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DOSSIER

Safety tested by humans and organisations

La seguridad puesta a prueba por humanos y organizaciones

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Abstract

In less than sixty years, civil aviation has been profoundly affected by a succession of revolutions in cycles of almost ten years. This article describes this development, its links with the human dimension and the changes in safety issues over time.

Resumen

En menos de sesenta años, la aviación civil se ha visto profundamente afectada por una sucesión de revoluciones en ciclos de casi diez años. Este artículo describe este desarrollo, sus vínculos con la dimensión humana y los cambios de los problemas relativos a la seguridad a lo largo del tiempo.

In just over half a century, the results of advances in aeronautical transportare of varied nature. On the bright side, commercial aviation has survived these revolutions; it is much safer, more global, still expanding, and holds a promising future. Safety in aviation has improved by a factor of almost ten during this period. The aircraft accident rate dropped from 7.10^{-6} in 1972 (accidents per million departures, statistical summary of global operations of commercial jet aircraft, source Boeing Statsum[1]) to 1.10^{-6} in 2017, and even fell below 10^{-6} in 2020.

On the downside, work, actors, and sociotechnical logics have changed significantly, as have business models, and aviation remains a colossus with feet of clay.

Six Revolutions over Sixty Years in the Civil Aviation Model, Continuous Improvement in Safety, and its Priorities

- 1970: Marks the end of the pioneering phase of aviation. In the 1960s, the risk of accidents was significantly reduced through a series of technically and organizationally important improvements (notably, engine reliability and the development of en-route air traffic control). Residual risk in the 1970s appeared to be primarily associated with crew malfunction and a lack of a shared safety culture. Loss of control in flight (LOC-I loss of control), observed in various emblematic accidents, combined technical events - often minor and controllable - with poor crew reactions. The 1970s marked the end of overly authoritarian captains, the "cowboys," non-standardized communications, and the implementation of controlled and regulated cooperation in the cockpit where dialogue was essential. Some important figures in the United States and the United Kingdom expressed this desire for change (Earl Weiner[2], Bob Helmreich[3], Jim Reason[4], to name the most well-known), advocating for new training methods, particularly Crew Resource Management (CRM). This made the system increasingly regulated and supervised.

- 1980: The cockpit changes; automation arrives and sets the pace in the 1980s and 1990s, which is crucial for transforming pilots. Ground collisions without confirmed loss of control - controlled flight into terrain (CFIT) - raise concerns. There are many safety fears, but the opposite happens after a decade of painful introduction, bypassing the 10^{-6} limit by the late 1990s at the cost of more intrusive human factors' regulations in training, operations, and certification. Zero-flight simulator training has become the international standard. CRM becomes a global cause with the support of the International Civil Aviation Organization (under the authority of Dan Maurino[5]).

> ***"Commercial aviation has survived several revolutions: it is much safer, more global, still expanding, and still holds a promising future."***

- 1990: The economic model changes. Traffic grows rapidly. International aviation, still largely reserved for privileged customers, seems to have unlimited potential. Access to airport infrastructure in major cities is a critical point for the expansion of this aviation. The issue of human factors is shifting towards the critical bottleneck of air traffic control capabilities to manage this traffic increase. Solutions operate on two fronts: one, initially imagined and then abandoned due to the impossibility of verifying, to date, the feasibility of massive automation; the other, much more developed, involves massive investment in compatibility logic and a single sky, particularly to facilitate continuous international control areas (see the example of Eurocontrol in Europe). On the airline side, the human priority is organizational with the advent of airport centers or hubs, seen as a solution to congestion.

1. Boeing Statsum. Available at https://aviation-safety.net/airlinesafety/industry/reports/Boeing-StatisticalSummary-1959-2017.pdf. This source contains all accidents, including hull losses, onboard deaths, and fatal accidents.

2. Wiener, E. L., & Nagel, D. C. (Eds.). (1988). Human factors in aviation. Gulf Professional Publishing.

3. Helmreich, R. L. (1984). Cockpit management attitudes. Human factors, 26(5), pp. 583-589.

4. Reason, J. (1990). Human error. Cambridge University Press.

5. Mauriño, D. E. (1999). Safety biases, training practices, and CRM: a middle point perspective. International Journal of Aviation Psychology, 9(4), pp. 413-422.

