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SYMPOSIUM JST

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The Transportation Safety Board presents the first multimodal symposium in Argentina, a space for the exchange of knowledge to work for a more modern, safe and sustainable transportation.

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Editorial

As President of the JST, I am pleased to present our Safety Journal RSO#2 published by JST Editions. This 2nd edition of the journal is being released in conjunction with the 1st International Symposium on Transport Safety, "Present and Future of Transport Safety in Argentina and the Region," a knowledge-sharing forum that brings together over 50 national and international experts from the public and private transportation sectors, focusing on safety, industry innovation, training, environmental impact, health, and a diverse, equitable, and inclusive perspective.

In this issue of RSO, you will find articles and notes from the symposium's keynote speakers, which will allow us to reflect on and assimilate the discussions that took place during this exchange of ideas. As representatives of the first session on Safety Innovation, Daniel Mauriño, Safety Advisor of the International Civil Aviation Organization (ICAO), shares his insights into the challenges and opportunities of multimodal investigation. René Amalberti, Director of the Foundation for an Industrial Safety Culture, takes us through the transformation of civil aviation over half a century and the changing issues related to safety. In the context of the second session on Diversity and Safety in Transportation, Lianne Van der Veen, Senior Investigator in Maritime Accidents at the Netherlands Safety Board, shares her experiences in a predominantly male sector. Authors Valeria Bernal Carvajal and Laureen Montes Calero, from the Inter-American Development Bank's (IDB) Transport Division, analyze transportation from a gender perspective. In the session on Transport and Environmental Safety, Engineer Alejandro di Bernardi presents a study on technological innovation and environmental sustainability in aviation transportation, and the RFG Group introduces a sustainable alternative by manufacturing synthetic sleepers from recycled plastics.

Additionally, there are studies and articles related to road and maritime transportation, analyses related to multimodal studies, and other topics and areas related to transport safety.

Both the Symposium and our Safety Journal are ways to create knowledge-sharing spaces for the national and international community. Our delegations across the country work with frontline sector agents, unions, universities, private companies, and organizations to provide training and awareness workshops to help improve their performance in their jobs. Signing agreements, we keep collaborating with provinces and municipalities, making JST's technical and scientific resources available for them, while advising on the implementation of evidence-based public policies.

Safety in all modes of transport is enhanced through collective efforts. This journal, created by an entire team collaborating with many authors and specialists, is another example of our commitment to continuous improvement, consistently addressing safety issues for an ongoing enhancement.

Dr. Julián A. Obaid
President of Junta de Seguridad en el Transporte (JST)

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Transportation Safety Board (JST)

(C1005AAG), Florida 361, CABA
argentina.gob.ar/jst
Tel.: 0800-333-0689

SUMMARY

Marcelo Barone,
Ph.D. in Engineering (UTN-UBA-CONICET), research professor at the UTN (FRH). Coordinator of the Magnetic Levitation Technologies research group.

ELECTRIFICATION OF RAILWAYS AND SUSTAINABILITY

Magnetic Levitation Applied to Transport

Magnetic levitation trains improve overall performance by eliminating mechanical transmission of motion on the wheel-rail pair and, at the same time, contribute to sustainability in the system.

Introduction

The increase in the world's population and the established demographic organization have led to a transport system crisis, resulting in environmental degradation (UIC, 2018a). According to recent studies, railways worldwide meet 60% of their total energy demand with petroleum-derived products (IEA, UIC, 2017). This is the primary motivation for promoting the development of magnetic levitation and applying it to railway transport. Being an electrified system, it aligns with the use of renewable energy resources, thus contributing to sustainability in the system (UIC, 2018b).

Magnetic levitation allows connecting two bodies without any mechanical coupling between them. In other words, magnetic fields are transformed into forces to levitate and guide an object. These systems have various applications, such as active magnetic bearing (AMB), flywheels, magnetic levitation trains, among others.

When analyzed comparatively, while high-speed railway networks, which are widely spread worldwide, have achieved operating speeds in the range of 300 to 350 km/h (Leboeuf, 2018; Lawrence et al., 2019), magnetic levitation trains (MagLev), on the other hand, have reached speeds of up to 600 km/h (CRRC, n.d.). On April 21, 2015, the SCMAGLEV train of the Central Japan Railway Company even set a Guinness World Record at 602 km/h (JRC, n.d.).

The main objective of this work is to review the state of the art on the topic of MagLev trains. The document provides various concepts of magnetic levitation systems and information on the level reached in different countries. This is intended to introduce the subject to the Argentine scientific-academic community and generate a knowledge base to define the development priorities for such a system at the national level.

Background

MagLev trains were first tested in July 1977 in the city of Miyazaki, Japan. The ML-500 reached a speed of 517 km/h on an inverted T-shaped guideway in 1979. Later, the guideway was changed to a U-shaped one, MLU001, and a speed of 405 km/h was achieved in 1987. In the same year, tests were conducted with a prototype MLU002 (Takeda, 1989).

In 1979, the first magnetic train approved for passenger transport, the Transrapid, began operating at the international transport exhibition in Hamburg (IVA 79). This vehicle transported more than 50,000 people. Subsequently, in Birmingham, England, between 1984 and 1995, a magnetic levitation train was put into service, connecting the airport to the city's railway station (Money, 1984).

Principle of Operation

A MagLev vehicle levitates without contact with any ground structure and only generates aerodynamic noise. The intensity of the magnetic field is approximately 2 mT on the floor in the passenger cabin of the MLU002 and around 0.6 mT at 600 mm above the floor. The method used to achieve levitation can be a system based on magnetic repulsion or magnetic attraction (Thornton, 2009; Saied and Al-Shaher, 2009).

> ***"According to recent studies, railways worldwide meet 60% of their total energy demand with petroleum-derived products. This is the primary motivation for promoting the development of magnetic levitation and applying it to railway transport."***

There are different types of MagLev systems: electromagnetic suspension (EMS), hybrid electromagnetic suspension (HEMS), electrodynamic suspension (EDS), and permanent magnet (PM-EDS).

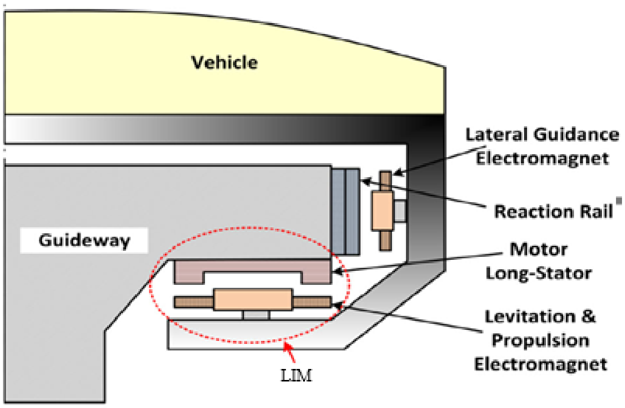
Electromagnetic Suspension (EMS)

This system uses the attractive force between electromagnets installed on the vehicle, located on its underside, below the ferromagnetic track and ferromagnetic rails used as guideway. It does not have permanent magnetism (He, Rote, and Coffey, 1992). This design can levitate even at zero velocity (Holmer, 2003; Kaye and Masada, 2004). The vehicle has ferromagnetic cores with an inductive coil, and the magnetized core generates an attractive field with a ferromagnetic guideway (Eastham and Hayes, 1988).

EMS uses standard electromagnets, distinguishing it from the EDS system, which uses superconducting materials (Meins and Miller, 1988). This means that the resulting magnetic fields are of lower intensity inside the passenger cabin, making the journey more comfortable for passengers.

The described system is used in German models Transrapid and M-Bahn, the Japanese high-speed HSST, the South Korean UTM, and the British Birmingham system. EMS was developed by the MagnetBahn Transrapid consortium and by Japanese airlines for implementation at Birmingham airport. It features two groups of electromagnets located on the vehicle. The first group's attractive forces allow levitation, and the second group's forces allow centering on the track (see Figure 1).

Figure 1. EMS system with side guideway



Source: Electrical Components of Maglev Systems: Emerging Trends, 2019.

The track is fixed, and the electromagnets move toward it, lifting and centering the entire train. It has position sensors that close a control loop that regulates the current in the coils. The train can travel at a distance (GAP) of approximately 10 mm (He, Rote, and Coffey, 1992). The GAP between the vehicle and the track depends on the electrical power used in the electromagnets and should not be too large. The magnetic field is concentrated in the GAP area between the vehicle and the track, so there is no need for shielding for passengers.

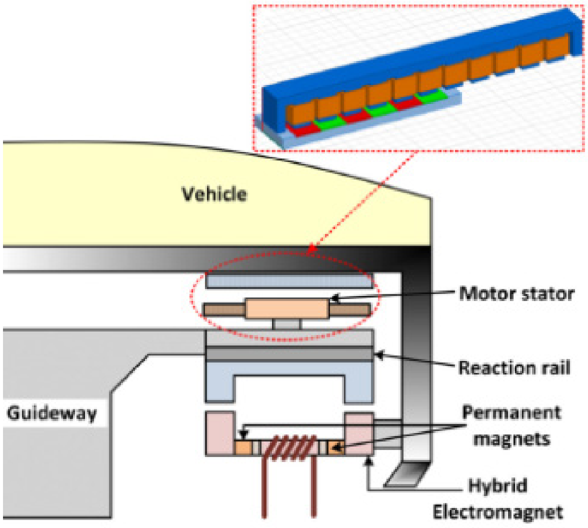
EMS system trains have limitations, with the main one being instability. When the GAP decreases, the attraction force increases, and although the electric current in the electromagnets can be regulated, there is a danger that the train may touch the guide track (Ahmadi et al., 2018). This makes precision in track construction critical and requires complex control systems. Therefore, this system is recommended for low to medium-speed applications (Holmer, 2003). The EMS train, when slowing down and approaching 10 km/h, is supported by braking skids. However, it can remain levitated while stationary.

Hybrid System (HEMS)

HEMS is a modified form of conventional EMS, as shown in Figure 2. It uses permanent magnets along with electromagnets to reduce electrical energy consumption and allows for larger air GAP's (Chin and Soulard, 2003; Zhang et al., 2013). At the beginning of the movement, it uses both electromagnets and permanent magnets (PM) together to achieve levitation. After achieving a stable GAP, the PMs keep the vehicle levitated, canceling out the electromagnets. PMs generate a constant magnetic flux; therefore, adjusting the excitation of the electromagnet provides the necessary gap control (Chin and Soulard, 2003). Due to this situation, the use of a variable input source is required to excite the electromagnets (Zhang et al., 2013).

This system is currently used by an experimental MagLev, the CMS04, designed by the National University of Defense Technology in Tangshan, China. The system requires low to medium speed to achieve stable levitation. Additionally, the use of hybrid magnets requires a sophisticated control system. However, this technology is under research for its robustness and high stability. Its application shows many future prospects in the field of contactless technology for high-speed transport systems (Zhang et al., 2013).

Figure 2. HEMS System



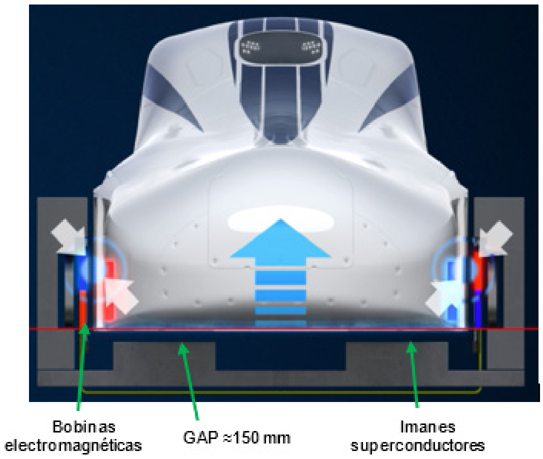
Source: Electrical Components of Maglev Systems: Emerging Trends, 2019.

Electrodynamic System (EDS)

This MagLev system uses the magnetic effect of superconducting magnets for levitation and guidance. It relies on the repulsion between the magnetic force induced by current in non-ferromagnetic conductor coils and the magnetic force of superconducting magnets located on the vehicle (Meissner effect). It involves the disappearance of the magnetic field's flux within a superconducting material below its critical temperature, meaning the superconducting magnet repels magnetic field lines so that they do not pass through its interior.

The term superconductivity refers to the property of certain materials that, when cooled to near absolute zero, exhibit almost zero electrical resistance. In the EDS system, developed by the Japanese National Railways, vehicles have superconducting magnets in a cryogenic environment with temperatures around 4 K. These magnets are located on the sides, at the bottom of the vehicle, while the coils are positioned on the track. The magnetic fields produced by these interact with the superconducting magnets on the train and generate the levitation and guidance force (see Figure 3).

Figure 3. EDS System



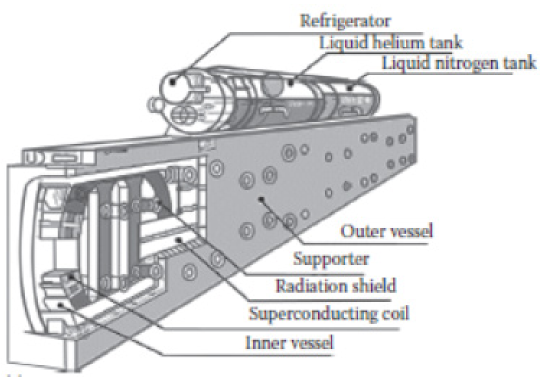
Source: Japanese superconducting Maglev. Present State and Future Perspective, 1989.

The EDS system is characterized by a GAP of 100 to 150 mm at high speeds; as a result, the guides are less precise but more stable. The levitation force depends on the speed and needs to reach around 100 km/h to achieve separation (Prasad et al., 2019). At lower speeds, a retractable wheel system is used.

One disadvantage of this system is the use of large magnetic fields near the passenger cabin, necessitating the installation of insulation systems for health protection. Another drawback to mention is the need for refrigeration equipment to maintain superconductors at low temperatures.

The superconducting magnet system used in the MLU002 (see Figure 4) consists of an aluminum alloy outer vessel and a stainless-steel inner vessel, facilitating heat exchange with nitrogen pipes.

Figure 4. MLU002 Superconducting Magnet



Source: SCMAGLEV. https://scmaglev.jr-central-global.com/about/

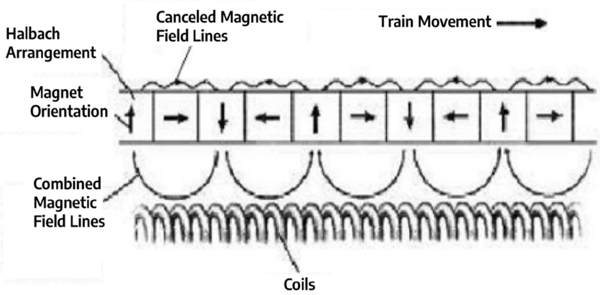
The superconducting coils installed are made of Nb-Ti alloys [8] and copper aggregate (1% by weight), which helps reduce the weight of the coils. Nitrogen exchanges heat with helium, and the evaporated liquid helium is liquefied again for reuse in a refrigerator. There are two sets of coils: propulsion, and levitation and guideway.

Permanent Magnet Electrodynamic Suspension (PM-EDS)

In the year 2000, Richard Post and Dmitri Ryutov introduced an innovation in MagLev technology called the Inductrack. Instead of superconducting materials, this system utilizes permanent magnets at room temperature arranged in a Halbach array (see Figure 5). This unique distribution of permanent magnets allows for the generation of sufficient levitation forces for the MagLev train.

The Halbach arrangement consists of magnets placed in such a way that the magnetic field of each magnet is oriented with the adjacent magnet. This arrangement produces a sinusoidal magnetic field on the underside of the array while completely canceling it on the upper side. Unlike the EDS system, this system does not use superconducting magnets, eliminating the need for cryogenic cooling (Uzuka, 2013; Schultz et al., 2005).

Figure 5. Halbach Array



Source: Study of Practical Applications of Magnetic Levitation, 2003

However, it requires auxiliary wheels to accelerate the vehicle until it achieves levitation force (Long, He, and Xue, 2011). It can be said that it is a lower-cost option.

This technology has been tested at General Atomics in the USA, with the suspension magnets separated from the propulsion magnets (Saied and Al-Shaher, 2009). The Inductrack track has coils that act as rails. Each of these rails is surrounded by two Halbach array configurations of magnets located in the lower part of the vehicle, one positioned above the rail and the other below it (see Figure 6). In this case, the rail coils are in a short circuit, and the magnets provide the induction as they move over the track (inducing a current in the coils, and then the magnetic field of these coils repels the magnets). Since the effect is electrodynamic, it is necessary to use wheels to support the weight until the train achieves levitation

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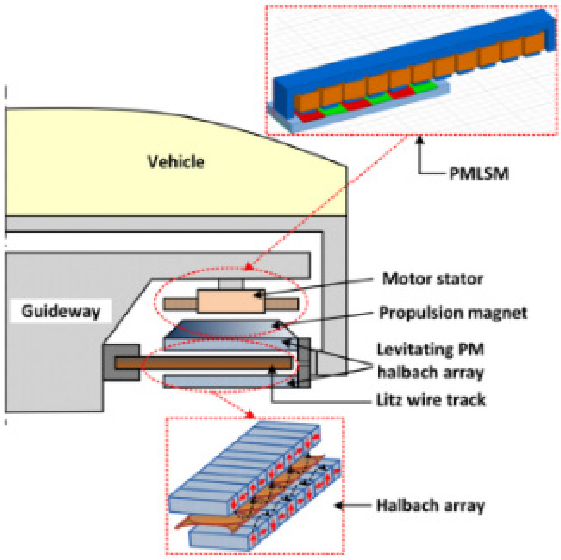
The main losses would be caused by air friction and by the electrical resistance in the short-circuit coils.

Figure 6. Inductrack Track with Halbach Array Configuration



Source: Electrical Components of Maglev Systems: Emerging Trends, 2019.

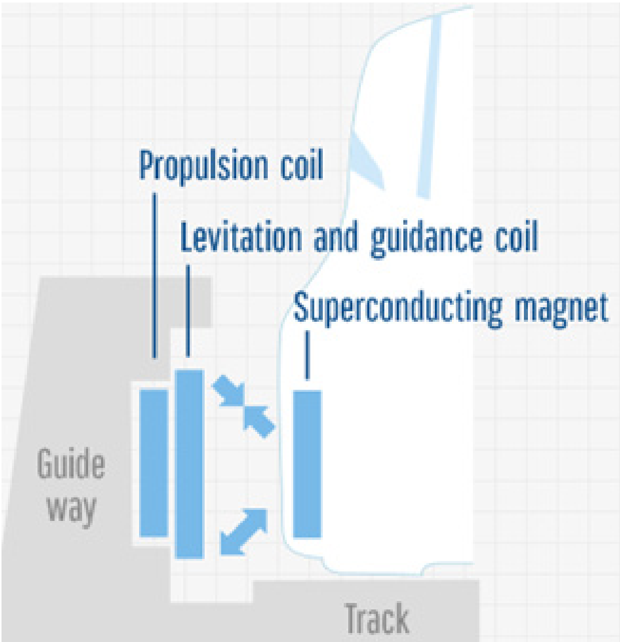
Guideway Systems

MagLev vehicles are guided to prevent lateral displacements (Boldea et al., 2018). This orientation mechanism generally uses magnetic-repulsive or attractive forces (Schultz et al., 2005).

The null-flux system is used, consisting of a guideway produced by a cross coupling, applied as the stator core of the linear motor, mounted on both sides. The coils on both sides of the guideway are interconnected. Therefore, the net electromotive force (emf) induced in the coils is zero when there is no lateral displacement (Cassat and Jufer, 2002).

If the train moves to one side, the net magnitude of the induced emf increases, generating a repulsive force on the side closest to the guiding coils, forcing the vehicle to center itself (Takeda, 1990). Japanese MLU technology integrates the guideway system with propulsion, while MLX integrates the guideway system with the levitation system. In the latter application, as seen in SCMAGLEV, there are two sets of coils: propulsion, and levitation and guideway. The propulsion coils provide forward force to the train, while the levitation and guideway coils are used to levitate the train and guide it to the center of the guide track (see Figure 7).

