Dynamique des lieux et de la technologie dans un secteur naissant

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Résumé :

De nombreuses recherches ont montré l'impact des lieux sur l'innovation. Toutefois, peu de travaux s'intéressent à la relation entre les lieux et les technologies au cours du temps. Pour étudier cette relation, nous avons réalisé une étude de cas historique de l'aviation commerciale depuis ses débuts jusqu'au transport de masse en 1960. Nos analyses montrent une relation récursive entre les lieux et les technologies qui a évolué au cours du temps. Les lieux ont d'abord eu un impact sur l'émergence de l'industrie et ont orienté le choix entre les technologies, puis les technologies ont été améliorées pour mieux s'adapter aux lieux. Enfin, les lieux ont été adaptés à la technologie choisie, ce qui a conduit à une standardisation à la fois des lieux et des technologies.

Mots-clés : Matérialité, technologie, lieu, étude de cas historique

The dynamics of place and technology in an emerging industry

INTRODUCTION

Research on materiality has grown over the past decades to better understand how the interrelationship between the social and material relate to organization, and technology has been one of the primary focus of attention (e.g. Barley 1986; Barrett et al., 2012; Orlikowski, 2007; Pickering, 2001). Materiality includes artefacts and spaces that are necessarily interrelated as usage of objects occurs in a space (Suchman, 2007). As put by Barley's (1986: 106) study of how the introduction of CT scanners triggered a restructuring of social exchanges in hospitals "the scanners occasioned change because they became social objects whose meanings were defined by the context of their use."

The location where industries emerge has been a topic of interest for a long time across several disciplines. For example, Saxenian's (1994) famous comparison of Silicon Valley and Route 128 has demonstrated the impact of location on innovation and industry development. However, new conceptions of place invite to bring back in organization studies (David, Jones & Croidieu, 2023). Conceptions of place in social geography define it as being socially constructed (Massey, 2005). Place involves location, material and meaning that makes it evolve over time (Cartel et al., 2022). The importance of meaning in the definition of place has already been used to study the emergence (Tarchen & Garud, 2023) or evolution (Lounsbury, 2007) of industries. However, considering places as spatio-temporal events (Massey, 2005) offers the possibility to complement extant research by looking at how organizations relate to places in addition to the usual focus on the impact of places on organizations. Such processual

perspective in which organization and place are intertwined is called for by Sergot & Saives (2016).

Our research aims at exploring how places and technologies evolve over time in emerging industries. For that purpose, we conducted a historical case study of commercial aviation until the advent of mass transportation at the end of the 1950s with a focus of Europe and the US. Building on affordance mechanisms, our analyses highlight how both place and technology first enabled of development of the commercial aviation. Our findings further highlight that places that first influenced the pace of industry emergence lose their importance over time as technology improved and actors shaped the place to fit their needs. Our analyses contribute to a better understanding of the dynamics between materiality and place as industries develop.

1. THEORETICAL BACKGROUND

Materiality emphasizes that artefacts and spaces are socially constructed. Relationships between the material and the social have been the object of much debate. In particular, some defend that the material and the social are co-constitutive (e.g. Orlikowski, 2007) whereas others draw on the concept of affordance to indicate intertwined or imbricated relationships (Pickering, 2001; Leonardi, 2017). All these authors point out the non-deterministic use of technologies and emphasize how the ways actors integrate them into practice impacts the consequences of technological properties (Orlikowski 2000). Leonardi (2011) argues that affordance is the main mechanism through which materiality is produced.

1.1. AFFORDANCE

Originally coined by ecological psychologist Gibson (1966), the concept of affordance refers to environmental properties that allow and constrain action. In a study of aircraft pilots'

skills in World War II, Gibson found that he had to consider actors and artifacts together as the unit of analysis. He reasoned that the environment has a number of properties that may be interpreted differently by different people. Affordances thus are "properties of things *taken with reference to an observer*" (Gibson, 1986: 127, italics in original). They are both enabling and constraining, or as Gibson (1966: 285) put it, are "what things furnish, for good or ill." Although artifacts and actors exist independently from one another, The potentials and constraints of artifacts and actors can only be theorized as affordances in their interwoven relationships (Zammuto et al., 2007).

