airplane. According to his autobiography, he considered that the aspect ratio of its wings was a key factor in designing the new airplane. The project was conducted by the two divisions of engineers working on the airplane body and the engine, and the division of the airplane body consisted several subcommittees including the basic design, propeller, structure, seat, material, and instruments.

63. The record was superseded by an Italian airplane next year. Takehiko Hasimoto, "Kōkenki," in Nihon Sangyo Gijutsushi Gakkai, ed., *Nihon Sangyo Gijutsushi Jiten* (*Encyclopedia of the History of Industrial Technology in Japan*) (Kyoto: Shibunkaku Shuppan, 2007): 248–249.

64. Kimura, *Hikōki Jinsei*, op.cit., p. 142.

65. On this project, see ibid., pp. 140–147, and Nihon Kōkū Gakujutsushi Iinkai ed., *Wagakuni Kōkū no Kiseki: Ken 3, A-26, Gasu Tābin* (*The Orbit of Japanese Aeronautics: Ken 3, A-26, and Gas Turbine*) (Tokyo: Maruzen, 1998), pp. 123–227.

Kimura participated all these subcommittees. At the divisional meeting of the airplane body, they discussed the appropriate aspect ratio and decided it to be 11 after the comparison between 10 and 13. For that decision, Kimura studied the function of the cruising range taking into account a variety of aerodynamic and structural factors and reached this conclusion.

As for the standard of the strength, it was discussed at a meeting of the division of the airplane body that the standard of the strength in principle was to follow the standard designated by the Aeronautical Council. But it also added that any inappropriate items in the official standard to be applied to the long range airplane should be investigated at the subcommittee of structure and modifications should be proposed.[66] The problem over the standard which had been crucial at the trans-Pacific project was in a sense built in as a constitutional factor in the project conducted at the A.R.I. For that, Kimura certainly should have played a crucial role.

7. Conclusion

I have shown above that though entirely forgotten from our memory, the trans-Pacific project of the Imperial Aeronautic Association after Lindbergh's success in trans-Atlantic flight developed into a national event, partly due to the successful effort of the propagation committee of the project as well as of editors of various national newspapers. It however did not become a historic event and quickly disappeared from pages of newspapers after the frustrating failure of the project. The constructed two airplanes for the project only showed poor performance, and the project was entirely halted.

Many historical accounts of this project blame the Aeronautical Bureau for its too rigid application of the newly established standard of airworthiness to these airplanes designed for special purpose. Kawanishi side claimed that their airplane should be able to make the

66. The minute of the first meeting of the Division of Airplane Body held on March 18, 1940. Ibid., p. 132.

flight at their calculated strength. Yamamoto at the A.R.I. more specifically recalls that the Bureau regarded the Kawanishi plane in the different category from the one usually allocated for special purpose planes. Consequently, the compromised planes gained their redundant weight and decreased their cruising range. However, close reading of newspaper clips tells us that the real story was not so simple as accounted by Yamamoto. At its initial test, the Aeronautical Bureau regarded the plane as the second category, and yet it concluded that the strength was below the standard. And later on the Executive Committee decided to register the plane initially as the first category, but apparently the Bureau refused to permit the change of its category despite the Committee's intention. Besides, we could say from the side of the Bureau that their members duly followed the recently established the aeronautical standard, and apply it strictly to the Kawanishi plane. Their conduct was ethical. It was so for sensible engineers, considering the possibility that the imperfect plane would have flown and disappeared over the Pacific, and the disastrous effect of such an accident on the recognition of Japanese engineering.

The crux of the problem centered around the standardization of the structural strength of the airplanes. Iwamoto and Kimura at the A.R.I. sharply realized the problem, and initiated the fundamental analysis of the engineering problems of the standardization. Kimura closely studied the newest German standard of airplane structure, and compared it with the American one. He concluded that the German one was more efficient though more complicated, while the American one was simpler but less efficient. He judged so, because he realized the fundamental conflict between standardization and individuality. Standardized airplanes cleared minimum safety standards, but necessarily had redundant performance in specific conditions. The consideration on these characteristics of the standard setting led to the selection of the German standard, and the new Japanese standard thus basically followed the German one.

Kármán who visited Kawanishi to assist its engineering work including the construction of its wind tunnel and the design of the propeller of Sakura, made a few comments on the Japanese characteristics of engineering work in his autobiography. He recalled an episode at Kawanishi that its technicians followed what was designated on Kármán's drawing so exactly that the constructed apparatus became useless having the two holes which did not meet. Realizing this Japanese tendency of the "slavish imitation," he stated he came to emphasize the importance of originality while in Japan. At its footnote, he added a comment after the war he witnessed the good performance of the Zero:

> Japan's reputation for copying the designs of other nations led a number of foreigners to conclude that Japan would never be a first-rate power in the air. But Japan startled the world when she unveiled the Zero, an excellent fighter plane in World War II. The result was the discovery that Japan had learned not to copy slavishly but to select the best aspects for imitation. So while I urged the Japanese to do original work when I was there, and I think this was the correct approach for them, I must admit now that talent for copying sometimes can lead to surprisingly good results.[67]

Kimura at the A.R.I investigated the standard of airworthiness precisely as Kármán characterized Japanese engineering in this footnote. He compared and examined German and American standards, and selected the German one to follow closely in order to develop the Japanese original standard. Although the selection was reasonable on the standpoint of making higher performance airplane, it would be possible to point out that the selection of complex standard made it more difficult to attain mass producing manufacturing system in Japanese aircraft industry.

Based on these experiences, the A.R.I. succeeded in making two long range airplanes in the 1930s and the 1940s. The A26 plane was originally designed to fly from Tokyo to New York over the Pacific Ocean, but was unable to do so because its construction was not completed until a year after the Japanese attack on the Pearl Harbor. Its aim to attain friendship between the two countries was unrealized due to the war.

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67. Kármán, op.cit., p. 132.

The answer to the trivial quiz stated in the introduction of this chapter was Clyde Pangborn and Hugh Harndon. They succeeded in making two-day-long non stop trans-Pacific flight from Sabishiro in Hokkaido to Wenatchee in Washington State in October 1931. Yusuke Edo, who has written a book on the story of their accomplishment, analyzes the reasons of their success as well as of its quick neglect in history. He calls attention to Pangborn's skillful operation as a pilot, and to the political backdrop of increasing antagonism between Japan and the United States which finally led to the war.[68] During the difficult flight, Pangborn, a noted acrobatic pilot, hanged out of a window and dropped ices stuck on a wing by a stick. After he had flown over the Pacific and finally made risky landing without wheels at Wenatchee, he allegedly offered to his waiting mother the apple he had brought across the ocean, saying, "Friendship from Japan."[69]

68. Edo, op.cit, pp. 182–184 and 191.
69. Edo, op.cit, p. 189.