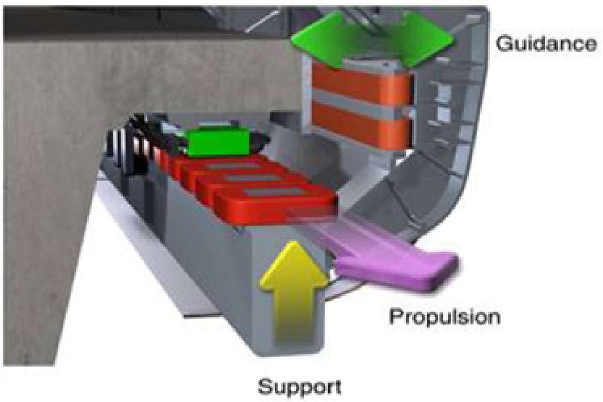
Figure 7. Propulsion, guideway and levitation



Source: SCMAGLEV. https://scmaglev.jr-central-global.com/about/

The German Transrapid also uses repulsive forces between the electromagnets on the vehicle and the side coils to fulfill the guideway function. The levitation and propulsion systems are kept separate to avoid magnetic interference (see Figure 8).

Figure 8. Propulsion, guideway and levitation of the Transrapid



Source: Transrapid. http://www.siemens.com/transportation

Power Supply System

In a MagLev system, the transfer of electrical energy from the ground is crucial for producing levitation, propulsion, and other onboard services (Uzuka, 2011). For speeds of up to 300 km/h, a pantograph can be used to transfer the required power (Long, He, and Xue, 2011). However, for speeds greater than 300 km/h, linear motors and generators are used (Mundrey, 2010; Powell and Danby, 2007). Together, they form the contactless power supply system.

The power supply from the public grid at 110 kV goes through power transformers of 110/20 kV (He, Rote, and Coffey, 1992). It then undergoes a transformation stage from 20 kV/1.2 kV and rectification to DC. Inverters and associated devices are used to obtain a voltage range of 0 to approximately 1,500 V and a variable frequency from 0 to 215 Hz. This three-phase system is directly connected to the windings of the long stator armature. Output transformers are used to increase the voltage to a maximum of 7,800 V. The maximum motor current is 1,200 A.

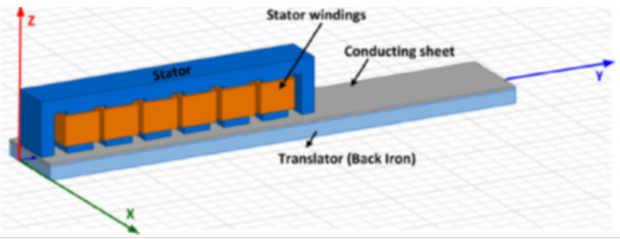
Propulsion

To propel a MagLev train, a linear motor is used. It can be either a DC or asynchronous AC motor (Hellinger, Mnich, 2009; Boldea et al., 2018). The use of linear DC motors is still in the research and testing stage because it has disadvantages in the brush systems used for power supply (Rivera, 2007).

An AC linear motor operates on the same principle as conventional induction motors but produces rectilinear motion. Unlike rotary motors, they can provide a levitation effect (Vijayvargiya et al., 2018). There are two types of motors: the linear induction motor (LIM) and the linear synchronous motor (LSM).

The LIM uses high frequency pulsed magnetic fields and is known as a short stator motor. It consists of a stator containing excitation windings and a linear rotor (LR) composed of a metal sheet placed over a ferromagnetic layer (see Figure 9).

Figure 9. Linear Induction Motor (LIM)



Source: Electrical Components of Maglev Systems: Emerging Trends, 2019.

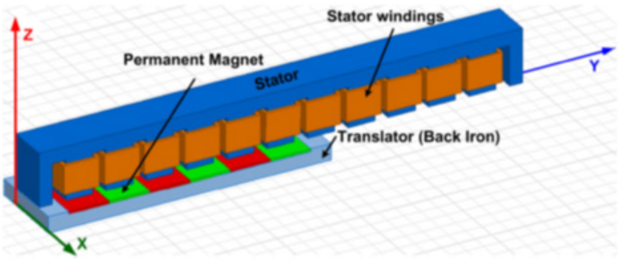
The LR is used in the vehicle as the moving part, while the stator forms the fixed guideway (Kaye, Masada, 2004). LIM-based propulsion systems are widely accepted for MagLev applications. This motor offers good reliability, robustness, and low maintenance. Additionally, they have excellent responsiveness in the speed range and the ability to operate in harsh conditions. However, they have a high weight, which reduces the vehicle's payload capacity (Vijayvargiya et al., 2018).

The LIM has less response and efficiency compared to the LSM for speeds exceeding 300 km/h. This is due to higher losses from parasitic currents. Consequently, it has lower propulsion force density and a lower power factor (Cho et al., 2008).

The LSM motor, known as the long stator, is the most used propulsion system for train applications. A circuit of coils through which controlled three-phase alternating current flows is used as the stator (see Figure 10). It resembles the stator of a LIM.

The LR incorporates a magnetic source, making the motor doubly excited. In high-performance propulsion systems, excitation is provided by the inclusion of permanent magnets (PM) (Cho et al., 2008).

Figure 10. LSM with Permanent Magnets



Source: Electrical Components of Maglev Systems: Emerging Trends, 2019.

Some MagLev systems also use electromagnets. In the case of an EMS system, the LR motor consists of electromagnets on the train, and in an EDS system, it consists of superconducting magnets. The alternating current in the stator generates a magnetic field with alternating north and south poles. Simultaneously, the LR is also energized, creating a magnetic flux. The interaction between these two magnetic fluxes forces the vehicle to move at a synchronous speed (Vijayvargiya et al., 2018; Cho et al., 2008).

Due to its higher force density, greater efficiency, and higher power factor, this motor has been the most widely used for magnetic levitation applications (El-Refaie, 2013; Lee et al., 2013), with the stator coils used as the guideway (Park et al., 2013). This configuration is suitable for high-speed applications as it does not require a current collector.

The energy that moves the train is supplied by the tracks, allowing the tracks to be energized in sections so that only the track sections the train is passing through are active (Kuntz, Burke, and Slemon, 1978).

The use of these motors allows MagLev trains to traverse slopes of up to 10°, in contrast to conventional railways that can only navigate slopes of up to 4°.

The linear motor is also used for train braking. To do this, the polarity of the current in the stator must be reversed to generate a force opposite to the forward motion. The deceleration is the same as acceleration: 1.8 m/s^2 (suitable for passengers). In emergencies, it can reach 3.5 m/s^2.

The MagLev vehicle braked from 300 km/h using sliding shoes made of a molybdenum alloy acting on the guideway. Brakes with aerodynamic panels installed on the body also demonstrate high performance (Barone, González, and Vilella, 2018; Prasad, Jain, and Gupta, 2019).

CONCLUSIONS

The need to increase transport capacity, improve energy efficiency, and reduce environmental impact has led to advances in MagLev technology. It is proposed as a sustainable and cleaner alternative. This article has provided an overview of MagLev technology, with a special focus on the components of the electromagnetic system. Different levitation, guideway, and propulsion technologies have their capabilities and limitations. SCMAGLEV technology is considered the most suitable for speeds above 350 km/h, with a gap of approximately 150 mm. However, it has a fundamental limitation because it uses superconducting magnets, which require cryogenic systems and generate high magnetic fields that could be uncomfortable inside the vehicle. This is why hybrid systems, incorporating permanent magnets, are the focus of current research.

The technological advancement of MagLev systems makes it possible to compete with railway transportation. Developing magnetic levitation systems is a challenging task that must be undertaken to project a sustainable future in our country.

References

Ahmadi, S., Dastfan, A., Mohsen, Assili, M. (2018). Energy saving in metro systems: Simultaneous optimization of stationary energy storage systems and speed profiles. Journal of Rail Transport Planning & Management, 8 (1), pp. 78-90. https://doi.org/10.1016/j.jrtpm.2018.03.003

Barone, M., González, S., Vilella, D. (2018). Introduction to Magnetic Levitation systems for railways. First Congress on Means of Transport and Associated Technologies, (September 26-28). UTN-FRH, Haedo, Buenos Aires, Argentina.

Boldea, I. (2013). Linear electric machines, drives and Maglevs handbook. Boca Raton: CRC Press. Boldea, I., Tutelea, L.N., Xu, W., Pucci, M. (2018). Linear electric machines, drives, and MAGLEVs: an overview. IEEE Transactions on Industrial Electronics, 65 (9), pp. 7504- 7515. 10.1109/ TIE.2017.2733492.

Cassat A., Jufer, M. (2002). MAGLEV projects technology aspects and choices. IEEE Transactions on Applied Superconductivity, 12 (1), pp. 915-925. 10.1109/TASC.2002.1018549.

Chin, Y.K., Soulard, J. (2003). A permanent magnet synchronous motor for traction applications of electric vehicles. IEEE Conference on Electric Machines and Drives Conference (IEMDC 1-4 de junio), Madison, Wisconsin, United States. https://www.academia.edu/18315117/

China Railway Rolling Stock Corporation (CRRC), (s.f).

Cho, H.W., Sung, H.K., Sung, S.Y, You, D.J., Jang, S.M. (2008). Design and characteristic analysis on the short-stator linear synchronous motor for high-speed Maglev propulsion. IEEE Transactions on Magnetics 44 (11), pp. 4369-4372.

Eastham, A.R., Hayes, W. F. (1988). Maglev Systems Development Status. IEEE AES Magazine, pp. 21-30.

El-Refaie, A.M. (2013). Motors/generators for traction/propulsion applications: a review. IEEE Vehicular Technology Magazine, 8 (1), pp. 90-99. 10.1109/MVT.2012.2218438.

Gerada, D., Mebarki, A., Brown, N.L., Gerada, C., Cavagnino, A., Boglietti, A. (2014). High-speed electrical machines: technologies, trends, and developments. IEEE Transactions on Industrial Electronics, 61 (6), pp. 2946-2959. 10.1109/TIE.2013.2286777.

He, J. L., Rote, D. M., Coffey, H. T. (1992). Survey of foreign maglev systems. United States. https://doi.org/10.2172/10134413.

Hellinger, R., Mnich, P. (2009). Linear motor-powered transportation: history, present status, and future outlook. Proceedings of the IEEEP, 97(11), pp. 1892-1900. 10.1109/JPROC.2009.2030249.

Holmer P. (2003). Faster than a speeding bullet train. IEEE Spectrum, 40 (8), pp. 30-34. https://acortar.link/GmJ5s3

Hur, J., Toliyat, H.A., Hong, J.P. (2001). Dynamic analysis of linear induction motors using 3-D equivalent magnetic circuit network (EMCN) method. Electric Power Components and Systems, 29 (6), pp. 531-541. https://doi.org/10.1080/153250001300338763.

Internacional Energy Agency (IEA), International Union of Railways (UIC) (2017). Railway Handbook Energy consumption and CO2 emissions focus on passenger rail services. uic.org/IMG/pdf/handbook_iea-uic_2017_web3.pdf

Central Japan Railway Company (JRC), (s.f). https://scmaglev.jr-central-global.com/future/

Kaye, R.J., Masada, E. (2004). Comparison of linear synchronous and induction motors. Urban Maglev Technology Development Program. Colorado Maglev Project. codot.gov/programs/research/pdfs/2004/inductionmotors.pdf.

Kuntz, S., Burke, P.E., Slemon, G.R. (1978). Active damping of maglev vehicles using superconducting linear synchronous motors. Electric Machines & Power Systems, 2 (4), pp. 371-384. https://doi.org/10.1080/03616967808955318.

Lawrence, M., Bullock R., and Liu Z. (2019). China's High-Speed Rail Development. World Bank. https://acortar.link/EXC3a0 https://acortar.link/EXC3a0

Leboeuf, M. (2018). High Speed Rail. International Union of Railways. https://uic.org/IMG/pdf/uic_high_speed_2018_ph08_web.pdf.

Lee J, Jo J, Han Y, Lee C (26-29 de octubre de 2013). Development of the linear synchronous motor propulsion testbed for super speed Maglev. International Conference on Electrical Machines and Systems, Busan, Corea del Sur.

Lee, H.W., Kim, K.C., Lee, J. (2006). Review of Maglev train technologies. IEEE Transactions on Magnetics, 42 (7), pp. 1917-1925. 10.1109/TMAG.2006.875842.

Long, Z., He, G. and Xue, S. (2011). Study of EDS & EMS hybrid suspension system with permanent-magnet Halbach array. IEEE Transactions on Magnetics, 47 (12), pp. 4717-4724. 10.1109/TMAG.2011.2159237.

Maglev technology (s.f.) Shanghai Maglev Transport Development Co. Ltd. http://www.smtdc.com/en/index.html.

Meins, J., L. Miller (1988). The Hahiigh-Speed Maglev Transportation System Transrapid. IEEE Transactions on Magnetics MAG, 24 (2), pp. 808-811.

Money, L. J. (1984). The saga of Maglev. Transportation Research Part A: General, 18 (4), pp. 333-334. https://doi.org/10.1016/0191-2607(84)90171-7.

Mundrey JS (2010). Tracking of high-speed trains in India. Rites Journal, 12 (1), 7.1–7.16.

Park, C.B., Lee, B.S., Lee, J.H., Lee, S.K., Kim, J.H., Jung, S.M. (2013). Design of coreless-typed linear synchronous motor for 600 km/h very high-speed train. International Conference on Electrical Machines and Systems, (26-29 de octubre) Busan, Corea del Sur.

Post, R., Ryutov, D.D. (6- de junio de 2000). The Inductrack: A Simpler Approach to Magnetic Levitation. 16th International Conference on Magnetically Levitated Systems and Linear Drives, Río de Janeiro, Brasil. https://www.osti.gov/servlets/purl/791522

Powell, J., Danby, G. (15-16 de septiembre de 2007). MAGLEV. the new mode of transport for the 21st century. Schiller Institute Conference on the Eurasian land-bridge becomes a reality, Kiedrich, Germany.

Prasad, N., Jain, S., Gupta, S. (2019). Electrical Components of Maglev Systems: Emerging Trends. Urban Rail Transit, 5 (2), pp. 67-79. https://doi.org/10.1007/s40864-019-0104-1.

Rivera, N. (2007). Permanent Magnet DC traction motor with reconfigurable winding control. Transportation Research Board of the National Academies. http://onlinepubs.trb.org/onlinepubs/archive/studies/idea/finalreports/highspeedrail/hsr-44final_report.pdf.

Saied, M. y Al-Shaher, M. (2009). Harmonic Distortion Assessment and Minimization for Railway Systems. Electric Power Components and Systems, 37 (8), pp. 832-846. 10.1080/15325000902817168.

Schultz, L., Haas, O., Verges, P., Beyer. C., Rohlig, S., Olsen, H., Kuhn, L., Berger, D., Noteboom, U., Funk, U. (2005). Superconductively levitated transport system: the SupraTrans project. IEEE Transactions on Applied Superconductivity, 15, pp. 2301-2305. 10.1109/TASC.2005.849636. SCMAGLEV. https://scmaglev.jr-central-global.com/about/

Takeda, H. (1989). Japanese Superconducting Maglev: Present State and Future Perspective. SAE Technical Paper. https://doi.org/10.4271/891718.

Thornton, R. (2009). Efficient and affordable maglev opportunities in the United States. Proceedings of the IEEE, 97 (11), pp. 1901-1921.10.1109/JPROC.2009.2030251. Transrapid. www.siemens.com/transportation.

International Union of Railways (UIC) (2018a). Passenger activities at UIC. uic.org/IMG/pdf/brochure_passagers.pdf.

International Union of Railways (UIC) (2018b). High speed rail fast track to sustainable mobility. uic.org/IMG/pdf/uic_high_speed_2018_ph08_web.pdf.

Uzuka, T. (2013). Faster than a speeding bullet: an overview of Japanese high-speed rail technology and electrification. IEEE Electrification Magazine, 1, pp.11-20.

Uzuka, T. (23-26 de mayo de 2011). Trends in high-speed railways and the implications on power electronics and power devices. IEEE 23rd international symposium on power semiconductor devices and ICs, San Diego, California, United States of America.

Vijayvargiya, A., Naruka, S. N., Bee, A., Saxena, A., Kumar Tak, D. and Verma, H. (2018). Linear Induction Motor Based Rapid Human Transportation System. International Journal of Advanced in Management. Technology and Engineering Sciences, 8 (5), pp. 9-13.

Zhang, W., Li, J., Zhang, K., Cui, P. (2013). Design of magnetic flux feedback controller in hybrid suspension system. Mathematical Problems in Engineering, Article ID 712764, 1-7. https://doi.org/10.1155/2013/712764

Area of Studies and Development of the National Department of Aviation Occurrences Investigation

STATISTICS ON THE MOST RECURRING AVIATION INCIDENTS

Accidents Involving Helicopters in Argentina

This article presents an excerpt from the bulletin that analyzes accidents involving helicopters in the Argentine Republic over the past ten years, with the aim of highlighting the latent conditions within the system.

This work presents both fatal and non-fatal accidents and categorizes them according to their characteristics using the categories established by the Common Taxonomy Team (CICTT) of the International Civil Aviation Organization (ICAO). It covers flight phases, the type of operation, and the georeferenced location of occurrences on a map.

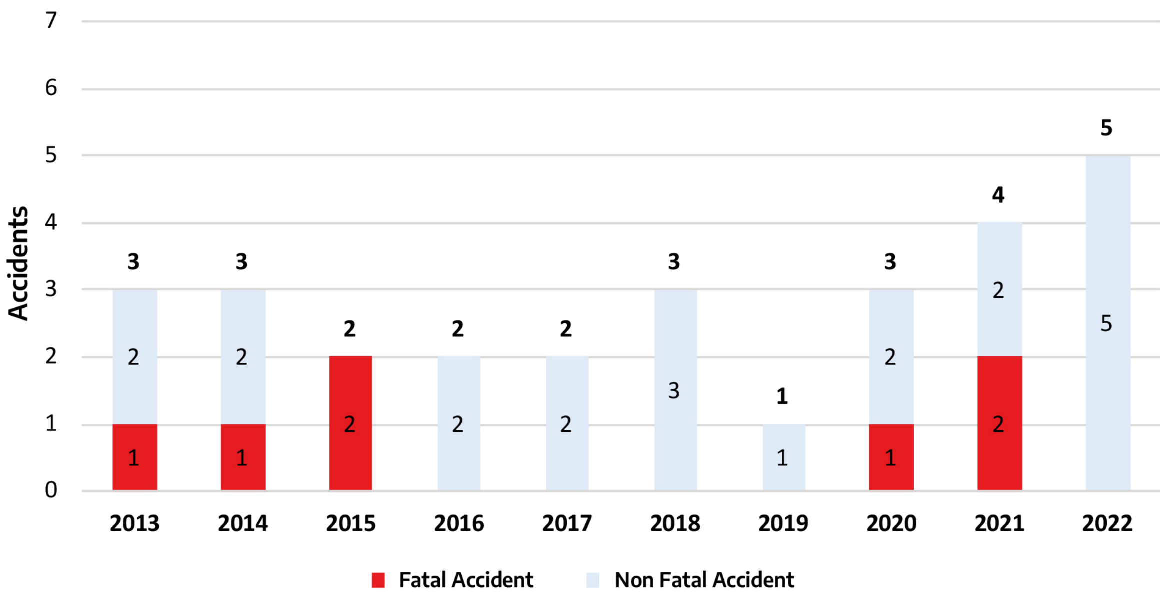
Historical Series: 2013 to 2022 Period

In the period under review, 28 accidents involving 29 helicopters were recorded; 7 of them were fatal. None occurred in the last year.

7 2013-2022 **FATAL ACCIDENTS**

2 TWIN-ENGINE
27 SINGLE-ENGINE

Graph 1. Fatal and non-fatal occurrences per year



Source: ADREP/ECCAIRS system, JST's Repository.

Analysis by Occurrence Categories

For the analysis of occurrence categories, those with more than two recordings were taken into account. Notable categories include loss of control in flight (LOC-I) and low-altitude operations (LALT). Fire and/or smoke occurrences after impact (F-POST) are related to other categories, associated to the resulting circumstances, especially LOC-I accidents.