This relational perspective has been adopted in much research on technology. A famous example is Barley's (1986: 106) study of how the introduction of CT scanners triggered a restructuring of social exchanges in hospitals. As noted by Davis and Chouinard (2016: 241), "the analytic import of affordance is its capacity to recognize technology as efficacious, without falling prey to technological determinism" (see also Davis, 2020).

The concept of affordance attracted attention outside of its original field and was further elaborated for specific purposes. Norman (1999) emphasized that designers need to distinguish between real and perceived affordances to ensure objects' functions are immediately perceived by users. This separation aiming at designing artefact appears also in Leonardi (2017). Fayard and Weeks (2014) further proposed a distinction between two dimensions of affordance: dispositional (i.e., affordances exist independently, regardless of whether they are perceived by actors) and relational (i.e., affordances are relative to the perceiver). They also proposed to shift the focus from artifacts to practices. With this extension to design, the concept of affordance can be used to study conception of artefacts in addition to their use.

Finally, affordances are contextually situated (Davis, 2020), in that a given actor can use a given artifact differently based on the situation. For example, one can use a cellphone as

paperweight if there is a sudden gust of air. Affordance is thus relevant to study the dynamics between place and technology.

1.2. PLACE

Place includes location, material forms it contains and meaning (Creswell, 2009). This definition of place comes from social geography, particularly Massey (2005) who defined place as socially constructed. A place is physically constructed as people can create, maintain and destroy it and socially constructed as its inhabitants interpret, narrate and imagine it (Cartel et al., 2022). Thus, interpretation relates to past, present and future. The concept of place is unrelated to a scale, from a location within a room to the entire world (Cresswell, 2009). In this socially constructed perspective, place can be more than a context for organization studies (David, Jones & Croidieu, 2023).

Materiality studies have mainly focused on artifacts but place has been "brought back in" to organization studies (David, Jones & Croidieu, 2023). Place features include physical geography, public policies, tradition and history (Marquis & Battilana, 2009). Several studies have shown the impact of place on industries. For example, Lounsbury (2007) showed how Boston and New York gave rise to distinct institutional logics in the mutual funds industry. Because of their history, places can display social structures or norms that impact the diffusion of innovation. For example, Tarchen and Garud (2023) showed that historical contingencies lead the US and the UK to categorize e-cigarettes differently as tobacco and non-tobacco products respectively, which impacted the diffusion of the product. However, these studies focused on place as original context, leaving reverse relationships from technology to place unexplored.

2. METHODS

To understand how place relates with the development of commercial aviation over time with conducted a historical case study. We selected the case of commercial aviation because materiality in usage was prominent and related to place which enabled rich analyses. Data were abundant, with primary documents providing detailed information about actors, events and regulations from the beginning of aviation. Technological features of planes were recorded from the early days, which enabled us to investigate materiality its relationship with places over time. Finally, because flying has been a fascination for many throughout history, we could tap into countless secondary documents and historical accounts. Among the various actors of the industry, airline companies were the major actors who drove the evolution of technologies by defining requirements in calls for tender in terms of performance of the plane, choosing the type of plane, negotiating routes and building or shaping choice in infrastructures.

2.1. DATA COLLECTION

We spent more than a decade amassing data housed primarily in specialized libraries and aviation museums in different countries. We used historical accounts of commercial aviation (e.g., Davies, 1964; Sutton, 1999; Mowery & Rosenberg, 1981; Trimble, 1995; Nicolaou, 1998) to define the period of investigation and identify episodes during the process. These secondary documents enabled us not only to understand the arc of the story, but also to notice the distinction between Europe and US at the beginning of the industry. We thus compared evolution over time in each place. Through several iterations, we eventually identified three groups of factors related to plane features, usage by airlines, and historical and geographical environment. Our analyses led us to conceptualize these into three dimensions of materiality—functional, relational and situational—and we complemented our data by collecting more on each dimension as specified below.