- 2000: Aviation becomes financially accessible to a broader population. Critical human factor issues shift towards passenger risk management. Aeronautics massively impacts a new category of middle and lower-middle-class customers and becomes one of the natural and privileged offspring of the globalization of the economy and tourism. The consequences of globalization also affect the aeronautical system, such as negative ecological factors for popular destinations (the so-called "over tourism"). At the same time, the weight of Asia is rapidly growing in the international aviation model, and low-cost carriers are invading the market, disrupting the certainties of major players. Market changes first hit large companies, which are too rigid, trapped in a cumbersome past, and a network that is often unprofitable for certain parts exposed to societal changes mentioned earlier, and disproportionate social and labor costs. Large companies invest in very large, long-range carriers, thinking that is the answer to the new demand explosion. This massive democratization poses new human factor problems related to passengers, the management of conflicts they can cause (rebel passengers), not to mention onboard medical care to treat increasingly common discomforts, given the increased power of long-range jumbo jets (the A380 is the perfect example).

- 2010: The sky darkens with predictions from the United Nations Climate Change Conference (COP27[6]) about the harmful role of aviation in greenhouse gas emissions (GHG) production. In this context, large aircraft will not be a convincing success, nor will long-range aircraft. The issue of Extended Range Operations with two-engine airplanes (ETOP) appears to be the solution, betting on reliable, fuel-efficient engines and single-aisle, long-range aircraft. We also witness an explosion of outsourcing, especially in maintenance and airport services, which complicates the system.

- 2020: The sky darkens with the COVID-19 crisis, and the growing pressure to reduce GHG emissions, significantly reshaping the aviation landscape, once again revealing the fragility of the globalization model. Telecommuting and video conferencing are gaining ground in businesses and will permanently change the habits of the business class. Market deregulation has been hailed as one of the most significant moments in commercial aviation in the past two decades. The low-cost model proves effective, with new and adapted aircraft, no long social history, and governance focused on limited and profitable goals. Additionally, in this system, they charge separately for each item, such as food, beverages, pre-boarding, carry-on baggage, and car rental services, to generate revenue apart from tickets. This, in conjunction with the widespread adoption of ticketless travel through the growing penetration of the Internet, is contributing to market growth. As a result, safety figures approach 107 at the cost of a systemic and global logic that definitively associates safe organizations, the economy, and technologies, encompassing both airlines and airport facilities.

"Safety has improved by more than a factor of 10 in 60 years (1962-2022). This spectacular progress hides an even greater gain, especially when considering that air traffic has increased sevenfold between the two periods (from 500 million to 3.5 billion passengers per year); that is, nearly 40 million flights per year with over 25,000 aircraft and 3,500 airports."

- 2022: The sky darkens again; war returns to Europe, slowing the global market.

- Beyond 2030: there are still many speculations as the aviation model has become global and systemic, increasingly sensitive to unexpected global-scale surprises.

6. United Nations Climate Change Conference. Available at https://unfccc.int/cop27.

A resurgence is announced, and the need for travel is rediscovered, but with what transformations in business models and organizations? Which companies? At what price? With what technology (automation, hydrogen, Sustainable Aviation Fuel - SAF)? In which market, with the growing weight of Asia and China as customers and as new players in aeronautical construction?

Six Lessons for Safety and the Human Dimension in Commercial Aviation:

- Safety has improved by more than a factor of 10 in 60 years (1962-2022). This remarkable progress conceals an even greater and larger gain when considering that air traffic increased sevenfold between the two periods (from 500 million to 3.5 billion passengers per year); in other words, nearly 40 million flights per year, involving more than 25,000 aircraft and 3,500 airports.

- The latest improvements were primarily achieved through human factors approaches focused on individuals or small collectives (cockpit crew) before being massively linked to the adoption of a systemic view centered on coherence and control of new internal and interprofessional organizations (cockpit, passenger cabin, control, maintenance, ground), along with technological and business model developments.

- The professional system has become highly regulated and monitored. Worldwide, the civil aviation domain is experiencing a gradual decline in salaries and social standing. At the same time, the system has become considerably more complex, with an extremely high level of coupling between all dimensions. It remains inhabited by a highly deterministic vision based on advanced engineering but has also become a colossus with feet of clay, susceptible to the butterfly effect.

- Paradoxically, passengers have become a significant and new source of variability and human factor risk for the business model in this new era of mass international transportation. Passengers shape the system's future through changes in their motivations to fly in this post-COVID era, despite the climate emergency and increasing competition posed by virtual communication tools, driven both by cost concerns and the global rise of environmental concerns.

- The low-cost social model questions the emblematic features of recommendations on human and organizational factors that have been advocated since the 1970s and adopted by most major historical airlines. This model seems to give little importance to the participatory and social vision defended by dominant human factor theories. However, the results show that low-cost carriers are often more agile, efficient, and, in many cases, safer. It remains to be seen whether this heralds the model of the future or simply benefits from its novelty.

- Similarly, albeit undoubtedly with other standards to consider, the gradual but massive shift of the aviation market towards Asia, associated with China's know-how in aircraft manufacturing, could challenge the Western standards of human factors that have prevailed in recent aviation history.