10 2013-2022 **LOC-I**

4 2013-2022 **LALT**

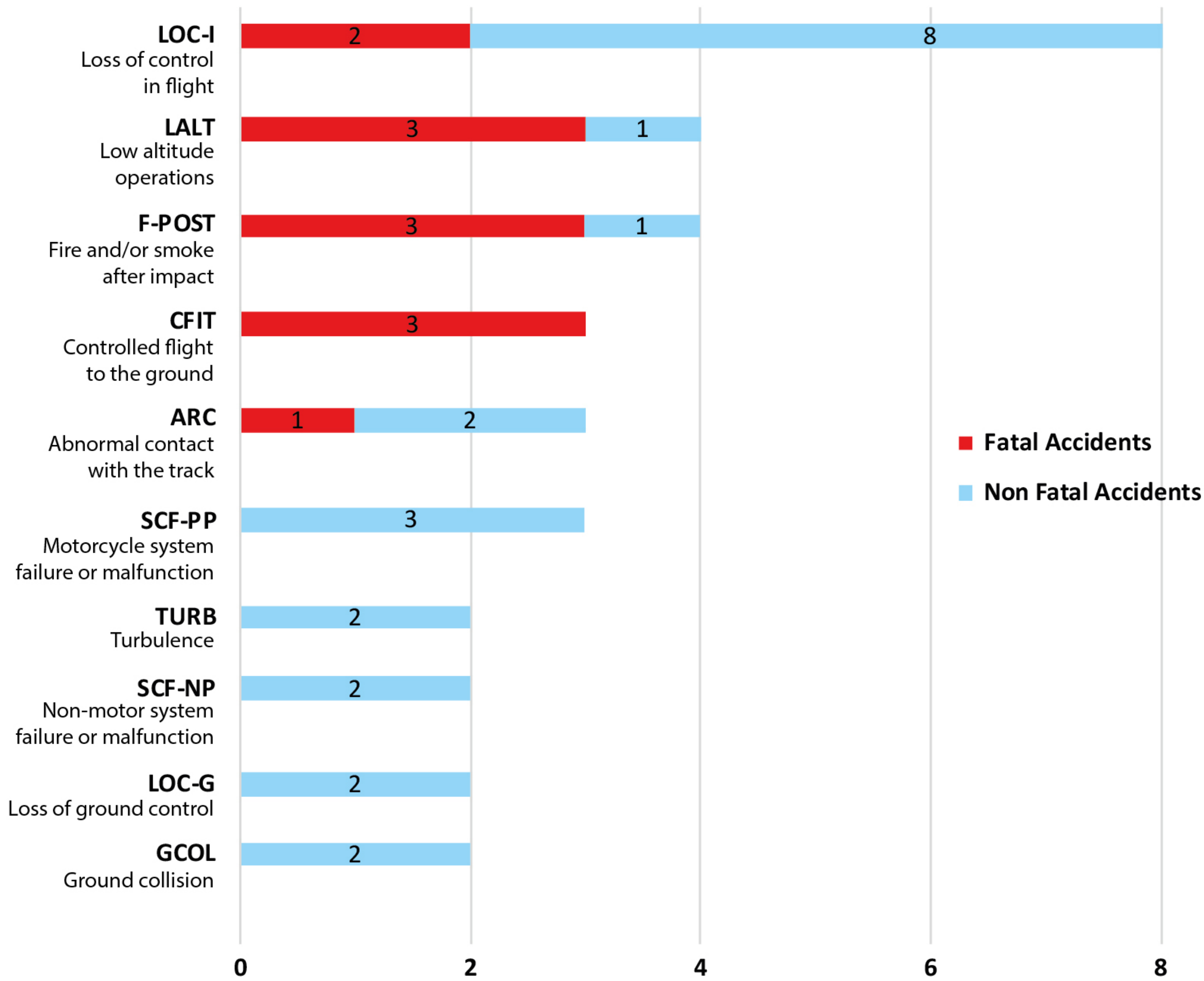
"During the analyzed period, 28 accidents involving 29 helicopters were recorded, with 7 of them being fatal. None occurred in the last year."

Additionally, five categories were recorded with only one occurrence: MAC, NAV, CTOL, ADRM, and F-NI (see glossary).

Categories related to controlled flight into terrain (CFIT), abnormal runway contact (ARC), and engine system failure or malfunction (SCF-PP) are also highlighted. These categories can be associated with each other or with other categories such as LOC-I and LALT in the same occurrence.

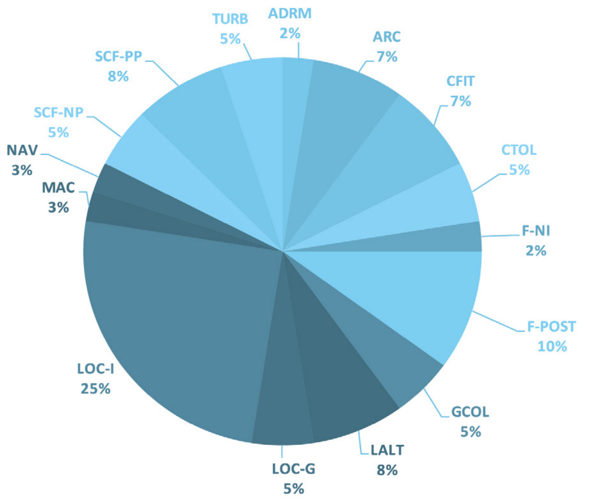
Fatalities were recorded in the occurrence categories LALT, F-POST, and CFIT, with three fatalities each; LOC-I with 2; ARC, MAC, and NAV with 1 (MAC and NAV are not shown in the chart due to having only one occurrence in the study period, which was fatal).

Graph 2. Occurrence categories with helicopters involved 2012-2023



Source: ADREP/ECCAIRS system, JST's Repository.

Graph 3. Accident categories 2012-2023 with helicopters involved



Source: ADREP/ECCAIRS system, JST Repository. DREP/ECCAIRS, JST Repository.

"The analysis of the type of operation conducted by the helicopters at the time of the accident, identified that 71% fell within general aviation."

25% 2013-2022 **LOC-I**

10% 2013-2022 **LALT**

The analysis of categorized LOC-I accidents allowed for the identification of their origin, which is largely operational aspects of helicopters.

It was also identified that the loss of tail rotor effectiveness (LTE) is recurrent, caused by sudden wind gusts that, when combined with not operating the aircraft within the parameters established in the manual — including the tail rotor effectiveness table — create conditions favorable to accidents.

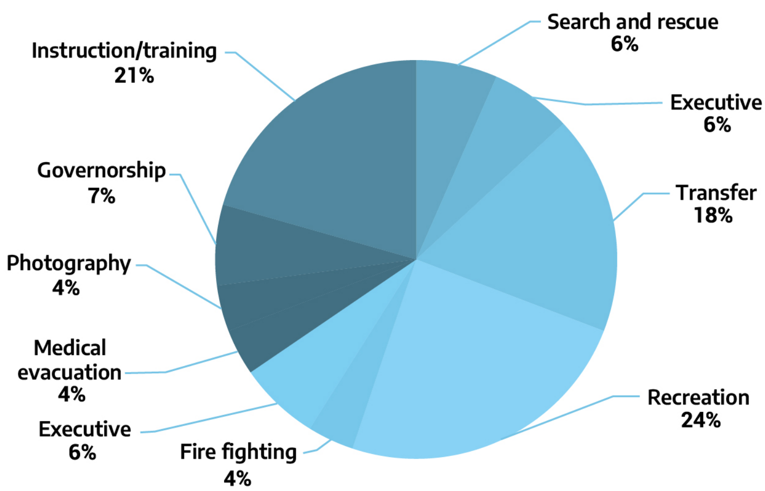
Another identified factor was deficient, incomplete, or insufficient flight planning. There were accidents where flight planning did not match the helicopter's performance, especially in high-altitude and high-temperature flights.

Analysis by Types of Operations

From the analysis of the type of operation runned by the helicopters at the time of the accident, it was identified that 71% fell within general aviation.

Additionally, it is observed that the majority (26% of accidents) involve general aviation operations in the form of recreational flights, and 22% involve instruction or training operations. General aviation is further complemented by transfer flights and test flights, representing 19% and 7% of operations, respectively.

Graph 4. Operation sub-type of the helicopters involved

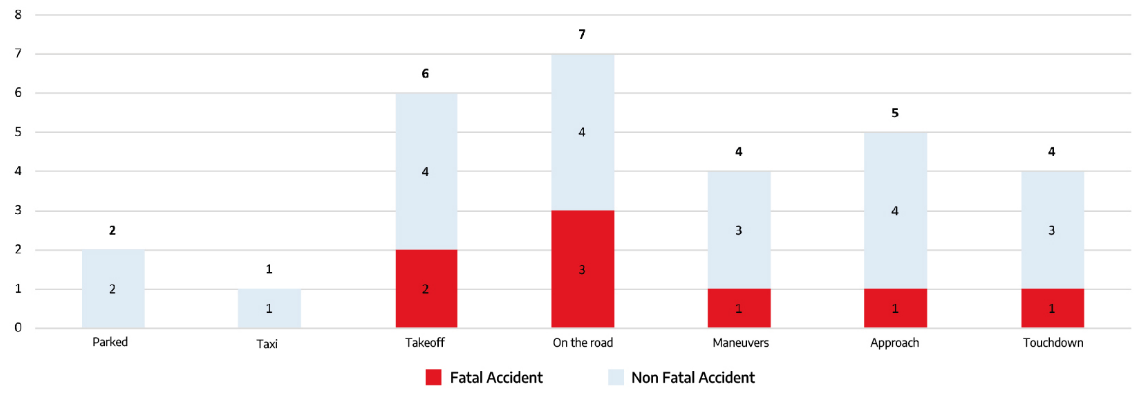


Source: ADREP/ECCAIRS system, JST's Repository.

Analysis by Flight Phases

From the analysis by flight phases, en route (ENR) accounts for 25% of accidents, and takeoff (TOF) accounts for 21%, concentrating the majority of fatalities. This is followed by the approach phase (APR) at 18%, and maneuvering (MNV) and landing (LDG) phases at 14%. In the APR, LDG, and TOF phases, impacts with obstacles or turbulence interference, both from the location and those generated by the helicopter itself, are common, resulting in loss of control.

Graph 5. Helicopters involved in fatal and non-fatal incidents by flight phase

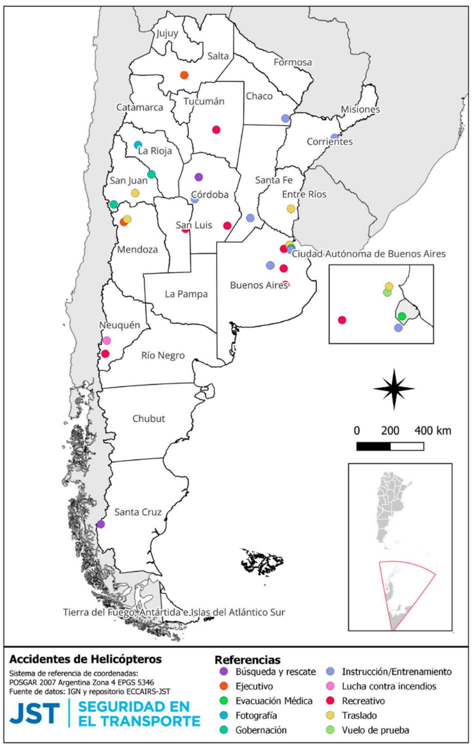


Source: ADREP/ECCAIRS system, JST's Repository.

Accident Locations

For accident location, the occurrence sites were georeferenced and are illustrated in the figure below:

Figure 1. Georeferencing of occurrence locations



Source: Own elaboration.

Glossary

Occurrences Categories:

ADRM: Related to the aerodrome
ARC: Abnormal runway contact
CFIT: Controlled flight into terrain
CTOL: Collision during takeoff/landing
F-NI: Fire and/or smoke without impact
F-POST: Fire and/or smoke with impact
GCOL: Ground collision
LALT: Low-altitude operations
LOC-G: Loss of control on the ground
LOC-I: Loss of control in flight
MAC: Mid-air collision/near collision/loss of separation in flight
NAV: Navigation errors
SCF-NP: Failure of systems/components unrelated to the engine
SCF-PP: Failure of engine systems/components
TURB: Turbulence

Flight Phases:

STD: Stationary
TXI: Taxiing
TOF: Takeoff
ENR: En route
MNV: Maneuvers
APR: Approach
LDG: Landing

Other acronyms:

CAST: Commercial aviation operational safety team
CICTT: Common taxonomy team of CAST/ICAO
LTE: Loss of tail rotor effectiveness
ICAO: International Civil Aviation Organization

Introduction to PERMANENT OBSERVATION TOPICS (TOPs)

The Permanent Observation Topics (TOPs) are a list developed by the Transport Safety Board (Junta de Seguridad en el Transporte, JST) that identifies and enumerates key issues for proactive action in the management of Safety. Their resolution contributes to the more effective and efficient operation of the State's Safety Management System (SSP).

JST | SEGURIDAD EN EL TRANSPORTE

Ministerio de Transporte Argentina

primero la gente

INTERVIEW WITH FERNANDO MORENO MIELGO

OAV: The Spanish Experience in Mass Victim Assistance

The head of the Victims Assistance Office for Air Accidents of the Emergency, Safety, and Crisis Management Unit, under the Ministry of Transport, Mobility, and Urban Agenda of Spain, shares with us the work that the organization does in supporting those who have suffered the loss of a loved one in an aviation incident.

What is the origin of RD632, and what motivated its drafting?

This royal decree is issued in accordance with the provisions of Article 21 of Regulation (EU) No. 996/2010 of the European Parliament and the Council, dated October 20, 2010, on the investigation and prevention of accidents and incidents in civil aviation, repealing Directive 94/56/EC.

The aim of this regulation is to ensure a broader and harmonized response to civil aviation accidents within the community, and to achieve this, it imposes on Member States the duty to establish national emergency plans that foresee, in particular, assistance to victims and their families. Member States must also ensure that airlines registered in their territory have assistance plans for victims and their families and encourage airlines from other countries to adopt such plans.

RD632 aims to ensure that civil protection plans include civil aviation accidents as a risk capable of generating emergencies; establish the measures to be taken by public administrations to guarantee assistance to victims of civil aviation accidents and their families; and develop the obligation of airlines to have an assistance plan in accordance with Law 21/2003 on Air Safety.

In short, its purpose is to ensure a comprehensive framework for the protection of victims of air accidents and their families, and to this end, it provides measures in various areas.

In Spain, the administrations already have civil protection plans, either territorial or special, adopted in their respective areas. This guarantees a homogeneous response at the national level, regardless of where the incident occurs and its scope, as it establishes common and essential minimum contents, considering international standards (International Civil Aviation Organization - ICAO - Policy and Manual, Doc 9998 and 9973).

For legal security reasons, it is advisable to establish the minimum obligations of airlines in assisting victims and their families, and, correspondingly, the minimum content of these plans, as well as to establish the assistance measures that must be provided for airport self-protection.

How did the Victims Assistance Office (OAV) come into existence?

The 2014 Protocol, which implements the assistance provided for in RD632/2013, stipulates that the Ministry of Development (now Transport) will establish a permanent OAV integrated into its structure.

What is the primary objective of the OAV's work?

In accordance with the regulations, the OAV's functions include providing permanent assistance to victims and their families of civil aviation accidents once the emergency situation is concluded and after the formal transfer is made by the designated contact person (PECO). Additionally, it must collaborate with the corresponding Spanish Embassy and its consular services in supporting Spanish victims of an aviation accident that occurs outside the national territory and their families, when jointly decided by the Ministries of Foreign Affairs and Cooperation and Transport.

At what point does the OAV actively intervene, and with which stakeholders does it interact?

The OAV begins to act once the emergency phase is completed, when the Family Assistance Center (CAF) is closed, and the designated contact person (PECO) formally transfers responsibility. In practice, the OAV intervenes from the early hours.

"It aims to ensure a comprehensive framework for the protection of victims of air accidents and their families and, to this end, provides measures in various areas."

What is the limit of the intervention, when does it end?

The regulations do not set a final deadline for assistance. It explicitly speaks of permanent assistance.

How is coordination at the national level with the aviation authority and those responsible for the initial response?

When an aviation accident occurs, a civil protection plan is activated at the regional (autonomous) level, which is coordinated with local emergency services, airport authorities, etc. A main command post (PMP) is established to ensure coordination of actions by all parties involved.

One tool you implemented is the single form system. Could you tell us how it works and why it is important?

The affiliation form is the document that collects the personal information of family members who come to the airport to seek information after an accident, in order to organize their assistance as effectively as possible and assign them psychosocial support by family groups.

It was observed that family members were often asked the same questions multiple times by different parties involved (such as their name, who they were inquiring about, etc.), which naturally caused irritation and demonstrated a lack of coordination. To prevent this, a working group reached a consensus on a single form with basic information to be shared by all parties involved, although each party can then expand on it in relation to their functions.

These forms are held by emergency services at the airports, and the information is later combined with that obtained by the airline's call center and then digitized to reach a common database.

> ***"The affiliation form is the document that collects the personal information of family members who come to the airport to seek information after an accident, in order to organize their assistance as effectively as possible and assign them psychosocial support by family groups."***

Do you have designated contact persons or PECOs at all airports?

More than an individual, it is a Unit: the PECO and their technical team. They serve as the point of contact for families to provide information about the passenger list, the extent of assistance, rights, the status and location of the injured, the recovery of personal belongings, legal and funeral needs, etc.

PECOs are not designated at the airport level but rather one PECO for each of the Spanish autonomous communities (regions). In fact, experience has shown that it is necessary to designate multiple PECOs for each autonomous community, either due to geographical characteristics (for example, there are island-based PECOs for each island in the Canary Islands) or to have an appropriate system of primary and backup PECOs.

Are these individuals volunteers? What requirements must they meet?

They are not volunteers; they are appointed by the Undersecretary of the Interior for each of the autonomous communities, following an agreement with the competent civil protection authority of the corresponding autonomous community's administration. Typically, they are individuals with experience in civil protection and emergency management and belong to either state or regional civil protection organizations.

In the case of aviation accidents that occur outside the national territory, when one of the situations specified in Article 7.4 of Royal Decree 632 applies, namely when the crashed aircraft is operated by an airline with a Spanish operating license and/or when a significant number of Spanish citizens are on board, civil protection has no jurisdiction. Therefore, it is the OAV that will act in support of the victims and their families in accordance with the Protocol.

PECOs must receive appropriate training from the Directorate-General of Civil Protection and Emergencies through the National School of Civil Protection. The OAV is involved in determining the content and delivery of this training, which includes topics such as knowledge of the structure, plans, and resources of the state and regional civil protection systems, affected aviation legislation, the obligations and assistance that both the central government and air operators and airports must provide, medical-forensic procedures, and forensic science, especially in incidents involving multiple victims, and more.

Additionally, they must be aware of airport self-protection plans, as well as the plans of airlines for assisting victims and their families, and possess basic knowledge of accident investigation, insurance coverage, victim rights, common cultural rituals related to interpersonal communication and grief, and, finally, the implications to consider when an incident is related to a crime.

Moreover, it is important that the individuals chosen are fluent in English, have psychosocial training, and are skilled in managing and coordinating teams in emergency and crisis situations. This training includes modules on decision-making in such situations, negotiation and resolution of critical incidents, communication skills in public during emergencies, training in delivering bad news, and emotional self-control and stress management in high-emotion situations.

PECOs must also participate in any drills within their territorial scope.

Annually, technical workshops are held to update knowledge and incorporate lessons learned, which may involve all stakeholders from the public and private sectors, airlines, and airport operators.

There was an accident of particular significance that we would like to discuss, the Germanwings accident. What was the experience of the OAV?

For the OAV, the Germanwings incident, because it was not really an accident - and the families insist on this - was the greatest challenge we had to face. We had to learn quickly and in a harsh way. It was a flight from Barcelona to Düsseldorf, and when it happened in March 2015, the assistance system under RD632 was not mature yet. The training of PECOs had not been completed, and the OAV had been operational for less than a year. It affected 50 Spanish families, almost all from the Catalonia region.