To capture the material features of airplanes, we focused on characteristic features of planes. Following previous research (e.g., Frenken & Leydesdorff, 2000; Saviotti & Metcalfe, 1984), we focused on each plane's speed, range and disposable load. These three measures, part of what are known as "service characteristics of products," capture the intended usage of planes. We collected these data from *All the World's Aircraft*, a volume published annually by Jane's Information Group and recognized as the most reliable source of information on the aviation industry. Each volume provides detailed data on airplanes, including prototypes and planes in production. We collected data for all commercial airplanes having flown beyond test flight stage, reasoning that functional properties of prototypes had not yet been proven.[1] To identify commercial airplanes, we selected those labeled "airliner" or "commercial transport," as well as those described as suitable for "passenger services" or able to transport a certain number of passengers, since the airliner and commercial transport categories did not exist at the beginning of our window of observation. We cross-checked our database with lists of airplanes used by airliners before 1960, using mostly Davies (1964) and fleet listings of early companies in France, the UK, and the United States. This led us to identify a few additional airplanes, such as four-seaters at the beginning of the period and bombers converted into commercial airplanes after war. Our database ultimately contained 342 models of commercial airplanes. We recorded cruising speed (or maximum speed for early airplanes), and range. We collected the maximum take off weight and the empty weight and obtained disposable load by subtraction (Smith, 1983). When empty weight was missing from the Jane's volumes, we used data available on the Internet and contacted manufacturers and museums.

[1] Accordingly, our database includes a few planes that were never sold to airlines even though they had demonstrated their functional properties, and excludes a few well-known planes documented in records that never flew properly. For example, we included the Saunders-Roe Princess flying-boat that successfully flew, yet was never incorporated into commercial operations. (BOAC eventually canceled its order and the three that had been built were scrapped.) However, we did not include the famous Hughes Aircraft H4 Hercules flying-boat because it only flew once for about 1 mile in 1947.

To collect the practices of airline companies, we read secondary documents airlines, newspaper articles, accounts written at the time, and more recent historical accounts. We also collected data on major airlines: Pan Am for the US, Air France and Imperial Airways (later BOAC) for Europe.[2] U.S. carrier Pan Am, dubbed the world's greatest airline, was a driver of usage by creating routes and introducing new aircrafts (Davies, 1987). France, the UK and Germany dominated the European market until World War II, after which German operations ceased for more than a decade. We thus focused on the leading companies in France and the UK to capture dynamics in Europe. We collected data on Pan Am's fleet from the company's founding in 1927 to 1960 using files from the Pan Am museum that we crosschecked with Davies (1987) and annual reports from 1928 to 1960 listing airplane investment decisions. Similarly, we documented the evolution of Air France's fleet using data from annual reports from 1934 to 1939 and 1948 to 1960 that we obtained from the Musée Air France and the company's archives. Data on the fleet operated by Imperial Airways and BOAC came from Higham (1960) and the Air-Britain website. In addition, a great many articles and advertisements produced throughout our study period complemented our data, thus enabling triangulation with other sources.

Finally, even though our window of observation closed 70 years ago, we interviewed several people with deep knowledge of the commercial aviation industry including the head of R&D at Airbus, two aviation historians specialized in the period of interest, the president of the Musée Air France, and the head of specialized aircrafts at Bombardier, the only remaining maker of flying-boats (currently used only for firefighting purposes). We also benefited from informal conversations with archivists, authors and enthusiasts we met in public and private libraries of airlines, manufacturers and public organizations.

[2] Companies changed names over time, usually following mergers. Here, we use their best-known names.

2.2. DATA ANALYSIS

Following Langley (1999), we built a narrative that chronicled commercial aviation from its inception in 1919 to the end of our study period in 1960 which is the advent of mass transportation (Ellison & Stafford, 1974). These fourteen years are characterized by the coexistence of two types of airplanes: landplanes, which take off from and land on airport runways; and flying-boats, which take off from and land on water. In 1910, air transportation experiments involving both mail and passengers began in Europe and the United States, and in 1914, the world's first airline established a passenger route in Florida between Tampa and St. Petersburg using a Benoist XIV flying-boat. Aviation specialists trace the birth of commercial aviation to 1919, after nearly a decade of experimentation, because several airline companies were founded around the world (Davies, 1964; Nicolaou, 1998). We also constructed 4 chronological databases: place, airplane features, airline company practices, other events, and systematically look for relationships between the four components.

We then turned to temporal bracketing analyses (Langley, 1999), and split our window of observation into 4 periods consistent with most historical accounts of commercial aviation: the rise of commercial aviation (1919–1927), expansion toward others continents (1927–1934), the conquest of transoceanic routes (1934–1939) and the new area of commercial aviation (1944–1960).

3. FINDINGS

Our analyses highlighted two types of affordances, one originating from place and the other from technology. Airline companies drew on both places and aircraft technologies to open routes and operate them with the aircrafts they considered the more appropriate. In turn, they ordered specifications of aircrafts including the type (landplane or flying-boat) and the required performance. They also shaped places while building infrastructures to ensure the delivery of

the service to passengers. As everything is situated, history impacted the relationship. In particular, the two world wars directly impacted aircrafts technologies, subsequently generating new technologies for airline companies.

Figure 1 shows the analytical framework we came up with for our bracketing analyses. Although the four relationships hold all over the period of observation, their relative importance differed over time, as shown below in the four periods organizing our findings.

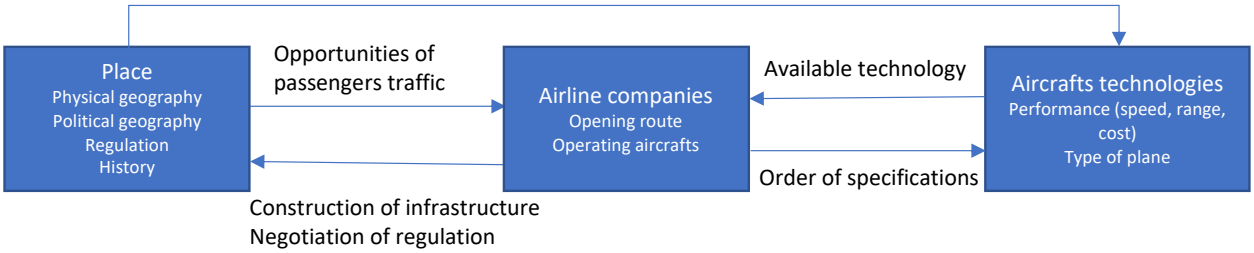

Figure 1. Analytic framework relating place, practice, and technology

3.1. THE RISE OF COMMERCIAL AVIATION (1919–1927): EUROPE AS A BETTER PLACE THAN THE US

In 1919, commercial aviation services began to be offered all over the world (Davies, 1964) partly due to the large surplus of airplanes from the war that could be acquired inexpensively and because pilots that were available for recruitment. Airplanes did not easily compete with trains, which were faster, safer and more comfortable. As passenger service was not profitable, airlines either specialized in mail only or combined mail and passengers. However, despite similar resources – similar planes with similar performance- the pace of development differed between Europe and the US because of 3 features of their respective places: physical geography, political geography, and regulation.

3.1.1. Rapid growth in Europe, driven by the small size of countries surrounded by seas, and safety regulations

Airlines began to flourish in 1919 just after World War I in Europe. Several airlines offered daily passenger services between London and Paris in 1919 (Davies, 1964: 15), some using five-seater Spad landplanes.

The physical geographic environment contributed to shaping commercial aviation in several ways. It partly explains the competition faced by the early commercial aviation industry—namely, trains on continental routes and boats on overseas routes. Although airplanes of the time were still slow (traveling at speeds less than 150 km/h; Davies, 1964), they saved time when crossing seas. Since early airplanes were faster than boats, but slower than trains, the prevalence of water in Europe favored the development of commercial aviation. Many cities in Europe are coastal and have strong relationships with countries located nearby, but separated by water (e.g., the British Isles, Scandinavia, Africa). Crossing water even for a small part of the travel was sometimes enough reason to choose flying over other modes of transportation because it saved time. For example, the route between Paris and London was highly successful from the start because passengers did not have to change means of transportation to cross the Channel.

In addition, geographic considerations largely determined which planes were used to service specific cities. Airline companies chose landplanes or flying-boats depending on the availability of flat pieces of land or calm water (i.e., a bay, river or lake) nearby. The biggest airline companies often operated both types of planes depending on the routes served. Imperial Airways in Great Britain and Aéromarine in France used landplanes on continental routes and flying-boats on overseas routes and to destinations with underdeveloped infrastructure.