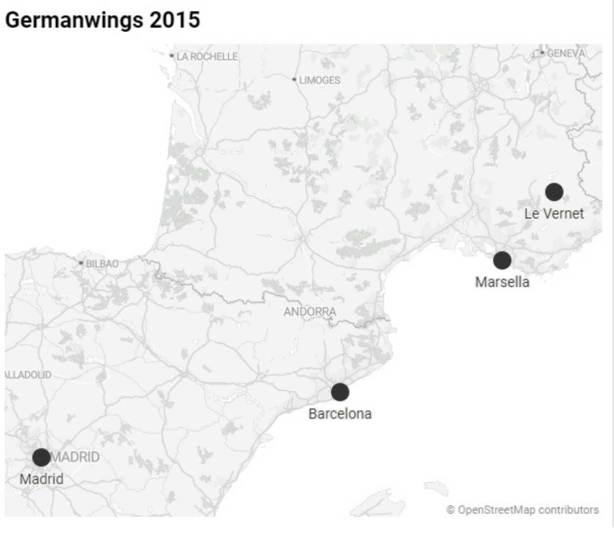
The crash occurred in the French Alps with a German airline, which required international coordination and fundamental teamwork. We had a very good relationship with the French and German authorities (a special ambassador designated by Germany). Lufthansa, the parent company of Germanwings, provided a significant amount of human and material resources for assistance.

Over the course of these seven years, we have been involved in all phases; summarizing so many actions is complicated. From the very first day, we went to Barcelona airport, El Prat, and the CAF set up in Castelldefels, near Barcelona, and accompanied the families to Marseille, to the press conference by French prosecutor Robin, where it was announced that the co-pilot had intentionally crashed the plane. Then came the transfer to Le Vernet, the impact zone, and we worked alongside the Spanish Consulate in Marseille to coordinate with local authorities for the identification and repatriation process.

We participated in organizing memorial events in Barcelona and Cologne, the repatriation process for the remains, psychological support follow-ups, compensation payments, the pre-release information meeting before the final investigation report by the BEA, the placement of a commemorative memorial at the crash site, anniversary commemorative events, and more.

After that first year, we have worked closely with the association of affected individuals that was formed, and we have supported them in all their requests. When does the OAV's intervention end? Seven years later, everything is just about stabilized. The most recent milestones have been achieving tax exemption for the assistance received from Lufthansa's fund after extensive parliamentary work, and the reform of the Social Security notification system to make it more difficult for similar cases to occur where an unfit pilot takes control of an aircraft (or any other mode of public transportation).

Graph 1 – Ref: OAV Germanwings Actions Map



You participate in commemorative events, especially anniversaries. What kind of relationship is established with families?

We try to establish a relationship of trust from the very beginning, aiming to be reliable intermediaries at all levels, whether with the administration, the airline, or any other necessary parties. I always say that affected individuals face a wide range of needs of various kinds, and we have very little in our hands to address them directly. However, what we can do is connect them with organizations that have the solutions they require. We see ourselves as facilitators in this process. The association of affected individuals has consistently appreciated and valued our role positively.

I would now like to discuss another accident, the Swiftair incident in Mali, in which Spanish individuals lost their lives. What was the specific intervention of the OAV?

In Mali (July 2014), it involved an Air Algerie flight operated by the Spanish company Swiftair under a wet-lease arrangement, flying from Ouagadougou (Burkina Faso) to Algiers, where the six Spanish crew members tragically lost their lives, and there were no survivors. The impact point in Gossi, Mali, was within an area known for jihadist activity, which greatly complicated all actions taken. Thus, the collaboration with French authorities and armed forces played a decisive role.

This was indeed our baptism of fire, as the OAV, and it provided valuable learning experiences regarding assistance, the needs of the affected individuals, and the dynamics of an international accident. We had excellent coordination with the Spanish Consulate, the special ambassador designated by France, and the French investigation authority, BEA.

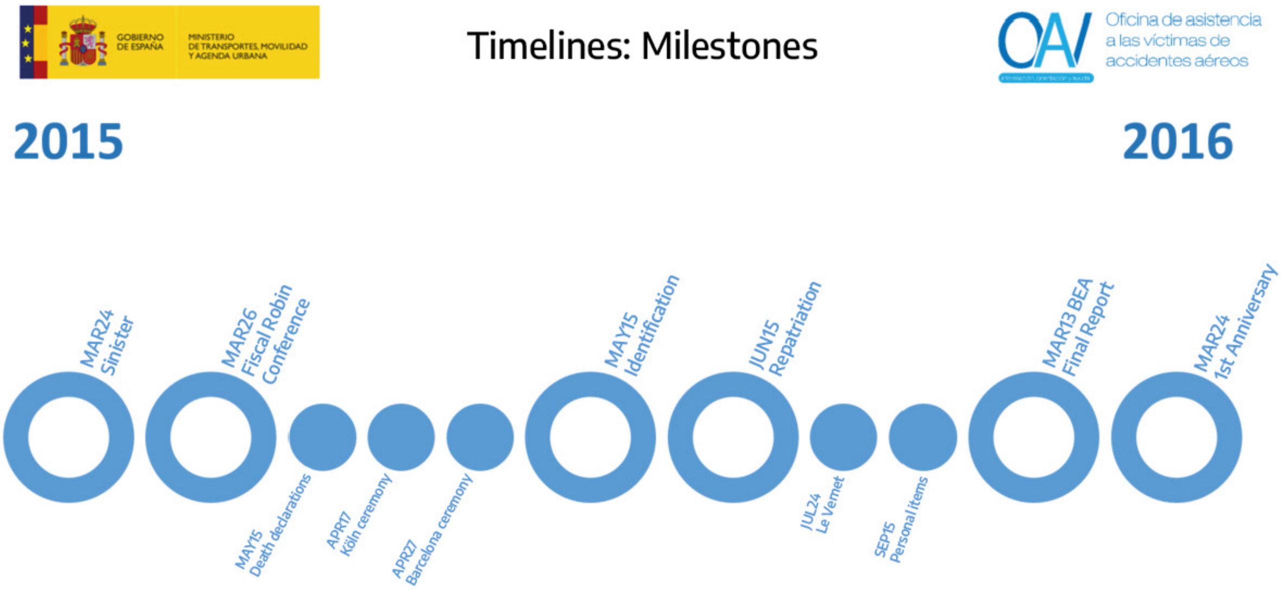
How do you intervene when there are Spanish fatalities in accidents that occur in other countries?

In such cases, the responsibility for the rescue and recovery of victims, technical investigation, and victim assistance lies with the state where the accident occurs, just like it does for any other individuals involved in the incident. The Embassy or Consulate of Spain in that country manages relations with local authorities, and the OAV makes itself available to them to perform any necessary functions.

In the cases we've mentioned (Spanish airline or a significant number of Spanish passengers on board), we act in support of the victims and their families.

Since 2013, ICAO has been attentive to the issue of family assistance; however, as of the 2021 Symposium in Las Palmas, more concrete measures have been taken, such as the mandatory inclusion of questions related to this topic in audits.

Graph 2 – Ref: OAV Germanwings Timeline



What is your opinion on these measures?

I believe that now, with ICAO elevating Recommendation 8.46 to Standard 8.47 in its 41st Assembly in September 2022, this will mark a significant change in making states take more seriously the need to adapt or create, if they didn't already have one, an assistance system aligned with the standards set by ICAO's guidance documents. Additionally, the organization anticipates the need to support many states with fewer capacities through guidance, training courses, and more.

I find it very relevant that the ICAO Council unanimously supported the thirty recommendations from the Las Palmas Symposium, as some measures, such as promoting the ratification of the Montreal Convention MC99, will require intense diplomatic efforts. But these measures are crucial to achieving a harmonized global response or at least minimum guarantees regarding compensation and other aspects. It's a complex issue that involves the best practices of insurers and international standards.

Let's delve a bit into the new directions the OAV is taking. Considering that RD632 strictly refers to civil aviation, when and how did the interest in extending this to other modes of transportation arise? What is the current situation regarding multimodality?

The Mobility 2030 strategy approved in 2021 is still in the process of being updated and consulted. As a novel development in our context, it envisions the creation of multimodal organizations, both in accident investigation (safety) and victim assistance. It's not yet clear how this will materialize, but in the case of the OAV, its capabilities, both in terms of human resources and materials, should be enhanced to enable appropriate intervention.

How do you think it might be possible to adapt the assistance plan to other modes of transportation?

In 2021, we presented a proposal with general guidelines to expand the OAV to all sectors. We believe that the needs of affected individuals will be similar, regardless of whether the passenger is traveling by plane, train, or ship. In the end, they will all need constant information, a CAF (Family Assistance Center), financial and psychological assistance, transportation, translations, repatriation, site visits, commemorative events, and so on.

The structure of assistance would generally be based on the same principles. Then there is all the work of adapting to the specific peculiarities of each mode of transportation, the obligations of operators, infrastructure managers, and so forth. There is still a lot of work to be done in this regard.

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Ministerio de Transporte
Argentina

José Nesis,
Medical Psychiatrist (UBA), and Licensed Psychologist (UBA). Specializes in the psychosocial aspects of Road Safety.

WRITTEN LAWS VERSUS PRACTICAL CODE NORMS

Road Safety or Safe Mobility? The Challenge of Compliance with Regulations in the Road Space

Understanding the factors that influence compliance with regulations while driving allows the design of public policies aimed at reducing the number of road accidents.

In the context of transport safety, road space represents perhaps the most complex challenge in terms of the number of participants and resulting interactions. Furthermore, it is the environment of human circulation that claims the most victims. Due to its transversality, almost the entire population is part of the road space, whether on foot or behind the wheel. Focusing efforts on drivers and how they behave can be key to reducing accidents.

To achieve this, public policies must be designed in line with the regulations that govern the road space, both those governing interactions (usually expressed in the framework of traffic laws) and those characterizing the personal state of drivers (psychophysical abilities, substance use, use of devices, among others).

In very broad terms, all these rules can be classified into the two sets of norms established by the jurist W. Michael Reismann. The first group includes written rules, which in democratic societies usually arise from legislative processes. The second group comprises the so-called norms of the practical code, which instruct individuals on how to act based on knowledge that arises from customary social practice and depends on the place and time. These two types of norms do not always coincide. For example, in our country, the rule that governs right-of-way at unmarked intersections indicates the right-of-way to the vehicle on the right, but few people know what the rule says when there is traffic congestion at the same intersection. In surveys, the majority responds that they act according to a maxim that is not taught in driving schools but is passed down through generations: "nudge your way in, because otherwise, you won't get through." This way of behaving is a clear example of Reissman's Code of Practice norm. Another common example is the disconnect between the rule that gives priority to pedestrians in the pedestrian crosswalk and the tendency of drivers not to respect it, with the general acceptance of pedestrians taking precedence. The greater the distance between written rules and those of the practical code, the greater the social dysfunction. This gap in the road space translates into a significant cost in terms of lives and resources. Any approach to public policy should consider both sets of norms when seeking to strengthen compliance.

"Public policies must be designed in line with the regulations that govern the road space, both those governing interactions and those characterizing the personal state of drivers."

Why do we comply (or not) with rules?

Normative adherence, intuitively speaking, is associated with the punishment that may result from non-compliance. This is the focus of Gary Becker, known as the Simple Model of Rational Crime (SMORC)[1], in which normative non-compliance arises as a product of a cost-benefit analysis, not always conscious, that results from weighing the following factors: 1) the benefit that can be obtained from non-compliance, 2) the likelihood of being caught, and 3) the magnitude of the presumed punishment.

For a long time, states considered this perspective as the only and exclusive one, generating policies accordingly: increasing both the probability of detecting violations (or the perception thereof) and the severity of penalties. It should be noted that the first set of measures is much more costly than the second. Thus, the more "tempting" trend is to increase punishments. The age-old human rhetoric prescribes that "where there's a dead person, there's a guilty one," so the demand for harsher penalties is an easy, readily available resource that captivates without too many reservations. The problem is that it is not effective because it addresses only one aspect of the much more complex set of factors that lead to non-compliance. Another drawback of approaches primarily based on increased punishment (whether by increasing penalties or detection probability) is that their effects tend to diminish over time.

If the SMORC approach proves insufficient to address the issue of normative non-compliance, what other tools can help us?

1. Becker, Gary S. (1968). Crime and Punishment: An Economic Approach, *The Journal of Political Economy*, vol. 76, núm. 2.

Law, Morality, and Culture

On the one hand, there are the developments of Nobel laureate Douglass North, which were translated into public policies by the philosopher, mathematician, and two-time mayor of Bogotá, Antanas Mockus[2]. The idea is that compliance arises from the unique and singular result of a behavioral matrix that includes legal, moral, and cultural dimensions, expressed through positive and negative modalities. This perspective adds richness and complexity to the question of normative compliance. This approach complements that developed by Law Professor Mauricio García Villegas[3], who investigates the roots of normative non-compliance, especially in Latin America, and thus proposes a classification of what he calls non-compliant mentalities. These contributions have resulted, in the case of Mockus, in high-impact public policies and, fundamentally, a reformation of civic culture.

"Human beings operate both mentally and attitudinally in two systems: one fast, spontaneous, automatic, intuitive, and the other more rational, slow, and precise. Driving in the road space mostly occurs in the former, a mode that 'consumes' less energy."

Biases, Automatisms, and the Challenge of Not Getting Used to Non-Compliance

The second group of factors associated with normative non-compliance addresses Behavioral Sciences. Here, we have aspects of general human behavior and some specific issues in road safety. Behavioral Sciences reveal a wide range of biases and barriers that govern our conduct. The optimistic bias, for example, expressed in the idea of "it won't happen to me," leads drivers to adopt reckless behaviors because they overestimate their abilities or their chances of being in a road accident. But perhaps the most important contribution from this perspective is the discovery that humans operate both mentally and attitudinally in two systems: one fast, spontaneous, automatic, intuitive, known as System 1, and another more rational, slow, and precise, System 2[4]. Driving on the road mostly occurs in System 1, a mode that consumes less energy. The shift from System 1 to System 2 occurs when there is a situation that requires active thinking. Just as Vision Zero[5] suggests rethinking road infrastructure with the assumption that people will make mistakes, knowing that we operate in System 1 also helps in designing roads that unconsciously influence our driving behavior, making it safer.

Behavioral Sciences emphasize what is called the architecture of decisions, and from that perspective, the concept of a "nudge"[6] was developed: low-cost interventions that predictably influence this architecture, without significant economic incentives and

2. Mockus, A. (1994). Anfibios culturales y divorcio entre ley, moral y cultura. *Análisis Político 21*.
3. García Villegas, M. (2009). *Normas de papel: la cultura del incumplimiento de reglas.* Bogotá: Siglo de Hombres.
4. Kahneman, D. (2012). *Pensar rápido, pensar despacio.* Ed. Debate.
5. Vision Zero. https://visionzero.global/es

6. Thaler, R. y Sunstein, C. (2008). Nudge: Improving Decisions about Health, Wealth and Happiness. Yale University Press.

without legal coercion. For example, speed indicators that inform drivers of their current speed or optical and auditory cues on the pavement are signals that influence driving behavior without constituting rules or imposing sanctions but still modifying behavior. Lastly, Behavioral Sciences have also identified that the balance between fear of punishment and the desire to be honest is fragile: discomfort decreases as the "practice" of non-compliance increases. It has even been determined to some extent what the neural basis of this adaptation is, hence, the title of the article "The Brain Adapts to Dishonesty[7]" which addresses the issue. The hypothesis is that, through small non-compliances and over time, the brain becomes accustomed to the initial discomfort, leading to a sort of "tolerance," with the threshold increasing. From this perspective, the most effective approach is to detect non-compliance and intervene early. It is worth noting that the approaches of Mockus and García Villegas, as well as those of Behavioral Sciences, can guide new forms of governance.

Changing Words to Improve Legitimacy: Language, Tone, Voice

Finally, the third factor associated with the issue of normative compliance is the perception of the legitimacy of authority. This approach, developed mainly by Tom R. Tyler, a professor of Psychology and Law at Yale[8], emerges as a questioning of punishment as a deterrent tool. According to Tyler's theory and experiments, deterrence in the style of SMORC, i.e., by increasing punishment or the probability (or perception) of being caught, is of much lower power than increasing the legitimacy (or perception) of authority when it comes to achieving favorable rule compliance.

What characteristics should authority have to "gain" legitimacy? Tyler highlights some key traits in his experiments with a population of drivers in their interaction with the police: the voice, neutral tone, reliable motivation, and the requirement for an expression of respect (e.g., gratitude from the police at the end of a checkpoint). Individuals who receive treatment with such characteristics trust the rules more and tend to comply with them to a greater extent and over time[9].

It is noteworthy that the approach based on increasing the legitimacy of authority implies a friendly interaction with citizens, the opposite of considering drivers as suspects of an offense from the start. Almost like a language trap, the term "safety" simultaneously includes, without discrimination, both the safety associated with the intrinsic risk of behavior or the use of a good and the safety linked to the danger of intentional harm to integrity or property. In the first case, examples could be the installation of a railing for using a staircase or a fence for a swimming pool. The second case can be exemplified by anti-theft alarm systems or regular security personnel providing protection. In the first group, there is no intentional plan for harm, which exists in the second group. In English, these two types of safety are referred to as "safety" and "security", respectively. Treating road safety as a matter of "security" can lead us to interpretations and approaches that distance us from the nature of the transport system in the road space. Welcome are the attempts to rename it as "safe mobility" or similar, and may it not be just a change of words but a new and comprehensive perspective.

"The term 'safety' simultaneously includes, without discrimination, both the safety associated with the intrinsic risk of behavior or the use of a good and the safety linked to the danger of intentional harm to integrity or property."

7. Garrett, N., Lazzaro, S.C. y Ariely, D, Sharot, T. (2016). The brain adapts to dishonesty. Nat Neuroscience 19 (12): pp. 1727-1732.
8. Tyler, T. R. (2006). Why People Obey the Law. Princeton University Press.
9. Mazerolle, L., Bennett, S., Antrobus, E. & Tyler, T. R. (2012). Shaping citizen perceptions of police legitimacy: A randomized field trial of procedural justice. Criminology, 51.

Claudio Luis Salvetti
Electromechanical Engineer (UBA) specialized in radiological protection, nuclear safety, and occupational health and safety. Master's in Business and Organizational Psychology.

Consultant in organizational management and trainer in management systems.

THE RELEVANCE OF AN INTEGRATED AND SYSTEMIC RISK MANAGEMENT

Accidents, Safety, and Risk Management

The issuance of recommendations arising from systemic accident investigations and integrated risk management can contribute to a more effective safety in organizations. This article examines these ideas based on the developments of the leading experts in each of these approaches.

Accidents and their Prevention

There is consensus in the field of safety that the beginning of accident analysis and investigation from a methodological perspective can be attributed to Herbert William Heinrich, who published his work "Industrial Accident Prevention" in 1931. The framework developed by the author has been revisited in numerous studies; it was a linear investigation model based on a study that indicated that most accidents occurred due to unsafe acts by individuals (Dekker, 2014).

This precedent initiated a path in which workers became the "center of the problem" in accident prevention, leading to the development of behavior-based safety programs. These programs focus on reinforcing "safe behaviors" of workers to prevent accidents. Prominent authors in this model include Scott Geller ("The Psychology of Safety Handbook," 2001), Terry McSween ("The Values-Based Safety Process: Improving Your Safety Culture with a Behavioral Approach," 1995), and José Meliá ("Seguridad basada en el comportamiento: Perspectivas de intervención en riesgos psicosociales", 2007).

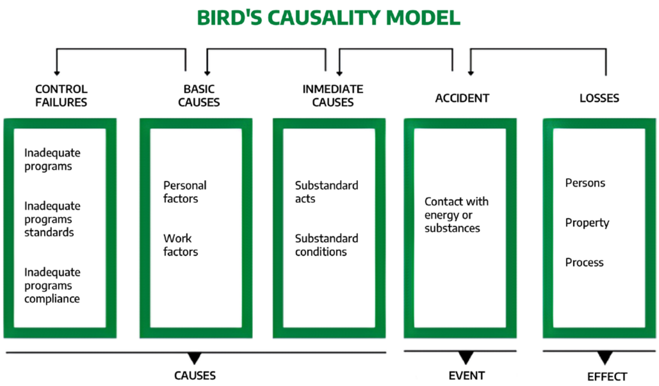
The behavior-based safety model still serves as a reference in many accident investigations in transportation and industries such as chemistry, mining, oil, and gas. However, advancements were made in prevention tools through the development of programs that focused on the role of supervisors. The most recognized of these was the program called "Safety Through Observational Practice" (STOP), created by Dupont and still applied in many industries.