In addition to its physical component, political geography impacted the development of commercial aviation, especially at the international level. The first transcontinental airline,

Compagnie Franco-Roumaine de Navigation Aérienne, was founded in 1920 and began service between Paris and Constantinople in 1922 (Herlea, 1995: 58) using a four-seater Potez 9 landplane (Davies, 1964: 30). In fact, airplanes made it possible to bypass customs checkpoints between an origin and a destination (Bilstein, 1969). As noted by Edwards and Tymms (1926: 112): "It may not be realized what a tremendous saving of customs delay is effected automatically by the use of air transport. The whole of the "en transit" clearance by agents, involved at every trans-shipment point in surface transport, is eliminated. Thus, goods consigned by air to Malmö, although transferred to a Swedish aeroplane at Amsterdam, do not come under the purview of the customs authorities in Holland."

European regulation also favored commercial aviation because it included safety recommendations, of major importance for passengers. The first regulation governing airspace usage was implemented in 1919 in response to increasing air traffic. The Paris Convention recognized states' sovereignty over their airspaces and was signed by 27 countries, but not the United States. It also stipulated safety recommendations such as licenses for pilots and international rules, including signals, collision prevention and procedures for landing and taxiing. As a result, travelling by air was relatively safe in Europe, with few fatal accidents.

3.1.2. Slower development in the US due to physical geography and lack of safety regulations

Like Europe, the US benefited from the large surplus of airplanes and pilots but used it differently because the places were different. Unlike Europe, surrounded by water and composed of many small countries, the US is a vast country spanning a continent with a large domestic market, which lowered incentives to develop commercial aviation. The two places used war surpluses differently. One example is the Airco DH4, which was massively produced during World War I in both the UK and the United States. Surplus DH4s were sold after the

war and used to carry mail in the United States while being converted to passenger airplanes in the UK. The passenger services started slowly in the United States with a few passenger airlines operating flying-boats to transport passengers on coastal routes, mostly between Florida and the Caribbean Islands (Davies, 1964: 43). For example, during prohibition in the 1920s, Aeromarine Airways used flying-boats to carry American passengers to nearby places where alcohol consumption was legal, such as the Bahamas and Cuba. U.S. Post Office (USPO) planes did not carry passengers. A few seats for passengers were integrated only after 1925 (Mowery & Rosenberg, 1981).

In addition, flying at that time in the US was dangerous as this country did not signed the Paris Convention and had no equivalent regulation. As a result, no license was required for pilots. Life expectancy for an airmail pilot in the United States was a mere 900 flying hours.[3] Safety improved slowly, and by 1927, traveling by air in America was described as adventurous, not suicidal. Still, a coast-to-coast trip took 32 hours in a spartan 4-seater, and passengers risked being replaced mid-trip by sacks of mail that were more profitable (Bilstein, 1995: 92).

3.1.3. Shaping places to ensure commercial aviation development

The small range of planes and the lack of reliability of engines required important infrastructures. Each landplane route required a parallel infrastructure on the ground to guide pilots, refuel and change motors. Additional emergency fields with little infrastructures complemented the route because of the lack of reliability of engines. In total, there were numerous infrastructures on the ground for landplanes as the lack of navigation instruments at that time required the pilot to see the road from the air.

[3] In 1919, one pilot died for every 115,325 miles flown, which is about 22 round trips between New York and San Francisco. In 1926, it was 20 times better (source: Smithsonian National Postal Museum).

Required infrastructure was more limited for flying boats because the route often followed an easy to see coast, they were able to use existing harbors, and could land on any calm water in case of emergency.

In addition to place, technology had evolved, providing airlines companies with bigger planes created to carry passengers, although passengers traffic was still low. For example, on the route from London to Paris with the greatest passenger traffic, planes carried, on average, only 1.8 passengers in 1920 and 4 passengers in 1925 (Edwards & Tymms, 1926: 117) although the new planes could transport 12 passengers instead of 4 in 1920. At the end of the period, commercial aviation had become safe even in the US, as proved by the drop of premiums by insurance companies. With bigger planes and safer travels, airline companies engaged to expand routes outside of their respective continent.

3.2. EXPANSION TOWARD OTHERS CONTINENTS (1927–1934): A CHOICE OF FLYING BOATS DRIVEN BY PLACE

After having developed internal continental networks, the European airline industry consolidated, giving birth to Imperial Airways in Great Britain in 1924, Deutsche Luft Hansa in Germany in 1926, and Air France in France in 1933. Similarly, the Hoover administration supported consolidation of the U.S. airline industry, leading to the establishment of "the big four"[4] in the domestic market, and Pan Am, which had a monopoly on foreign markets. Consolidation increased resources and investments in better flying equipment (Davies, 1964: 133) and the establishment of intercontinental routes. Both Europe and US followed similar paths of reinforcement of internal continental networks and extension to connect to other continents. Accordingly, European airlines created routes to European colonies (mostly in Africa and Asia) whereas the US Pan Am opened routes in South America.

[4] The "big four" airlines were American Airlines, Eastern Airlines, Trans World Airlines, and United Airlines.

3.2.1. Choosing flying-boats because of place

Others continents are different types of places from the two where the nascent industry emerged. They are distinct in terms of physical geography and history. Asia, Africa and Artic have more extreme weather that impacts technological choices, and sometimes raised barriers for airplanes. For example, Charles Lindbergh, acting as a consultant for Pan Am, advised the company to abandon its planned Artic route to the Orient in 1931: "Flying-boats could not be operated from ice covered water…Airports for landplanes would be expensive to construct and maintain in sub-zero temperatures. Strange electronic phenomena created new problems for radio communications" (Leary, 2005: 58).

In both Europe and the US, the lack of infrastructure led airline companies to prefer flying boats over landplanes. Edwards and Tymms (1926: 136) explained that although landplanes were cheaper to manufacture than flying-boats, savings were offset by the costly infrastructure required: "In spite of the disadvantages associated with marine aircraft, there are other factors to be considered, which may, in many cases, render it desirable that they should be used; for example, on routes which involve long sea flights, or on those which follow a mountainous or difficult coast line which is badly supplied with land communication, or again on those which cross country mainly composed of forests and lakes. The cost of providing the necessary ground organization on many land routes would be prohibitive, and in such cases, it will be cheaper in the long run, and generally safer to operate with the more expensive type of aircraft. It may be accepted that in ninety-nine cases out of one hundred, a sea route in infinitely cheaper to prepare, equip, and maintain than a land route."

3.2.2. Shaping the places

Place was mostly shaped in two ways: through changes in infrastructure, and through changes in regulation. Although flying boats had been chosen to reduce the costs of ground infrastructure, some adjustments were necessary to transform harbors in sea bases. Further, the increased size of planes on continental routes made landing on a grass field complicated. It thus required to model the field to make landing safer. In addition, increased traffic on international routes beyond once own continent led many countries—and for the first time, the United States— to ratify the Warsaw Convention in 1929, which regulates liability for goods, luggage and passengers transported internationally via airplane. In doing so, nations shaped places by foregoing legislative prerogatives and embracing international regulation.

Thanks to improvements in the range of aircrafts by the end of the 1920, the idea of regular transoceanic airline service for commercial purposes emerged (Davies, 1964: 218).

3.3. THE CONQUEST OF TRANSOCEANIC ROUTES (1934–1939): ORDERING TECHNOLOGIES FOR THE APPROPRIATION OF PLACE

3.3.1 Places constraining technological performance

Contrary to intercontinental routes, oceans offer little physical possibility to stop, except a few islands and require enough range to cross the ocean. Both Europe and the US first chose flying-boats to overcome the challenge because they outperformed airplanes in terms of range and could land on water if needed. Airline companies thus shaped technological development by commissioning aircrafts with very specific characteristics to master the challenge of the oceans. For example, in 1931, Pan Am specified a "high speed multi-motor flying boat having a cruising range of 2500 miles against 30-mile headwinds, and providing accommodation for a crew of four, together with at least 300 pounds of mail." This choice of flying-boats technology

was based upon perception that "safety comes before speed" for passengers on commercial flights (Captain Bonnot, 1936, as cited in Bousquet, 2006: 13).

The mid-1930s was dominated by competition between nations to open transoceanic routes. These investments proved successful for Pan Am, which began to offer transpacific service in 1936 with a Martin-130 flying-boat and transatlantic service in 1939 with a Boeing 314 flying-boat. Travel via these flying-boats was not only a fast means of transportation, but also a luxury experience emulating that of a cruise ship (see Figure 2).