Figure 1. STOP Program Fragment

Source: Dupont Security.

Other studies advanced in the direction set by Heinrich, among which the work of Frank Bird and Robert Loftus (1976), "Loss Control Management," stands out as a qualitative leap in accident investigation.

Figure 2. Causality Model



Source: Bird, Loftus (1976), Loss Control Management.

The main contribution of this model can be summarized in the idea that not only immediate causes (unsafe acts and substandard conditions) occurring at the accident scene should be determined, but also:

- Basic or underlying causes related to higher levels of the organization: contributing factors, which can be personal (e.g., inadequate capacity, lack of knowledge or skills) or work-related (e.g., insufficient supervision, inadequate engineering or maintenance, inadequate tools or equipment, inadequate procedures).

- Control failures in work programs and standards, which are related to management and various levels of supervision.

This model expands the scope to accidents that do not have consequences for people but cause material damage, affect processes, or impact the environment (losses). In subsequent studies, Bird developed a safety management system called "loss control".

From a more comprehensive perspective, with management retaining a central role in accident prevention, James Reason, renowned for his studies on human error, focuses on organizational aspects that influence safety management. He notes, "We cannot change human nature, but we can change the conditions under which people work in organizations" (Reason, 1990, cited in Covello, 2021).

This author emphasizes the problem of human fallibility in relation to "organizational accidents," which are characteristic of complex technological systems associated with the potential for serious consequences in communities and the environment (Reason, 1997).

Reason postulates the "Swiss Cheese Model," in which accidents occur due to the "alignment of defense layers." He proposes that all accidents occur within a combination of active failures and latent conditions.

Active failures correspond to actions or omissions (lack of attention, demotivation, procedure violations) and are typically associated with front-line personnel (operational staff). Latent conditions can exist long before an accident occurs and are related to organizational factors, such as decision-making at managerial and supervisory levels, leadership, goal setting, communication, work organization, training, procedures, or design.

It should be noted that, although industries often focus on analyzing active failures in investigations, there is greater resistance to analyzing latent conditions. This difficulty stems from the following clarification in ICAO Doc. 9859 (2018):

> "It is important to highlight that latent conditions, when created, typically have good intentions. Decision-makers in the organization often must balance finite resources, conflicting priorities, and potentially conflictive costs. Decisions made routinely in large organizations could, under particular circumstances, inadvertently lead to harmful outcomes".

In line with this statement, we may also ask: should we also highlight the good intentions of operational levels where active failures occur?

Investigating accidents under this model would lead to considering not only the identification and critical analysis of active failures but also the conditions under which people work, created by the organization," as stated by Covello (2021). This underscores the importance of risk management throughout the organization, as we will discuss in more detail later.

We will now move on to safety management, in which accident investigation, albeit with a reactive approach, is an essential part. Following Leveson (2019), we affirm that "an accident in which people die is tragic, but not as tragic as not learning from it."

Safety Management

The loss control management or modern safety management model (Bird and Loftus, 1976) marked a significant advancement in accident handling and safety management. It focuses on management, a management activity, and introduces a shift in safety perspective:

- It shifts the focus from people's behaviors to control, giving prominence to management: "80% of safety problems are attributable to decisions or actions ofmanagement" (Bird and Loftus, 1976).
- It places particular emphasis on measuring performance as a key element of safety management.
- It links safety management with other organizational (business).

This model includes stages of identifying loss exposures, risk assessment, planning, system implementation, and monitoring (ISMEC). It consists of twenty elements, among which leadership, training, procedure and task analysis, communication, change management, system measurement, and accident investigation stand out.

"The latent conditions can exist long before the accident occurs and are related to organizational factors."

It also incorporates organizational management practices, under the premise that what cannot be measured cannot be controlled, managed, improved, and deteriorates.

In this direction, many organizations develop specific policies, programs, and procedures for accident prevention. Reasons for this change include:

- The increasing demand of labor legislation and regulatory authorities' oversight.
- The need to prevent accidents due to their impact on people and the organization.
- Awareness of the cost impact of accidents on the business.

The Company Dupont, a leader in the field, supplemented its STOP program with others focused on safety leadership and operational discipline. To do this, they applied management practices to safety management with a focus on operational processes (Thomen, 1991; Briceno Graterol, 2017). Among the principles of their safety policy, the following stand out:

- All injuries can be prevented.
- Safety is the responsibility of line management (from top management to various levels of leadership and supervision).

Special mention should be made of industries that manage complex technologies, such as nuclear and aerospace, in which safety management has been determined from the beginning by a rigorous regulatory framework based on national and international regulations, as well as standards and guidelines issued by specific international organizations (International Civil Aviation Organization [ICAO], International Atomic Energy Agency [IAEA]).

In the 1990s, safety management systems emerged. These began with the publication of British Standard 8800, followed by similar standards in different countries. In Argentina, IRAM 3800 (Occupational Health and Safety Management Systems) was published.

In 1999, the first international standard specifying the requirements for an occupational health and safety management system was issued: the Occupational Health and Safety Assessment Series (OHSAS), which was updated in 2007.

A management system consists of a set of interrelated elements within an organization to establish policies, objectives, and processes to achieve these objectives (ISO, 2018). System elements include organizational structure, roles and responsibilities, planning, operation, performance evaluation, and improvement. It can address a single discipline (e.g., safety) or multiple disciplines.

The scope of a management system can include the entire organization, specific sectors or functions, both within the organization itself and within a group of organizations.

Safety management systems (SMS) currently constitute a relevant reference framework not only for industries that manage complex technological systems, such as aerospace and nuclear (ICAO, Doc. 9859, 2018; IAEA, 2011; ARN, AR 10.6.1., 2020) but also for the maritime industry (ISM Code, 1998), the railway industry (MT SMS 1st Railway Safety Directive, 2018), as well as other industries and organizations in general (ILO, 2001; ISO 45001, 2018).

The following main characteristics of safety management systems in general are highlighted:

- They are systems, meaning their elements interact and should not be analyzed in isolation.
- They are based on the Deming cycle (plan, do, check, and act for improvement) (ISO, 2018).
- They focus on implementing measures to ensure compliance with requirements, achieve objectives, and improve safety performance (performance, in terms of the ICAO Manual of Safety Management (Doc 9859, 2018)).

These systems consider leadership and the commitment of top management as success factors, as well as the commitment and participation of workers at all levels of the organization.

The planning stage of the management system involves establishing policy, identifying hazards, evaluating safety risks, and defining objectives.

Implementation also includes considerations regarding necessary resources, employee competencies, awareness of the importance of safety, necessary communications, and the definition of documented information required by the system. This stage also includes operational controls required to reduce operational risks to as low as reasonably practicable levels, along with emergency response planning.

“A management system consists of a set of interrelated elements within an organization to establish policies, objectives, and processes to achieve these objectives.”

In the verification stage, activities are carried out to assess the effectiveness of operational risk controls, monitor safety performance indicators or safety performance, and achieve objectives, safety inspections, and safety management audits. In this phase, top management must also review the effectiveness and improvement of safety performance resulting from system implementation.

The act stage includes activities such as reporting safety deviations or findings, highlighted by Hopkins as a central tool for maintaining and improving performance, as well as any other improvement activities (Hopkins, 2021). Accident investigation is also included in this stage of the safety management system.

Nancy Leveson (2019), at the Massachusetts Institute of Technology (MIT), applied systems theory and developed two models that differentiate between the proactive moment and the reactive moment of safety management (the latter includes accident investigation). One of them, the Causal Analysis based on System Theory (CAST), is used for analyzing scenarios in which accidents occurred, while the other, the System Theoretic Process Analysis (STAMP), is a proactive model aimed at identifying potential scenarios that can lead to losses.

Risk Management

The significant development of complex technological systems during the second half of the last century was accompanied by growing interest from the community and social sciences in the study of risk associated with these systems. This led sociologist Ulrich Beck to characterize contemporary society as a "risk society" (1999). Authors began to ask questions such as: What is an acceptable risk, and who defines it? (Mary Douglas, 1986), How safe is safe enough? (B. Fischhoff, 1978).

This made it clear to the industry that it was no longer sufficient to manage the safety of technological systems solely from a technical perspective. In this regard, German sociologist Niklas Luhmann (1991) analyzed the concept of risk and highlighted that it was complementary to security: "greater security, less risk," a statement that aligns with the technical approach. Safety management has focused on preventing accidents and acting to reduce their number and severity, a perspective that falls under what Hollnagel (2014) calls Safety I.

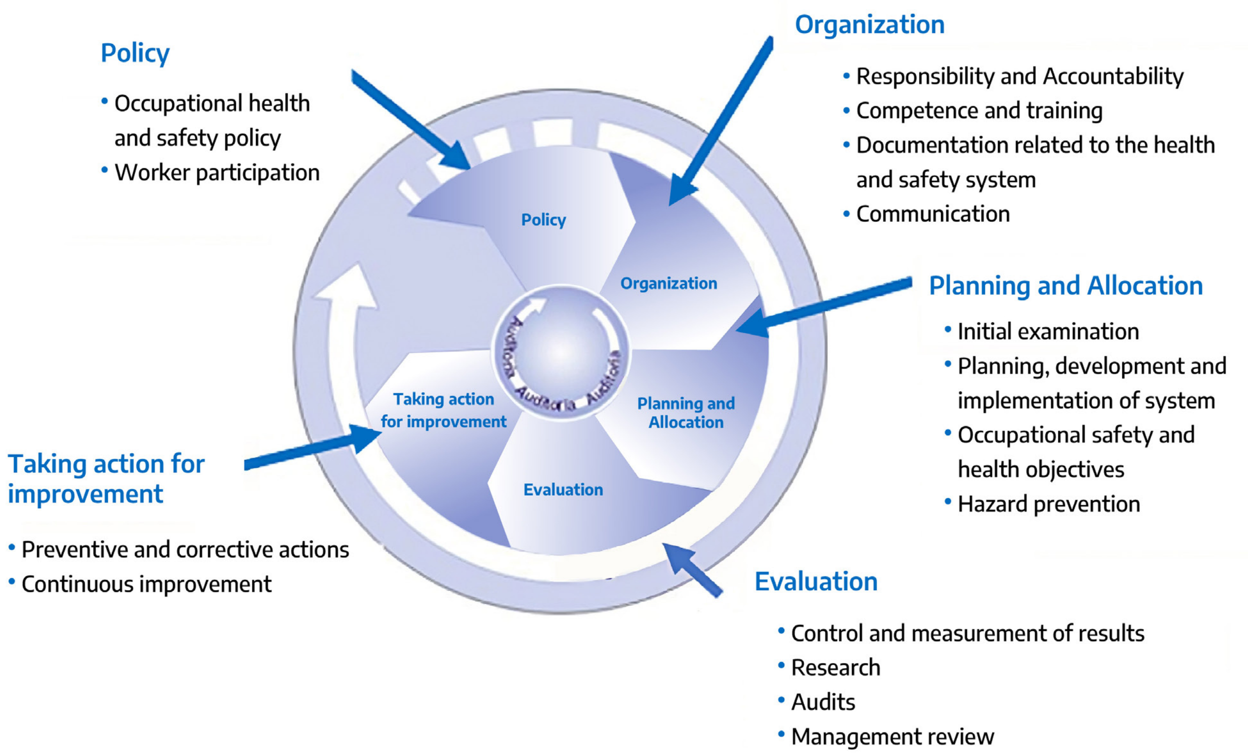
The focus on risk management, complementarily, revolves around questions such as: Have all hazards or sources of risk been identified? Are safety controls being applied? Are these controls adequate and effective? Are safety inspections and management audits effective in detecting deviations before accidents occur?

Safety management systems (SMS) were developed to address these questions and specialize in proactive risk management, particularly operational risks. However, within these same systems, questions like the following can also arise: Are there issues related to the context or stakeholders that can generate risks affecting safety management? Can safety be impacted by risks associated with other processes within the organization or the political-administrative-organizational system?

Safety management systems address the aspects mentioned in these questions and create conditions for integrated risk management with a systemic perspective.

Let's briefly examine one of the internationally recognized models for risk management: the one

Figure 5. Guidelines on Occupational Safety Management Systems



Source: OIT (2021).

developed in ISO 31000 (ISO, 2018). This model can be applied at any organizational level, from strategic to operational (where safety risks are included), and it can be applied in various industries, including industrial and financial sectors.

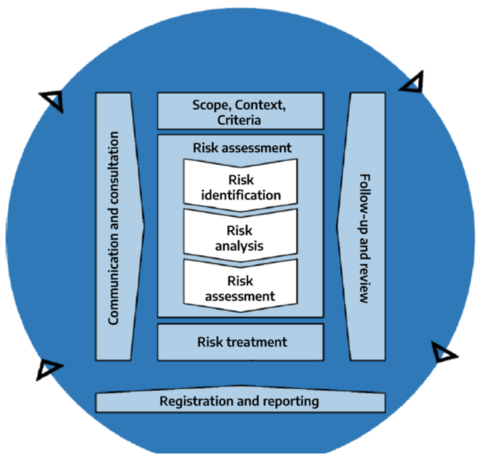
In ISO standards, risk is generally defined as "the effect of uncertainty on the achievement of objectives." These objectives include compliance with legal requirements and those of other interested parties, achieving goals, and improving safety performance.

This standard defines risk management as "the coordinated activities to direct and control an organization with regard to risks associated with its activities." Its purpose is to create and protect the organization's value. Managing risk, from this perspective, emphasizes achieving expected results; thus, it is a positive approach aligned with the principles of Safety II developed by Hollnagel (2014).

In the same vein, there are high-reliability organizations (HROs) models that operate safely in complex scenarios. They are characterized by promoting a culture of reporting failures and errors, delegation of decision-making at all levels, and a higher perception of the risk associated with disruptions in operation that could eventually lead to accidents (such as the U.S. air traffic control system) (Dekker, 2019). The organizational robustness model also fits in this context, defining a robust system as one that can adapt to disturbances through more or less complex regulation mechanisms (Boissieres, 2007).

ISO 31000 highlights that top management should exercise leadership and commitment in managing each of the organization's processes as a whole system. Process owners should also be responsible for managing risks related to their processes.

Figure 8. Risk Management Process



Source: ISO 31000 Std.:2018.

Figure 7: Relationship between Risk and Safety

Source: Own elaboration.

The main stages of the risk management process stipulated in this standard, similar to those established in management systems, include risk identification, analysis and assessment, and subsequent treatment to meet acceptability criteria. These criteria should be established based on the best available information, industry or sector standards, legislation, policies, and current regulations. Organizations should define the scope to which the risk management process applies, document it, and carry out monitoring activities for each of the mentioned stages.

Additionally, this model includes activities such as context analysis and consultation and participation of stakeholders (including suppliers, regulatory bodies, workers, and the public) in the operational risk management process. Let's see how some of the previously presented management systems address these issues.

ISO 45001, which includes requirements for occupational safety and health management systems applicable to organizations in various industries, states that issues related to the context (such as potential changes in legislation, macroeconomic, political, environmental, technological, or social factors) and the needs and expectations of interested parties should be determined. Then, based on this analysis, risks associated with these issues that could impact safety management system planning and implementation should be addressed.

Furthermore, according to the regulations issued by the Argentine Nuclear Regulatory Authority (ARN), the management system "must integrate specific safety elements (radiological and nuclear) with environmental, economic, social, organizational, and human factors" (2020).

Among the requirements of the management systems published by the IAEA (2011), it is established that the management should "take into account the expectations of interested parties in the activities and interactions of the management system processes to increase the satisfaction of interested parties while ensuring that safety is not compromised." The same organization also recommends good practices related to involving stakeholders in risk management (IAEA, 2006).

In the aviation sector, the SMS developed in ICAO Doc. 9859 (2018) indicates that recognizing the aviation system and its context, considering all organizations and processes involved, contributes to better risk management and, consequently, improved safety performance of the "total system."
Furthermore, in the same manual, what is known as Integrated Risk Management (IRM) is developed, emphasizing the overall reduction of risks within the organization. The document specifies the following:

> The aviation system as a whole comprises different systems and processes, such as financial, environmental, safety, and aviation security. While each system has developed risk management frameworks and practices aimed at addressing their own characteristics, consequences can occur between systems, given that effective risk management action in one sector may have negative consequences on another operational aviation sector (e.g., restrictions on carrying personal electronic devices in the cabin may shift the security risk from the cabin to the cargo hold, increasing safety risks).
>
> Successful risk management in aviation should aim for the overall reduction of risks in the system, including all involved systems or functional areas, a process that requires a system-wide assessment at the highest level (State, regional organizations, service providers)
>
> Integrated risk management aims to coordinate management processes from a systemic perspective with the goal of reducing hazards through their assessment in each sector, using a holistic approach to achieve the highest level of system performance at a socially acceptable level (ICAO, Manual of Safety Management, 2018, section 1.4.3).

Finally, it is important to emphasize that risk management has an anticipatory nature. Were the risks associated with the dysfunctional characteristics of the Chernobyl plant's structure and leadership system not known before the catastrophic accident in 1986? Were the managers of the Challenger project at NASA not warned in the same year about the possibility of component failures before launch? Were Boeing's leadership not informed about the risks of lowering safety standards to meet business objectives, which created the conditions for the 737 Max accidents?

The hazards related to these accidents were known, and these examples underscore that risk management should not neglect the political, power-related, and general interests involved in high-impact decision-making within organizations and their context, as highlighted by Covello in the context of accident investigations (2021), which poses "a political, ethical, and intellectual challenge."

"Risk management should not neglect the political, power-related, and general interests involved in high-impact decision-making within organizations and their context."

CONCLUSIONS

This article highlights the relevance of integrated risk management with a systemic perspective to achieve more effective safety management.

In this regard, we would like to summarize the following aspects:

- Due to its preventive nature, risk management should guide safety management.
- Integrated risk management, considering the interaction between risk management functions in various areas and processes of the organization (finance, procurement, human resources) and the global system it belongs to (transportation system or others), leads to more effective operational risk management.
- Analyzing the context, as well as communicating and consulting with stakeholders (suppliers, workers, customers, etc.) in the operational risk management process, can promote better safety performance.
- The determination of recommendations arising from the systemic accident investigation, with a focus on the analysis of the degree of integration of risk management of all processes in the organization, can contribute to the prevention of new accidents.
- While security risk management focuses on operational processes, it is essential that it is integrated into the management of risks associated with all functional areas and processes from a systemic perspective and under the leadership of senior management, given the interaction that can exist between them.

References

Bird, Frank E., Robert G. Loftus. (1976). Loss Control Management. Institute Press.

Briceno Graterol, A. (2017). The Path through Competencies for Zero Accidents. Dupont Sustainable Solutions.

Covello, A. (2021). Systemic Accident Investigation. Ciccus Publishing.

Dekker, S. (2019). Foundations of Safety Science. CRC Press.

Fischhoff, B., Slovic, P., Lichtenstein, S. (1978). How Safe is Safe Enough? Policy Sciences.

Hollnagel, E. (2014). Safety–I and Safety–II. The Past and Future of Safety Management. Ashgate.

Hopkins, A. (2021). Becoming a High-Reliability Organization. ICSI.

Leveson, N. (2019). CAST Handbook: How to Learn More from Incidents and Accidents. Independent Publication.

Reason, J. (1997). Organizational Accidents. Ashgate.

Thomen, J. (1991). Leadership in Safety Management. Wiley.

Norms and Regulations:

Ministry of Transportation (2018). Railway Safety. Safety Management System.

International Civil Aviation Organization (ICAO). Doc. 9859. Manual of Safety Management. Fourth Edition.

International Atomic Energy Agency [IAEA] (2006). Stakeholder Involvement in Nuclear Issues. INSAG 20.

International Atomic Energy Agency [IAEA] (2011). Facility and Activity Management System. No. GS-R-3.

International Organization for Standardization [ISO]. (2018). Standard 31000. Risk Management.

SYMPOSIUM JST

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The symposium is divided into three days, each addressing different topics. On the first day, the focus will be on "Innovation in Transport Safety: New Technologies and Processes." This session will discuss the impact of technological advancements and investigation tools in various modes of transportation that influence data monitoring, decision-making, and policies aimed at improving transport safety.