Figure 2.— Interior designs of a Short Empire flying-boat (left) and a DC-3 landplane (right)

3.3.2. Shaping the places with massive infrastructures

The size of flying boats required sea bases that sometimes needed significant investment. For example, the route to cross the Pacific Ocean required significant infrastructure despite the use of flying boats because one the required stop was a tiny inhabited island of Wake. Thus, Pan Am had to create a sea base, equipment facilities for the plane, a hotel for passengers, and storage for food and fuel.

Although flying-boats achieved records and offered services that no other aircrafts could, by the end of the 1930s, improvements were made to landplanes. The DC-3, the first plane with operating costs that made passenger transport profitable, first flew in 1935. This generated a shift in investments for long range airplanes. For example, in 1936, Pan Am, which previously had commissioned only flying-boats, invested in landplanes such as the Boeing 307. The decision was backed by Charles Lindbergh: "I am glad that you are developing a landplane [the Boeing 307] in addition to the new flying-boats [Martin M 130 and Boeing 314]. I believe that it is probable that the landplane will replace the flying-boat on all important routes in the future…It is important to keep in mind that planes can now be built better, by a fairly large margin, than any we have yet ordered." (Leary, 2005: 61)

3.4. THE NEW AREA OF COMMERCIAL AVIATION (1944–1960): SHAPING PLACES TO ADAPT TO TECHNOLOGY

The consequences of WWII on commercial aviation were numerous and complex. WWII first slowed and then boosted a new aera for commercial aviation.

3.4.1. Technological improvements led to the domination of landplanes

World War II impacted commercial aviation by halting the development of commercial operations and then by shifting the evolution of relative performance between flying-boats and airplanes. First, the war interrupted the manufacturing of giant flying-boats designed before the war (Nicolaou, 1998: 150). Further, marine aviation did not benefit from the enormous investments in R&D and production made during the war, which were focused on landplanes because flying-boats were deemed ineffective against fighters (Nicolaou, 1998: 115). As a result, only 10,000 flying-boats were built during the war, in contrast to over 100,000 landplanes, which greatly improved their engine reliability. In addition, innovations such as the

landing gear solved the shock-absorption problem for big landplanes, thereby negating a competitive advantage once held by flying-boats. Finally, successful tests of the jet engine on fighters sparked a vision for a new generation of higher speed commercial airplanes. In 1943, the UK government's plan for the future of commercial aviation involved the development of jet landplanes for commercial purposes.

3.4.2. Adaptation of places to landplane technology and passenger service

World War II not only produced a vast surplus of bombers that could be converted inexpensively into commercial airplanes but also many runways that were built for bombers and fighters in areas that previously had lacked appropriate infrastructure. These runways were able to accommodate large landplanes, thus eliminating the infrastructure disadvantage they had against flying-boats.

In addition, regulation extended worldwide standardizing practices in every place. In 1944, the United States organized the Chicago Convention that created the International Civil Aviation Organization (ICAO, an agency of the United Nations) and introduced the "freedoms of the air" and safety regulations, including certificates for aircrafts and crews. The next year, 57 airlines created the International Air Transport Association (IATA) to promote safe and economical air transportation.

Finally, the influence of geography declined. Improvements in reliability and infrastructure for landplanes during World War II were so significant that many airline companies switched to all-landplane fleets. Post-war surpluses created even more incentives to do so. For example, DC-3s had been produced in great quantities and were adapted for civilian use after war, including by Air France when it restarted operations in 1945. A few airlines such as BOAC and Air France continued to use some flying-boats to service colonies with specific geographies. However, by the end of the 1950s, both airlines had stopped using their flying-

boats due to a lack of reliability and sold them to small companies that operated them until the end of the 50s.

In 1952, BOAC introduced a new generation of landplanes with jet engines. Its Comet jetliner reduced the travel time between London and Tokyo from 86 to 33 hours (Taylor, 1993). New jetliners opened transatlantic services in 1958, and for the first time, more passengers crossed the Atlantic by air than by sea. This marked the start of the era of mass transportation and the demise of flying boats.