During the second day, under the topic "Diversity and Safety in Transport: Resilience through Inclusion," discussions will address public policies promoting the inclusion of women and diverse individuals in transport, as well as regarding the accessibility and inclusion of children and people with disabilities in transportation systems. The role of children in shaping safe, accessible, and sustainable transport systems will also be explored.

Lastly, the third day will focus on "Transport and Environmental Safety." This session will delve into low-impact environmental resources and technologies in various modes of transport, as well as the impact of climate change on safety.
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PROACTIVE APPROACH TO EVENT ANALYSIS

Multimodality in Transport Accident Investigation: Challenges and Opportunities

The success of the aviation industry over its more than one hundred years of existence has stimulated the transfer of many of its procedures and practices to other modes of transport.

Introduction

Advancements in aviation accident investigation have been remarkable, and their contribution to the safety of the industry has been significant. This has allowed aviation to climb successive steps in safety through accident analysis.

This article compiles, in a necessarily summarized manner and from an international perspective, how the pillars that contributed to aviation's success have become challenges to maintaining the contribution of accident investigation in the face of the minority and incipient—but growing and irreversible—trend towards the integration of multimodal investigation bodies, while outlining the improvement opportunities that these challenges present.

One fundamental consideration to keep in mind when transferring experiences between modes of transportation is that the successful path taken by aviation investigation and, especially, accident analysis didn't come without its flaws. The lessons from aviation achievements may not always be transferable to other means of transport, but the lessons from its failures certainly are.

A note before addressing the matter: this article does not concern conceptually with the collection of evidence during the investigation but with the analysis of the evidence collected after the investigation. This is because the challenges for multimodality do not arise from the investigation itself, which is essentially practiced as it was a hundred years ago, but from the transformation of the collected evidence into information that contributes to the safety of transport operations[1].

The (Im)probable Cause

Historically, the foundational notion of aviation accident analysis has been the probable cause. This notion and its perpetuation are, like many others, a legacy of the American system to aviation, and its transfer to other modes of transportation is a fait accompli. It was first used in aviation in 1934, in an amendment to the Air Commerce Act of 1926, which was the starting point for the regulation of air transportation in the United States. The clause has legal connotations: in U.S. criminal law, probable cause is the standard that defines the reasons authorities must provide to justify the detention of a suspected criminal or the search of private homes. The standard aims to limit the power of authorities and promote the lawful collection of evidence, observing appropriate procedural forms.

[1]More comprehensive treatment of the topic can be found in "La causa improbable. Una crónica de la contribución de la aviación civil al análisis de accidentes de transporte en el siglo XXI" by Daniel Maurino and Juan F. Mangiameli (2022). This book is available in ePub format on Baja-Libros.com offering insight into the contribution of civil aviation to the analysis of transportation accidents in the 21st century.

"The challenges for multimodality do not arise from the investigation itself but from the transformation of the collected evidence into information that contributes to the safety of transport operations."

One can argue good intentions in applying the standard to transportation accident analysis, such as explicitly defining the authority of investigators, promoting protocol-based evidence collection, justifying the analysis, conclusions, and safety recommendations, etc. However, the result has been controversial, and the controversy has not been exhausted. This is because the application of the standard to transportation accident analysis fits into the intersection of issues with safety, technical-operational, legal, juridical, and cultural dimensions. Nevertheless, it would be a mistake to completely discard the notion of probable cause as a comprehensive framework for accident investigation. There is consensus in the international safety professional community about the validity of retaining probable cause applied to the analysis of technical system failures, where anomalies speak clearly and rarely repeat, making each accident something new. However, there is also consensus that probable cause, as applied to the analysis of failures in sociotechnical systems, becomes improbable when applied to the analysis of sociotechnical system failures, where anomalies speak in whispers, ambiguities, and repetitions, resulting in no new accidents.

The fundamental argument against applying probable cause—or its contemporary version, the root cause—to the analysis of sociotechnical system failures can be summarized in three considerations:

- The clause conveys extreme simplification and is a framework that distorts and fails to reflect the real complexity of the multitude of factors converging in the triggering of accidents in the sociotechnical system.
- Even the best-worded statement of probable cause does not say much about why the accident occurred; it diverts attention from the multiple and diverse factors always present in the causal chain and channels it toward a single factor.
- Like any technical statement specifically oriented toward a single conclusion, the clause can be interpreted by those who are not integral to the

> investigation, by those who know the end of the story but not its course, and by the public media as if the statement of a single factor leads to assigning responsibility to the one who caused the accident.

Many countries, in addition to the United States, retain the clause, and the United States has entrenched itself in an immovable position justified by the fact that the clause arises from federal law. Due to the influence of the United States at the global level, probable cause endures, both institutionally in organizations and individually in accident investigators. Opposing the use of the clause are countries such as Argentina, Australia, Canada, Finland, France, Japan, the Netherlands, Norway, New Zealand, the United Kingdom, Singapore, and Sweden, which have abandoned the notion of probable cause and have adopted clauses such as "factors related to the accident," "risk factors," "factors related to causes," "other risk factors," etc.

A first specific challenge and opportunity for improving the multimodality of accident analysis is clearly expressed through a battle cry that originated in aviation back in the 1980s: "down with probable cause!"

Difference Between Investigation and Analysis

All modes of transportation collect safety data. In the case of aviation, data collection is substantial and stored in computerized repositories with tremendous potential for optimizing the management of stored data. However, transforming this substantial volume of safety data into actionable information through analysis is another story. Some propose that aviation is an industry rich in data but poor in information. This is a systemic condition that transport accident analysis cannot ignore. The collection of evidence about the facts and circumstances surrounding an accident generates data that the subsequent analysis must transform into actionable information for the purpose of formulating safety conclusions and recommendations. These are two connected but distinctly different activities within the same process: investigating (collecting evidence) is finding the puzzle pieces, and analyzing is putting the puzzle pieces together coherently. Nevertheless, in most—if not all—investigation bodies, both activities are performed by the same professionals, assuming that the competencies for analysis are congruent with the competencies for evidence collection. This is a fallacious presumption.

Training in aviation—and in transportation in all its modes—for the development of professional competencies for evidence collection (finding the puzzle pieces) is extensive. It is the central axis of safety professional training, offered by official bodies, universities, and industry organizations, with an offering accessible to all budgets. In contrast, training for the development of specific professional competencies for accident analysis (assembling the puzzle pieces coherently) does not have a similar offering and is typically limited to material analysis. The reason is a historical continuation: the absolute priority of transport accident investigation during the precontemporary era—the era of technical system failure analysis, from the 1950s to the 1970s—was the improvement of technology, and evidence analysis was based exclusively on knowledge of exact sciences, which was common among investigators. Under this approach, competencies for evidence collection and analysis overlapped. The landscape is quite different when it comes to analyzing failures in sociotechnical systems, where knowledge of exact sciences contributes but is not sufficient on its own, demanding a multisectoral, multidisciplinary approach and, therefore, multiple and different competencies.

"The absolute priority of transport accident investigation during the precontemporary era was the improvement of technology, and the analysis of evidence was basedexclusively on the application of knowledge from the exact sciences, mastery of which was common among investigators."

The fundamental problem that hinders training to develop the necessary professional competencies for accident analysis under the sociotechnical approach is that—at least in aviation—neither the position's profile nor the task analysis of the aviation safety analyst have been formally defined. Throughout its history of institutionalized dialogue, the aviation industry has not reached a consensus on the competencies, profile, or tasks of the safety analyst.

A second specific challenge and opportunity for improving multimodal accident analysis lies in reaching a consensus across different modes of transportation regarding the profile of the safety analyst and the associated competencies, formalizing task analysis, and developing training curricula to facilitate the effective alignment between the activities of evidence collection and analysis, all integrated within the overall accident investigation process.

Reactive vs. Proactive

The distinction between reactivity and proactivity is a term that emerged as a result of the introduction of Safety Management Systems (SMS) into the aviation industry in 2005. This differentiation was considered necessary because, up until then, accident investigation—a reactive process—had been the primary source of safety information. It was initially intended to raise awareness without sparking controversy. However, the issue and the associated debate have persisted. Like the concept of probable cause, this terminology has also been transferred to other modes of transportation.

It's evident that accident investigations are reactive since they cannot begin until after an accident has occurred. After all, what would they investigate otherwise? However, whether accident investigations are reactive or proactive is neither inherently good nor bad. It doesn't imply merits or demerits but simply describes their nature. Engaging in a debate about the merits of proactivity versus the demerits of reactivity, or vice versa, is unproductive. The real issue here is the confusion between the nature of the accident investigation process and the institutional attitude of the investigative body responsible for it. The fact that the process is inherently reactive doesn't mean that the institutional attitude of the accident investigation body should also be reactive.

Some accident investigation bodies—though not many—have recognized this difference and have taken measures to prevent institutional inertia during periods between accidents when the body is not called upon to perform its specific function. These organizations utilize their data repositories, for example, to conduct multi-theme safety analyses at the national system level, develop information regarding safety priorities, coordinate studies on specific safety issues, etc., which are then shared with a broader range of government and industry organizations to find macro-level solutions. These organizations have institutionalized an internal department, permanent and independent of the investigation activities, for data mining and the development of safety information. In this way, even though the accident investigation process is inevitably reactive, the institutional attitude of the body reflects a healthy integration of reactivity and proactivity.

A third specific challenge and opportunity for improving multimodal accident analysis is raised: the development of consensus guidelines for the formalization of internal structures within accident investigation bodies to support data mining—without forgetting that the specific function of the body is investigation—and to foster a proactive institutional attitude. It goes without saying that the likelihood of successfully addressing this challenge depends largely on the resolution of the previous challenge.

Cooperation between Technical and Judicial Investigations

Cooperation between technical and judicial investigations is a thorny issue in accident analysis, given the particular nuances of each mode of transportation and closely related to the actual degree of independence and autonomy of the investigative body. Finding a solution for harmonious cooperation between two activities with such disparate purposes (one focused on not determining responsibility or assigning blame, the other on determining responsibility and assigning blame) is a significant challenge. In aviation, the international regulatory support for cooperation between technical and judicial investigations of accidents is established by the International Civil Aviation Organization (ICAO) in Annex 13 (Aircraft Accident and Incident Investigation) to the Convention on International Civil Aviation, as well as in the Manual on the Protection of Safety Information (Doc 10053), which provides supporting material for implementation.

The global landscape in this regard is heterogeneous. In some jurisdictions, ICAO's regulations and supporting material on this topic have been adopted as long as they are compatible with the prevailing legal code. In others, the issue has been sidestepped. This should not be surprising since the matter combines legal, sociopolitical, technical-operational, and cultural dimensions more than the application of probable cause to the analysis of sociotechnical systems. The problem in advancing on this issue is that, at least in aviation, the solutions proposed by ICAO invariably originate from countries with common law legal systems, which represent less than one-third of the world. In the remaining more than two-thirds of the rest, civil law legal systems prevail. The compatibility between the two systems is relative, based on the defining characteristic of each: common law arises from precedents that can be binding; civil law arises from explicit, transcribed codes that are publicly accessible. Under common law, a judge may make binding decisions based on precedents; under civil law, a judge must decide based on the relevant explicit code, and precedent can be used as reference but is never binding.

Why highlight this detail? Because aviation experience indicates that, for reasons that go beyond the scope of this article, common law is more amenable than civil law to formalizing protocols that coordinate technical and judicial investigations of accidents. The dilemma is evident, at least in aviation: the solutions proposed by ICAO for the majority derive from legal systems that are in the minority and have recognized differences from the legal systems that are in the majority worldwide. This complicates the transfer of solutions between the two systems and, more importantly, their real effectiveness. Therefore, attempting to coordinate technical and judicial investigations after an accident in jurisdictions with civil law legal systems using solutions originating from common law legal systems may have little merit. The foregoing should not be interpreted as resignation but rather as an argument in favor of contextualized solutions rather than copied ones. The formalization of protocols for coordinating technical and judicial investigations after accidents in jurisdictions with civil law legal systems should consider three realities of these jurisdictions:

- The participation of the judicial authority in the investigation after an accident is inevitable and prominent.
- Under the rule of law, denying access to information to the judicial authority is not permissible.
- It should be assumed that the final report of the accident investigation will be used by the judicial authority as a matter of course.

From these three realities, efforts to formalize coordination between technical and judicial investigations after an accident in jurisdictions under civil law must operate within the possibilities and limitations of each jurisdiction, rather than attempting solutions incompatible with the system or fantasizing about modifying it. For example, it should be attempted to reach a consensus on a protocol for the limited involvement of judicial authorities immediately after an accident, establish explicit guidelines for access to investigation data that are time-sensitive for each authority, produce final reports that describe and explain without subjective language, etc.

A fourth specific challenge and an opportunity to improve the multimodality of accident analysis is presented: the consensual development of standards for formalizing coordination between technical and judicial investigations of accidents among different modes of transportation in jurisdictions under common law, based on a contextualized assessment of the possibilities and constraints of the prevailing legal code, avoiding the copying of solutions.

Effectively Communicating the Message

All modes of transportation have their own jargon. In aviation, for instance, the distinctive feature is the use of abbreviations: control tower becomes TWR, aerodrome becomes AD, flight level becomes FL, and so on. This is inconvenient for someone reading a technical aviation document without a filter, and the fact that the abbreviations are of English origin doesn't help either. Furthermore, the predominant profile among aviation professionals, and in transportation in general, is oriented towards the exact sciences rather than humanities. Finally, until recent times, the average formal education level of technical and operational personnel, at least in aviation, was at the secondary school level. The combination of the above factors results in a professional profile, on average, that favors technical content in writing and telegraphic brevity in communication.

> ***"The collection of evidence about the facts and circumstances surrounding an accident generates data that the analysis must then transform into actionable information for the purpose of formulating conclusions and safety recommendations.***

Naturally, the final report of a type of accident investigation drafted by professionals with the characteristics described in the previous paragraph can only reflect them. A non-exhaustive exercise in quality control would reveal the following aspects to improve in the writing of a type of accident investigation report:

- Telegraphic sentences and writing errors.
- Excessive technical jargon and unexplained abbreviations.
- Presumption of the reader's knowledge of technical issues related to the facts and circumstances.
- Lack of context that allows for an understanding of facts and circumstances.
- Excessive detail in data and parsimony in analysis.
- Qualitative adjectives, including value judgments, at the expense of neutral description

- Repetition of factual content in the analysis.
- Obscure connection between analysis and conclusions.
- Ambiguity in safety recommendations.

The final report of an accident investigation is the main product of the accident investigation agency, as well as a public document that must be widely accessible. Its writing should facilitate understanding of the facts, circumstances, analysis, and conclusions that arise from it. Its content should be accessible to the widest spectrum of society. However, the writing style of the typical accident investigation report makes it manifestly inaccessible to those who are not experts in the field. Attention to the writing and editorial correctness of the final accident investigation report is not a minor issue: a good idea communicated poorly loses its value. It is not uncommon for the effort, the product of evidence collection and analysis, to see its potential devalued by shortcomings in the communication of the message, which is transmitted incompletely or not at all. There are alternatives –non costly– to address this challenge, the most obvious of which is the incorporation of professional editors into the accident investigation agency.

A fifth specific challenge, and an opportunity for improving the multimodality of accident analysis, is as follows: the accident investigation agency should institutionalize mechanisms to ensure editorial correctness and readability of the final report for the widest audience.

Finally, Regarding Multimodality Itself

Accident investigation originated in aviation with the aviation industry itself. In the absence of other guiding sources, aviation initially adopted techniques and procedures from judicial and police investigations, gradually adapting and innovating in favor of its own process for which it assumed ownership and responsibility. Other modes of transportation followed a similar initial path to aviation but with one key difference: they retained the judicial and police systems as the custodians of the investigation process. Consequently, in many jurisdictions, the responsibility for investigating accidents falls to court officials supported by transport experts for road and rail accidents, the coast guard for maritime accidents, and so on.

This situation began to change during the 1990s. Various jurisdictions started the institutional integration of accident investigations from various modes of transportation into a single organization, based on the one that had been investigating aviation accidents up to that point. This gave rise to the concept of a multimodal accident investigation agency. Consequently, these aviation accident investigation boards became, institutionally, multimodal transport safety boards. As a result of this situation, in October 1993, the United States, Canada, Sweden, and the Netherlands established a forum for institutional learning through the exchange of information between multimodal investigation agencies: the International Transport Safety Association (ITSA). A condition for joining ITSA is precisely that the requesting agency must be multimodal to contribute to the exchange of experiences between modes of transportation. Thirty years later, ITSA has 18 member countries out of the 193 United Nations member countries. This fact alone reveals the challenges to be overcome on the path to establishing multimodality in accident investigation agencies. Additionally, off-the-record sources suggest that in some of these 18 countries, the institutionalization of multimodality does not necessarily translate into multimodal practices in accident investigation.

> ***"A third specific challenge: the development of consensual guidelines to formalize to formalize internal structures within organizations and foster a proactive institutional attitude.***

Ultimately, the decision regarding the necessity and convenience of multimodality for the accident investigation agency should consider two factors: What is the problem in the local context of the country for which the multimodality of the accident investigation agency is a solution? Why is it considered necessary in the local context? It should be noted that introducing multimodality without a clear purpose, as an end, rather than to an end, could jeopardize the credibility of the accident investigation process. The specific goal should be established explicitly in advance because the fact that multimodality works and is a solution in one context does not necessarily mean it will work and be a solution in others.

A sixth and final specific challenge, and an opportunity for improving the multimodality of accident analysis, is as follows: each jurisdiction must assess the real need for the multimodality of the accident investigation agency. This is an individual challenge for each jurisdiction, and the decision should not be based on what is done elsewhere but rather on the needs and constraints of each context. If decided upon, copying solutions should be avoided, and multimodality should be established considering local needs and constraints.

CONCLUSION

The resolution of the challenges to multimodality in accident analysis outlined in this article is a significant factor in reaffirming the accident investigation process as one of the key components of transport industry safety. These challenges do not arise from the process itself but rather from the actions of the agencies responsible for carrying it out, including their personnel. They are a result of the impact that the evolution of accident analysis thinking, and practice has had at an institutional level. In this regard, it is appropriate to conclude with a basic guideline: if there are criticisms of accident investigations in transport, they should be directed towards the agencies responsible for them rather than towards the process itself.

Biography: Daniel Mauriño is a safety operational advisor for the Technical Cooperation Bureau (TCB) of the International Civil Aviation Organization (ICAO). He worked at ICAO in Montreal, Canada, for 21 years, initially as Coordinator of the Flight Safety and Human Factors Program of the Organization, then as the manager of the ICAO project for implementing safety management, and finally as the head of the Integrated Safety Management (ISM) Section, which he created.

Recently, he served as a project manager for the Spanish Aviation Safety Agency (AESA) and the National Civil Aviation Administration (ANAC) of Argentina in the implementation of their respective SSPs. He also advised the Argentine Civil Aviation Accident Investigation Board (JIAAC) on accident analysis and safety information management, as well as in the transformation of JIAAC into the current multimodal accident investigation agency, the Argentine Transportation Safety Board (JST). He is an Honorary Professor at the Transportation Institute (IT) of the National University of San Martín (UNSAM).

He is the author of several books related to human factors and safety.

René Amalberti
Professor and Doctor of Medicine, Doctorate in Psychology, Director of the Foundation for an Industrial Safety Culture (FONCSI).

Speaker at the JST Symposium

TRANSFORMATIONS IN AVIATION

Safety Tested by Humans and Organizations

In less than sixty years, civil aviation has been profoundly affected by a series of revolutions occurring roughly every ten years. This article describes this development, its links to the human dimension, and the changing safety issues over time.

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.

INTERVIEW WITH LIANNE VAN DER VEEN

"We are equal to any man in the world, but we are not the same"

Lianne van der Veen, Senior Maritime Accident Investigator at the Dutch Safety Board (DSB) and President of the International Forum of Maritime Accident Investigators (MAIIF) since 2018, served as the keynote speaker on the second day of the JST Symposium: 'Diversity and Safety in Transport: Resilience through Inclusion'. She shares her experiences in this interview.

Why did you decide to start your career in the maritime world, or when did you realize you wanted to pursue this?