4. DISCUSSION

Our study aimed at analyzing the dynamics of place and technology in an emerging industry. Our study of commercial aviation showed a recursive relationship between technology and place, orchestrated by actors, and mainly airline companies. Consistent with literature, actors designed artifacts with required technological properties to perform certain functions (Garud & Rappa, 1994). In our case, airline companies shaped technological development by commissioning airplanes with specific characteristics. In turn, artifacts enabled and constrained what actors could do with them. For example, although airlines had envisioned transpacific flights for a long time, range limitations prevented them until 1936.

In addition, we highlighted a recursive relationship between places which also constrained and enabled practices. In turn, practices shaped place for the industry by expanding the set of possible places, shaping the geography of places by building infrastructure and by changing continental regulations toward international norms such as the "en transit" zones to help passengers to avoid customs checkpoints (Edwards & Tymms, 1926).

Over the first period, places influenced the pace of development (slowing and accelerating, depending on continents) and technological choices. During the second period,

places also impacted technological choices. The third period marked significant improvements of technologies and the beginning of massive infrastructure, according to places. The last period showed a standardization of both planes and infrastructures all over the world. Thus the evolution of technologies reduced the impact of place, except for regulations actors had put in place.

These finding contributes to materiality literature by developing the relationships between place and technology in an emerging industry. As noted by Orlikowski and Barley (2001: 149): "Every technology constrains and affords use… Although some constraints and affordances are malleable, others are not." Our findings are consistent with affordance literature. More than material properties, what matters is how artifacts and users interact in practice. Our study includes examples of different usages for a given artifact (e.g., the DH4) that contributed to the development of passenger transportation in Europe but airmail only in the US. Similarly, affordance hold to places. Our findings illustrate differential practices based on the geographies of the United States and Europe. These results echo works by Suchman (2007) and Barley (1986) documenting how the relationships between artefacts and practices are situated. For Douglas (2010: 301), situatedness is paramount: "the economic and political system in which the device is embedded almost always trumps technological possibilities and imperatives." Further, Pinch and Trocco (2002) showed that the relationship between materiality and context could work both ways, with the synthesizer being shaped by the psychedelic sixties and in turn contributing to shape it. Our research also illustrates a recursive relationship between technologies and context but further shows that the recursive process evolves over time to the point that technology tends to become independent of context.

Our study also contributes to place literature by showing that standardization can break ties to places. Our study has shown how place including physical geography and history contained meaning that supported the nascent commercial aviation. Europe and the US differed

in physical geography and did not give the same importance to safety in the early days, which impacted the pace of development of the industry. With the process of building standardized infrastructures, places became more similar all over the world. The development of the industry that was tied to places became less tied to them. This result resonates with research in geography that points out the lack of meaning of some places that are placeless or nonplace (Creswell, 2009). Incidentally, airports are in the list of examples of non-places by Auge (1995), as it refers to sites of transit to other places, with no attachment. Like this author, we found that places have lost part of their meaning in the development of the industry. However, rather than describing a place, our results aim at showing that the industry no longer has to fit the places, as it will build the places to fit its needs.

Our finding of the fading importance of place in shaping a nascent industry contrasts with Tharchen and Garud's (2023) observation for e-cigarettes. This contrast might point to boundary conditions to both studies. It might be that our window of observation being longer, we capture the entire process while they focus on the early stages. If so, the contrast in results is only apparent as theirs align what we document in the first phases. Another possibility has to do with the regulator, whose importance is stressed in both studies. The boundary condition here would be that our industry is eminently international, since flying mostly makes sense between countries. Accordingly, international laws were necessary, and international regulation bodies were established with ICAO and IATA. This helped to iron out international differences. In contrast, e-cigarettes can entirely be regulated by countries independently, which could explain lasting differences between countries. Time will tell, as the e-cigarette industry matures, which possibility yields most explanatory power.

This paper is not without limitations. We studied a single case which is specific with a process that unfolded in the previous century. More importantly, organizations and places are intertwined in complex ways. For simplicity, we chose to focus on the main actors, namely

airline companies, without denying that others actors also participated in the evolution of spaces and technologies. Without pretending that any emerging industry develops like the commercial aviation did, we hope that our study provides insights in the relationship between technology and place that may be relevant for emerging technologies which are currently unfolding such as the electric car.

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