My parents had an inland navigation barge company (there are many of these small inland cargo barges on the rivers in Europe), and my parents had one, so I was born and raised on such a barge, and I always liked it. I didn't want to do what they did, but I always knew I was going to continue in the shipping business and do something with it. That's why I went to the Naval Architecture university.

What was it like being a woman in these spaces? Did you encounter any barriers or obstacles?

In the inland navigation where I grew up, it was quite common for women to do the work as well. So, for me, that wasn't very strange. This is a question that makes me reflect, but I don't think there's a definitive answer. I think I was able to adapt to the circumstances I found myself in; I never had major obstacles to achieving the goals I set for myself just because I was a woman. It was at university, where I was one of four women in a class of 45 students, that I realized "something was different." Anyway, I'm not sure I really encountered barriers. I suppose that from the beginning, I always tried to understand how the industry worked, and it was my more masculine side that allowed me to be accepted. Maybe only once did I experience prejudice when, after a phone call, my colleague said, "They thought you were the administrative assistant, not the investigator." But I think that was the only time.

Certainly, the way you dealt with everything and your knowledge of how to navigate these situations played a significant role. Additionally, do you think that the situation in the Netherlands is different from other places?

Of course, I see differences all around the world. In the Netherlands, we have a good working environment, but we also face difficulties. It's a combination of factors; I think in my case, it has to do with my ability to adapt to each situation.

You were one of only four women in your class, and due to your life experiences, you dealt with discrepancies with a different approach, more focused on your abilities than the difficulties that might arise from being a woman in that field. Do you think it was the same for others, or perhaps someone who wasn't connected to the maritime world would have had a different experience?

One of my classmates had no experience in the maritime world, but she also managed to succeed. I believe the key is to have confidence in your knowledge. We all started from the same place, and she also reached a position. You must believe in your own way of doing things. It's essential to be able to adapt to different circumstances. You need to understand that it's a male-dominated world, and perhaps, at times, they want to keep it that way. It doesn't necessarily require fighting it but defending your own position, trying to achieve your goals instead of feeling dominated. Unfortunately, this feeling arises in many women, but it's essential to recognize it and not fight against it but defend it.

What challenges do you see today regarding women's participation and diversity in the maritime world?

There is a difference between being equal and being the same. I am equal to any man in the world, but we are not "the same." I am fighting for equality, but I don't want to be the same as a man. Looking at biological factors, we are not the same, but that doesn't mean we can't achieve the same goals. If you strive to be the same, that becomes an obstacle. But equality and being taken seriously, for example, that's what we should strive for.

"We must work for equality and to be taken seriously as women.

The challenge I see is that if you are a man accustomed to working with men, working with a woman will be different. It's in our DNA to be as comfortable as possible, so it's not always easy to accept something in your group when it poses a challenge and requires a new way of thinking. To be honest, I wouldn't want to be on a team with only women, as a team composed of both men and women is more complete. The key is to accept differences and seek the necessary balance.

To work in a male-dominated environment, such as women in the maritime world, sometimes you need someone to introduce them to a male team. You can fight alone, but it's not always easy; sometimes you need someone to clear part of that path for you.

Do you see any evolution since you started?

I think there is some evolution, but on the other hand, if you look specifically at the maritime career, I don't see that much progress. If a man goes to sea for three months, we accept it, but I couldn't be away from my family for three months. Throughout history, it has been easier for men to do that. Of course, this is not a generalization; there will always be people who think differently, but I don't believe there has been much evolution. It's not about men versus women; we are equal, although different.

Of course, I only know the European situation. It is known that Dutch women raise their voices, but

I think this is not accepted or as common in all cultures. There are differences. In my environment, I see opportunities; neither my parents nor anyone else has pressured me to stay at home, take care of the children, or not go to work. But of course, if you go back forty years, the situation was different. In the Netherlands, I see some evolution, but I know that not everyone is at the same stage. We can learn from each other.

"I wouldn't want to be on a team with only women because a team composed of both men and women is more complete. The key is to accept differences and seek the necessary balance.

Since 2014, you have worked as a maritime investigator at the Dutch Safety Board (DSB), becoming a senior investigator in 2021. What can you tell us about your work there and about the DSB? Could you share your opinion on safety and multimodality?

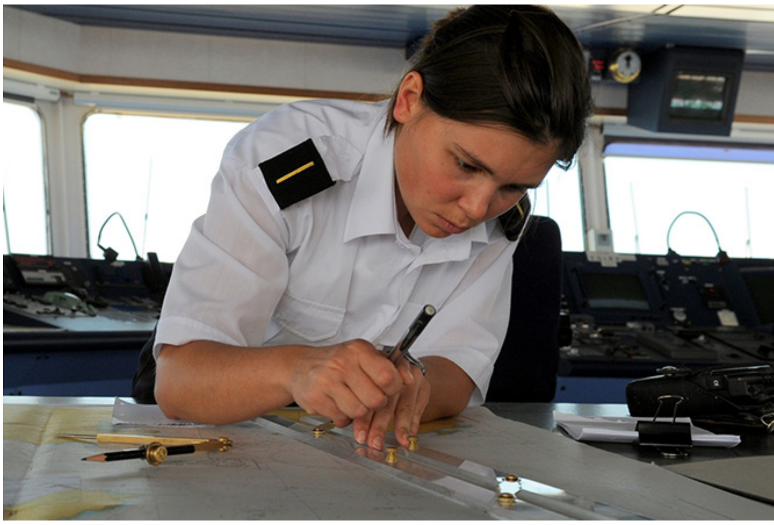
For a long time, I wanted to work for the DSB. Our goal is to make things safer, and what interests me is not just finding out what went wrong but taking it as an opportunity to do things better and prevent other disasters from happening. We will never be without accidents, and what I learned at the DSB is that when you solve one problem, new risks can be introduced. For me, it's always a challenge to balance that, to see where we can be useful. At the DSB, we look at the entire system, not just the accident itself but also the interrelationships and variables beyond the event.

Working in a multimodal board helps because you get opinions from people with expertise in investigations outside of the maritime domain, who often ask you questions you didn't know you had to ask and contribute with their different perspectives on the accident. They give you a new perspective. However, being multimodal means there is always tension about something beyond the maritime department's issues, so we can't always investigate each maritime incident in-depth.

The reason I started in 2014 and became a senior in 2021 is primarily based on experience, and a job opening! But most importantly, it was my international experience working with the Marine Accident Investigators' International Forum (MAIIF) and the International Maritime Organization (IMO) that allowed me to gain knowledge not only in the maritime business but also in dealing with others and achieving a holistic approach rather than focusing on detail. I believe that senior investigators in our department, to be good at their tasks, need to be able to see the bigger picture, to perceive different aspects and challenges by looking at the problem from a different level.

In addition to your work at the DSB, you hold a leadership role as the President of MAIIF since 2018. What is MAIIF, and how has your journey been there? What would you highlight, and what were the challenges you encountered?

MAIIF is the International Forum of Maritime Accident Investigators, a global network of peers, where we are all maritime accident investigators. It's a forum for learning from each other. In our meetings, we exchange different investigation cases we are working on to pinpoint challenges and share results. It's also a forum where everyone seeks to cooperate with each other.



Our obligation is to investigate very serious maritime incidents. You are responsible for your flagships, but also for vessels of other flags in your territorial waters. It's crucial that if something happens outside our waters, we stay in touch with our colleagues. In these situations, we are not the first to board because we would have to hurry, and while it is desirable to be there within the first hour of the incident, this is not always possible. That's why it's essential to have a good network worldwide to call for help, and that's also what MAIIF is about.

I attended my first MAIIF meeting in 2014, just a few months after joining DSB. I was lucky because most of my colleagues were on vacation, and my director offered me the incredible opportunity to attend that meeting in Panama. Something truly amazing about MAIIF is that you will always find someone who makes you feel welcome and enjoy the meeting. In 2016, a vacancy opened for the position of president; it was my third MAIIF meeting, and someone asked me why I hadn't applied for it, but then I considered myself too new to the organization. I knew the president would stay for the next two years, and during that time, the idea started to appeal to me. In 2017, the position of vice president became vacant, and this time I decided to run. Then, in 2018, a vacancy for the position of president opened, and I was elected. I have held that position since then, and although it typically lasts for two years, we couldn't have a proper MAIIF meeting during the pandemic, so we will have elections later this year. During this period, we achieved good things, and I think the way we decided to work helped keep MAIIF alive during the pandemic. It's essential to be able to meet, preferably in person, but I am very happy that we managed to keep the group together in 2020. And I was delighted to see so many people in Peru in 2022, where we held our first meeting after the pandemic.

You participated in IMO's Sub-Committee III. How would you explain to someone outside the field what IMO's Sub-Committee III is? What was your experience like there?

The acronym "III" in the sub-committee stands for "Implementation of IMO Instruments," and it is responsible for the Maritime Safety Investigation Report Analysis Working Group, which I am a part of as a member of the Dutch delegation. What we do is analyze maritime safety investigation reports to identify safety issues. These are discussed during the III working group meeting, along with other topics related to maritime incidents that are addressed in the Sub-Committee III meeting.

"Minorities must defend their position, claim their own space and opportunities, and have confidence in their work, knowledge, and experience."

You are going to participate as the keynote speaker on the second day of the JST Symposium. What are your thoughts on having these dedicated spaces for discussion? If you had to summarize the main message you would like to convey in your presentation, what would it be?

To have such dedicated spaces for exchange is very important because someone needs to give topics like these the importance they deserve. It's not always straightforward, and if you find yourself in an environment dominated by one gender, it's essential to give the other gender a voice. If everyone thinks the same way, some effort must be made to move towards something different. If we don't "force" ourselves to engage with what's different, we won't always know how to observe and acknowledge it. I believe it's essential to have these dedicated spaces, but without going overboard. I think it's in these matters where minorities must defend their position, claim their own space and opportunities, and have confidence in their work, knowledge, and experience, even when they sometimes need support.

When I went to my first MAIIF meeting, I had only been working at DSB for three months, and yet, someone from the office supported me to attend. We need to have opportunities. Looking at the Symposium in this way, I feel honored to have received the opportunity to travel to Argentina to talk about my career in the study of safety in the maritime mode.

The interview was conducted by Agustina Facciolo and María Constanza Mones Ruiz, from the International Relations Department of JST.

Valeria Bernal Carvajal
Architect, Consultant at IDB, MSc in Urban Planning and Policy Design.

Laureen Montes Calero
Economist, Transport Specialist at IDB.

Speakers at JST Symposium

TRANSPORT SAFETY AND PROTECTION OF WOMEN

Analysis of Transport from a Gender Perspective

Safety not only involves reducing or eliminating accidents and incidents in various modes of transportation (air, rail, road andmaritime), but its ultimate goal is the protection of individuals using these infrastructures and services. In this regard, this article discusses how to approach the study of safety comprehensively and how to leverage technology as an ally.

Both perceptions and levels of safety for women and men differ when using certain transport services and/or working in these industries. It is essential to acknowledge that there are distinctions that affect everything from vehicle and infrastructure use to mode of transportation choices, and ultimately impact the likelihood of accidents.

Within this framework, this article provides an initial exploration of the link between safety and gender perspective in transportand its implications for safety, highlighting the potential of innovation to enhance the safety of women in transport.

Transport, Public Life, and Insecurity

Analyzing transport from a gender perspective involves understanding the impact of cultural constructs on our personal and professional decisions. Gender roles traditionally assigned to men and women, along with gender biases and stereotypes, influence the transportation modes we choose, how we use transportsystems, and even the decision to work in the transportsector.

These cultural constructs begin with the traditional division that associates men with the public sphere, where visible work, economic power, political participation, and spaces for social exchange are located. Conversely, women are assigned the private sphere with family and domestic connotations, linked to caregiving and reproduction tasks (Delgado De Smith, 2008; Rose, 1993). Because of this differentiation between public and private domains, the "male" dominated public space has become an insecure territory for women. This insecurity is a manifestation of gender-based violence that often disproportionately affects women, ranging from common crimes like theft, to road insecurity and sexual violence, such as harassment or sexual assaults (Falú, 2009; Montoya Robledo, 2019; Soto Villagrán, 2017).

Numerous studies at national and international levels demonstrate that these perceptions of insecurity influence how people move and their effective access to opportunities facilitated by transport (Scholl et al., 2022). In fact, the numbers highlight a clear issue regarding the safety and protection of women in transport. According to a 2016 Thomas Reuters survey, six out of ten women in Latin American cities have experienced a sexual harassment incident in transport, but over 70% do not report the incident. A study conducted by the Inter-American Development Bank's Transport Gender Lab on women's mobility patterns in Buenos Aires revealed that 44% of surveyed female users stated that safety-related reasons discourage them from using public transport. Additionally, the study revealed a normalization of harassment, as while 80% claimed not to have experienced sexual harassment situations on public transport, when analyzing specific experiences (unwanted touching, intimidating stares, etc.), 73% admitted to having experienced them (Inter-American Development Bank, 2019).

> ***"Analyzing transport from a gender perspective involves understanding the impact of cultural constructs on our personal and professional decisions."***

Furthermore, besides the safety challenges faced by women users of urban transport, there is a similar challenge for women working in the transport sector. For example, women in certain occupations within the sector are at a higher risk of experiencing workplace violence or harassment. This includes women who handle cash or drive buses or taxis, as well as those who deal with frustrated or intoxicated passengers at airports, trains, transport terminals, and ports. This risk is particularly pronounced when women work alone, at night, or in isolated locations such as toll booths or ships. A survey conducted in 2017 among 1,444 women working in the transport sector in Europe showed that more than half of the respondents had experienced some form of violence at work, with 44% reporting incidents within the last year, and at least 20% experiencing five instances of violence (Pillinger, 2017). In Argentina, according to data from the Office for Advice on Workplace Violence and an analysis of reports in 2021, out of 865 consultations, 65% were made by women. In this analysis, the transport sector accounted for the fourth-highest number of reports of workplace violence, at 7% of the total (Tomei, 2018).

This issue of workplace sexual harassment is not isolated and can be observed across various modes of transportation. In maritime transport, for example, an online survey conducted by the Women's International Shipping & Trading Association (WISTA) in 78 countries revealed that 60% of surveyed women had experienced some form of gender-based discrimination, and 25% reported physical and sexual harassment as common issues aboard fleets (Centre Anglo-Eastern Maritime Training, 2022).

Similarly, in aviation, a study conducted among flight attendants in North America and the United Kingdom showed that 26% of flight attendants had experienced at least one incident of sexual harassment in the past year, perpetrated by passengers, pilots, and supervisors (Węziak-Białowolska, Białowolski, Mordukhovich, & McNeely, 2020).

Lastly, it is essential to highlight the connection between road safety and gender. Within gender stereotypes, women are characterized by lower use of private cars and a higher aversion to risk, as well as being more cautious and respectful of rules. This is reflected in the lower rate of women killed in road accidents, which is significantly lower than that of men. However, it is crucial to note that a gender perspective is often absent from road safety strategies. For instance, data demonstrates gender gaps in vehicle and infrastructure design that directly affect women. A study analyzing road accident data in the United States found that women wearing seatbelts were 47% more likely to sustain serious injuries compared to men under the same conditions (Bose, Segui-Gomez, & Crandall, 2011). Since the 1970s, crash tests have been conducted using male figures, leading to a lack of data on female physiognomy. Consequently, in road accidents, women are three times more likely to suffer whiplash injuries compared to men due to the data gap regarding female anatomy. Although women may have less access to vehicle driving, they are equally or more affected in other roles in public spaces. For example, in Argentina, out of all female fatalities in road accidents in 2019, 45.2% were passengers in cars or on motorcycles, while 24.8% were drivers, 15% were pedestrians, and no data is available for the remaining percentage.

Technology and Innovation for Universal Safety

What can be done to improve the quality of life and safety for women in the transport sector?

We are currently at a critical juncture, with the Fourth Technological Revolution transforming how we move, relate, protect ourselves, and communicate. Simultaneously, we are aware that there are significant gender gaps in our industry, which hinder achieving a more inclusive and sustainable transport system. Therefore, we have an excellent opportunity to harness technology to address the safety challenges discussed earlier.

Firstly, current innovations have facilitated the collection of disaggregated, geolocated, and real-time mobility data. These features have led to the development of multiple web applications driven by transport operators, government entities, and even citizen groups, which enable more efficient and safer use of transportation. For instance, a report from the International Automobile Federation (FIA) in 2016 lists several technological measures that can contribute to reducing personal safety concerns for women. These measures include closed-circuit television, mobile applications, reporting websites, and the use of social media campaigns (Allen & Vanderschuren, 2016). Other innovations include the use of crowdsourcing to create maps of areas considered unsafe, both based on personal experiences and infrastructure audits. These maps serve as inputs for city policymakers to identify physical and social issues to address.

Indeed, data is the new fuel and, therefore, the primary input for creating more effective public policies to improve the quality and safety of transportation systems for women. However, it is also essential to leverage the new developments stemming from advances in artificial intelligence for the analysis of such data. This is the case with ELSA, a digital tool created by GenderLab and funded by the Inter-American Development Bank, which aims to prevent sexual harassment in workplace environments. The tool measures three indicators: tolerance, prevalence, and confidence. The company's personnel complete a 10-minute questionnaire, which is then processed by ELSA to identify areas of opportunity and potential recommendations for providing an early and accurate response to harassment issues within organizations. Along the same lines, artificial intelligence systems connected to closed-circuit television are being developed to identify risk situations in different public spaces and transportation systems. This technology will enable early alerts in such situations and act as a deterrent to potential acts of sexual violence against women.

"Since the 1970s, crash tests in the design of safe vehicles have been conducted using male figures, and therefore, in road accidents, women are three times more likely to sufferwhiplash injuries compared to men due to the data gap regarding female anatomy. ”

On the other hand, there are also other innovations that may seem straightforward but have a direct impact on safety. Small changes like these affect women's mortality rates in road accidents. An example of this is the recent design of female crash test dummies, developed at the Swedish National Road and Transport Research Institute under the leadership of Dr. Astrid Linder. Currently, the use of female crash test dummies is not mandatory, but several companies are already evaluating their vehicles using these models, which provide better insights into the consequences of a possible crash on the female body and generate disaggregated data to improve vehicle design and have a positive impact on road safety.

To conclude, it is important to note that technology can be an ally or a barrier to improving the safety and protection of women. By itself, it is only a tool for change, requiring public policies that provide a regulatory framework and ensure comprehensive solutions to the safety challenges that women face in transport. In effect, multisectoral and institutional interventions are needed that go beyond the technological tool and address behavior changes to eliminate gender biases and stereotypes in transport.

"The inclusion of a gender perspective to protect and ensure women's safety should begin with efforts to highlight the issue and should require the same rigor as that applied to other factors affecting safety.

Therefore, the inclusion of a gender perspective to protect and ensure women's safety should begin with efforts to highlight the issue and require the same rigor applied to other factors that affect safety. In this sense, having protocols for handling sexual harassment cases, investigating and processing information, having a comprehensive institutional framework to address these processes, and having gender-sensitive infrastructure, vehicles and procedures are just some examples of actions that will ensure the operation of safer and more inclusive transport for all people.

References

Allen, H., & Vanderschuren, M. (2016). Safe and Sound International Research on Women's Personal Safety on Public Transport. FIA Foundation Research Series, pp. 6, 1-55. Available at [link](https://www.fiafoundation.org/media/224027/safe-and-sound-report.pdf)

Inter-American Development Bank (2019). Characterization of the mobility of female users of public transportation services in the Metropolitan Region of Buenos Aires.

Bose, D., Segui-Gomez, M., Crandall, J. R. (2011). Vulnerability of female drivers involved in motor vehicle crashes: an analysis of US population at risk. American Journal of Public Health, 101(12), pp. 2368-2373. Available at [link](https://doi.org/10.2105/AJPH.2011.300275)

Centre Anglo-Eastern Maritime Training (2022). Gender Diversity.

Delgado De Smith, Y. (2008). El Sujeto: los espacios públicos y privados desde el género. Revista Estudios Culturales, pp. 113-126.

Falú, A. (2009). Mujeres en la ciudad: De violencias y derechos. Red Mujer y Hábitat de América Latina, Santiago de Chile: Ediciones SUR.

Montoya Robledo, V. (2019). Uno se resigna a que el transporte es así: Trabajadoras domésticas sindicalizadas atravesando Medellín. Revista CS.

Pillinger, J. (2017). Violence and harassment against women and men in the world of work: trade union perspectives and action. International Labour Office, Bureau for Workers' Activities (ACTRAV). Geneva: ILO.

Rose, G. (1993). Feminism and Geography: The Limits of Geographical Knowledge. Minneapolis: University of Minnesota Press.

Scholl, L., Fook, A., Barahona Rebolledo, J. D., Rivas, M. E., Montes, L., Montoya, V., & C. Mojica et al. (2022). Transport for Inclusive Development: Defining a Path for Latin America and the Caribbean. Available at https://doi.org/10.18235/0004335

Shiona, M. (2022). The crash dummy aimed at protecting women drivers. BBC News. Available at https://www.bbc.com/news/technology-62877930

Soto Villagrán, P. (2017). Diferencias de género en la movilidad urbana. Las experiencias de viaje de mujeres en el Metro de la Ciudad de México. Revista Transporte y Territorio, (16), pp.127-146.

Tomei, M. (2018). Violencia y acoso en el trabajo. Revista Trabajo, pp. 23-24.

Węziak-Białowolska, D., Białowolski, P., Mordukhovich, I., & McNeely, E. (2020). Work, Gender, and Sexual Harassment on the Frontlines of Commercial Travel: A Cross-Sectional Study of Flight Crew Well-Being. International Journal of Aerospace Psychology, 30(3-4), pp. 171-189. Available at https://doi.org/10.1080/24721840.2020.1796488

Franco Frola
Bachelor of Business Administration, specialist in waste management and sustainability.

Speaker at the JST Symposium

SUSTAINABLE ALTERNATIVE FOR THE RECOVERY OF THE RAILWAY SYSTEM

Manufacturing Synthetic Railway Sleepers from Recycled Plastics

With the aim of providing environmental solutions that promote the implementation of circular economy principles and prevent the burial of this material, the first factory for manufacturing synthetic railway sleepers from recycled plastics has been developed in Argentina.

Introduction

The lack of availability of wooden railway sleepers has led to ecosystem degradation in central and northern Argentina during the 20th century, particularly due to indiscriminate logging of valuable tree species. Additionally, poor planning in the sector and the expansion of agricultural and urban borders have impoverished the national railway system, discouraging its rehabilitation. Furthermore, plastic constitutes the material with the highest proportion of waste and the most significant environmental and cost-related problems for its management. Therefore, the manufacture of synthetic railway sleepers provides a definitive and long-term solution for the recovery of railway tracks, reducing environmental impact, optimizing regional logistics, and creating new jobs in the sector. In this regard, the main objectives of this project are as follows:

- Promote the development of the national industry.
- Restore the Argentine railway system as a clean and efficient transport system.
- Meet the objectives of the Paris Agreement regarding sustainable mobility.
- Reduce the environmental impact of plastic waste without a commercial circuit.
- Protect the native forests of Argentina by avoiding the logging of valuable species like quebracho.
- Foster strategic partnerships to achieve long-term scalability and exportability for the project.
- Recover complex plastic materials, avoiding sanitary landfill and the associated costs.
- Generate new job opportunities and professionalize trades.
- Manufacture other furniture or urban products as a replacement for wood.

Talking about the circular economy today implies a deep commitment to the environment and society, understanding that the cost-benefit formula no longer works from a linear perspective. We are currently facing an unprecedented crisis, where it depends solely on us to question the ways of economic growth to ensure future well-being. In this sense, this socio-environmental crisis opens opportunities if we become aware of our place and our potential to take local actions. This is how Grupo RFG company committed to this innovation project, with the potential to drive the country's industrial development (image 1).

Image 1: Ground plastics ready for processing

Source: own elaboration.

The vision and mission to pursue this path date back almost ten years when the dream of this family company was just beginning to take shape. During all this time, Grupo RFG has had the opportunity to work with important organizations in the province of Córdoba, which trusted them with the management of their recyclable materials. This has allowed them to get to know the sector closely and plan their work on the three pillars that the system should be based on: economic, social, and environmental. In this context, with each new material, the challenge arises to give it a new life before disposal, following the principles of the circular economy. Here, raw materials are obtained from discarded materials, reducing them and reusing them within the production chain. This is why a holistic approach to sustainable development is advocated, ensuring environmental management that reaches all sectors involved.

> ***"To ensure their functionality and durability, the railway sleepers have been tested for strength by the National Institute of Industrial Technology (INTI) and certified according to the IRAM 1610 standard on Synthetic Railway Sleepers."***

The agreement with Trenes Argentinos for the manufacture of plastic sleepers and the rehabilitation of the country's railway tracks is of great importance for the current reality. It is not just about recycling one of the most abundant materials in the market but precisely about giving it a definitive disposal. Because until now, although most plastics are potentially recyclable, there were no channels for all their types that guaranteed their traceability, or even their new life, and their subsequent recovery would again depend on responsible circuits and management.

Thinking today about synthetic sleepers is projecting an increasingly positive environmental impact; it is promoting a sector for the promotion of public policies for job creation and the consolidation of public-private sector alliances; it is reducing deforestation and finally providing the country with a clean, safe, and high-potential transport system.

For the first time in Argentina, the manufacture of sleepers from recovered plastic material is a reality and thus guarantees a progressive reduction in greenhouse gas emissions, contributing to Argentina's commitments under the Paris Agreement to tackle climate change. In this regard, according to the United Nations Environment Program (UNEP), plastic accounts for 85% of the waste that reaches the oceans and warns that, by 2040, the volumes of this material flowing into the sea will almost triple, with an annual amount of between 23 and 37 million tons. This situation is not only critical for marine life but also for human health, which is vulnerable to pollution in water sources, which could cause hormonal changes, developmental disorders, reproductive abnormalities, and cancer.

Furthermore, this project contributes to halting deforestation of the country's native forests, which are carbon sinks par excellence. Based on recent research, 85% of the red quebracho forests in the Chaco have been lost, so the project would contribute to the restoration of one of the most important ecosystems in Latin America. It is even known that white quebracho sleepers are an alternative; however, they do not have the same durability, so the pressure on the system is even greater. At the same time, the wood of the sleepers must be treated with creosote or heavy metal salts, which are toxic and can leach into the groundwater. Table 1 presents a comparison between both alternatives.

In contrast, plastic sleepers allow for the recovery of a widely circulated material, perpetuating it for sustainable use and enabling recycling at the end of its life cycle. This technology, widely used in other parts of the world, had its beginnings in Argentina based on the research thesis of engineer Mariano Fernández Soler, a member of the National Center for Railway Development and Innovation (CENADIF), who has been researching its formula and applicability for several years. Additionally, to ensure their functionality and durability, the sleepers have been tested for their strength by the National Institute of Industrial Technology (INTI) and certified according to the IRAM 1610 standard for Synthetic Sleepers. This standard establishes the requirements that synthetic sleepers must meet for their application in railway infrastructures, manufactured from polymer matrix compounds, additives, and/or reinforced or unreinforced with substances improved in physical, mechanical, or weather resistance characteristics.

"To think about synthetic sleepers today is to project an increasingly positive environmental impact: it is to drive a sector for the promotion of public policies, for job creation, and for the consolidation of public and private sector alliances.

On the other hand, rehabilitating the country's railway tracks not only provides a cleaner mode of transport with reduced emissions of pollutants but also optimizes the logistics of raw materials and

Table 1: Comparative table between sleepers alternatives.

Characteristics	Railway sleepers	
	White quebracho	Recyclable materials
Lifespan	10 years	50 years
Fixation physical behavior	Fails over time	Good
Resistance to climatic behaviors	Bad	Good
Resistance to organic decomposition	Bad	Good
Fire resistance	Bad	Good
Abrasion resistance	Bad	Good
Electrical isolation	Good	Good
Elasticity	Good	Good
Ability to withstand derailment	Good	Good

Source: own elaboration.

products within the country. This implies, on the one hand, alleviating congestion and discouraging the construction of new highways, which restrict the growth of our cities and harm the health and resilience of our ecosystems. On the other hand, it offers the potential for greater economic development in the logistics and transportation sectors.

Furthermore, channeling this bulky material promotes the growth and institutionalization of the industry. Today, informal recyclers play a key role in material recycling; however, their working conditions do not meet basic social security requirements. In this regard, the procurement of raw materials for sleepers will generate not only thousands of direct and indirect jobs but also their formalization and consolidation in the market.

> ***"Rehabilitating the country's railway tracks not only provides a cleaner mode of transport with reduced emissions of pollutants but also optimizes the logistics of raw materials and products within the country."***

Finally, one of the most significant benefits of the project is the formation of key alliances, as promoted by Goal No. 17 of the Sustainable Development Goals (SDGs). When we talk about public policies, it not only refers to a management that integrates economic, social, and ecological aspects for sustainable development but also aims for the participation of all involved actors, interdisciplinary and cross-sectoral, to ensure its long-term continuity. This effort would not make sense or be a reality today without the involvement of the academic, public, and private sectors, in all their spheres of influence, with the confidence to develop a one hundred percent national innovation technology. Thanks to the participation of the Ministry of Transport, the Ministry of Environment and Sustainable Development, and the Ministry of Productive Development of the Nation, the National Center for Railway Development and Innovation (CENADIF), the National Institute of Industrial Technology (INTI), Belgrano Cargas, the Faculty of Exact, Physical, and Natural Sciences (FCEFyN) of the National University of Córdoba, the Secretariat of Environment and Climate Change of the province of Córdoba, the Argentine Institute of Standardization and Certification (IRAM), the Argentine Network of Municipalities Facing Climate Change, the Biocórdoba entity of the Municipality of Córdoba, the Municipality of Córdoba, Córdoba Works and Services (COyS), Cormecor, the Municipality of Montecristo, and associated private companies, it is now possible to plan a large-scale venture that will achieve new sustainability goals for the entire region.

The project has also been declared of national interest by the Ministry of Environment and Sustainable Development of the Nation and the Ministry of Transport of the Nation, of legislative interest by the Legislature of the province of Córdoba, and of municipal interest by the Deliberative Council of the City of Córdoba.

Wood and Concrete vs. Recycled Plastic

Most of the railway sleepers in our country are made of quebracho wood and concrete. These materials, while having certain benefits, also present some problems. For example, it is impossible to meet the total demand for quebracho sleepers, and the unsatisfied demand drives up the selling price, leading to massive deforestation and environmental damage. Concrete sleepers, on the other hand, are less flexible and heavier than wooden ones and can only be used for full track renovations.

The possibility of replacing these materials with recycled plastic not only contributes to environmental conservation but also enhances transport safety. Synthetic sleepers are lightweight, have a rapid manufacturing process, are flexible, and resistant to torsion and weather-related wear and tear.

The use of components enhanced by new technologies (R&D) could lead to much more reliable track structures and, therefore, safer transportation for both cargo and passenger trains. It could improve the circulation speed and capacity for cargo transport vehicles. Additionally, more efficient maintenance plans could be established to reduce the risks of railway incidents.

National Directorate of Railway Incident Investigation

Alejandro Di Bernardi
Air Transport Group (UIDET GTAGIAI), Department of Aeronautics, Faculty of Engineering, National University of La Plata.

Speaker at JST Symposium.

TECHNOLOGICAL INNOVATION AND ENVIRONMENTAL SUSTAINABILITY

New Trends in Urban and Advanced Air Mobility

This article proposes an approach to aspects related to technological innovation as part of a systemic approach aimed at reducing or neutralizing aviation emissions and their contribution to climate change, noise generated by aircraft, and emissions associated with local air quality.

Introduction

Air transport can be analyzed and assessed from various perspectives, whether international, regional, national, provincial, local, or specific, depending on the facility or infrastructure under consideration. Additionally, the inherent dynamics, evolution, and transformation of this activity must be considered, which implies defining different spatial and temporal scales of action and execution, all in line with the appropriate operational contexts that correspond to it.

Also, the air transport system should be integrated with an intermodal transport plan in support of strategic development plans, all in accordance with state policies and associated objectives, among which safety, environmental protection (and within, the concept of sustainability), the regulatory legal framework and the optimization of management models should be present in a harmonious manner.

In this context of permanent change, the International Civil Aviation Organization (ICAO) establishes a series of lines of action, generates reference documentation and sets strategic objectives (SOs) in accordance with the Sustainable Development Goals (SDGs) of the United Nations.

"The air transport system should be integrated with an intermodal transport plan in support of strategic development plans, all in accordance with state policies and associated objectives".

Thus, taking the above into consideration, the present work aims to address in a general manner certain trends in specific aspects of research and development, also delving into the new concepts of Urban Air Mobility (UAM) and Advanced Air Mobility (AAM), keeping in mind the overall context of operation within the international civil aviation framework and highlighting certain actions related to the thematic axes of this publication.

United Nations and Sustainable Development Goals

The Charter of the United Nations established, in 1945, the creation of the Economic and Social Council (ECOSOC) being today one of the six main organs of that body. In its website[1], its mission is evident, which is transcribed below:

> "The Economic and Social Council is part of the core of the United Nations system and aims to promote the realization of the three dimensions of sustainable development (economic, social, and environmental). This body serves as a fundamental platform for fostering debate and innovative thinking, achieving consensus on how to move forward, and coordinating efforts aimed at achieving internationally agreed-upon goals. It is also responsible for monitoring the outcomes of major United Nations conferences and summits."

To carry out this mission, it is necessary to coordinate efforts and actions among the different entities of the United Nations that work on issues related to sustainable development. These areas of operation and action include regional economic and social commissions, organic commissions —responsible for facilitating intergovernmental debates— specialized agencies, programs and funds, research institutes, and other entities and bodies that coordinate specific actions with the goal of ensuring that commitments related to development translate into real changes in people's lives.

In this framework of containment, it is now the moment to make a general reference to the UN Sustainable Development Goals (SDGs), which can be clearly seen in their website[2].

By exploring the general contents of each SDG, we can appreciate that there are currently about 169 targets related to poverty, hunger, nutrition, food security, promoting sustainable agriculture, the health and well-being of the population, inclusive, equitable, and quality education, gender equality, the empowerment of women and girls, access to water and sustainable water management, affordable, safe, and sustainable energy, sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all, resilient infrastructure, inclusive and sustainable industrialization, innovation, inequality, inclusive, safe, resilient, and sustainable cities, sustainable consumption and production, climate change, the sustainable use of water resources, terrestrial ecosystems, and biodiversity, societies, institutions, and the global alliance for sustainable development.

The question that arises then is: which of these SDGs have their direct correlation with ICAO SOs? This question has an answer on the ICAO[3] website, indicating that its 5 SOs relate to 15 of the 17 UN SDGs.

1. Available in <https://www.un.org/ecosoc/es/content/about-us>

2. Available in https://www.un.org/sustainabledevelopment/es/sustainable-development-goals

3. Available in <https://www.icao.int/about-icao/aviation-development/Pages/ES/SDG_ES.aspx>

By exploring them, we can observe the actions that the International Civil Aviation Organization is carrying out to contribute to each of the referenced SDGs.

"ICAO has defined three major environmental objectives by limiting or reducing aircraft-generated noise and emissions associated with local air quality.

Clearly, we could analyze and specify which programs, plans and actions are specific to each SDG in relation to each SO, but attentive to the extension that this would entail, we'd better leave this for another publication.

ICAO, its Strategic Objectives and Lines of Environmental Action

ICAO regularly establishes general strategic objectives[4] (SOs), the following five being in force:

- Safety
- Capacity and efficiency
- Security and facilitation
- Economic development
- Environmental protection

From the review of the thematic areas addressed by each SO we can infer their contents without the need to delve too deep into them. However, on this occasion, and considering the subject chosen for this article, we will make specific reference only to one of them, with the intention of reviewing, in a reflective manner, certain aspects and then link them in a very general way with the UN's SDGs.

Environmental Protection, a Strategic Objective of ICAO

> "Minimize the adverse environmental effects of civil aviation activities. This strategic objective promotes ICAO's leadership in all environmental and aviation-related activities and is consistent with ICAO's and the United Nations system's environmental protection practices and policies[5]".

From the above, the indicated guidelines are clearly linked to social, economic and environmental development as a whole, in accordance with the precepts of sustainable development.

In this context, ICAO[6] has defined three major environmental goals in which it seeks to limit or reduce:

- aviation emissions and their contribution to climate change,
- noise generated by aircrafts,
- emissions associated with local air quality.

When analyzing them, we can appreciate different scales of action and impact. The first one is mainly related to the interurban section and the plane, while the next two are linked to the airport and its immediate surroundings, all according to an urban or suburban context of multimodality.

In turn, in accordance with this, the following areas of action have been established seeking to contribute to the achievement of the established goals, to obtain a 2% annual improvement in fuel efficiency and carbon neutral growth for 2020:

- implementation of aircraft technologies and standards,
- improved air traffic management and operational improvements
- development and use of sustainable aeronautical fuels,
- implementation of the carbon offsetting and reduction scheme for CORSIA international aviation.

These new technologies are evidenced and projected in all the links that make up the air transport system, as they seek to optimize the processes and operations that occur in their own airports, in airspace, in support elements at aerodromes and, of course, in the aircrafts themselves and their assistance vehicles.

The intention is to optimize the processes and operations, contributing significantly to environmental care and protection, minimizing the emission of polluting gases and reducing the acoustic impact, in accordance with the concepts of sustainability and the ICAO SOs.

4. Available in <https://www.icao.int/about-icao/Council/PAges/ES/Strategic-Objetives.aspx>
5. Available in <https://www.icao.int/Documents/strategic-objectives/strategic_objectives_2005_2010_es.pdf>

6. Available in <https://www.icao.int/environmental-protection/Pages/default.aspx>

Air Transport Industry and Innovation

In line with the above, the Member States are working towards a more environmentally friendly transport system, and it is in this context that they have published their action plans, which show the different strategies used to achieve the objectives set. Technological innovation is one of the fundamental axes of investigation, development and action of the aviation sector.

In this context of permanent transformation, the concept of biomimicry appears, where it seeks to imitate the designs and processes of nature to solve technical problems, generating certain development patterns that allow, in the case of aircraft, to reduce aerodynamic resistance and the weight as negative forces, while optimizing those positive forces that are related to the lift and thrust of the engines.

Weight-Focus Innovation Overviews

This line of action basically seeks to have lighter aircraft by using composite and alternative materials, applied to primary and / or secondary structures, allowing in turn optimized maintenance processes. Accordingly, Airbus is studying:

- **Biomass fibers:** obtained by carbonizing precursors obtained from biomass derived from raw materials. Its use in biocomponents could result in composite materials that provide an alternative to carbon fibers obtained from petroleum. Research areas include algae.
- **Resins of biological origin:** derived from biological sources, such as sugar cane and lignin, among others. Its use could provide an alternative to phenolics in aircraft. Research areas include furan, epoxy and polyamide.
- **Natural fibers:** these are derived from animals, plants or minerals and, due to their low weight and high strength properties, can be used as biocomponents in non-critical secondary aircraft structures. Areas of study include basalt fibers, spider silks, bamboo reeds and linen.

General Aspects of Innovation Focused on Strength and Lift

This line of action aims to ensure that aircraft and their components are adapted to the functional requirements of established missions. Reconciliation involves changes in the system's characteristics, including the aircraft's states during various flight profiles, giving rise to the concept of morphing wings.

The idea, although a bit futuristic, focuses on the fact that the plane or its wings can be transformed in flight adapting to the condition of minimum resistance according to the flight profile (altitude and speed), as if it were a bird.

Furthermore, there is a desire for improved aerodynamic cleanliness of the airflow over the wings, aiming for laminar flow over them, which would reduce wing friction by increasing collaborative widths, thus delaying boundary layer separation during takeoff.

Another example is the ability for aircraft to modify the aspect ratio of their wings using semi-aeroelastic hinges at the wingtips. This directly impacts induced drag, which in some cases accounts for more than 30% of the aircraft's aerodynamic resistance.

Other trends focus on designing lightweight, ultra-thin, and more aerodynamic wings to increase fuel efficiency.

In line with these developments, there are new coatings or textures that mimic sharkskin or shape-memory alloys, where a metal exhibits unique properties that enable the device to adapt to each flight condition on its own.

> ***"Member States work to get a more environmentally friendly transport system. The technological innovation is one of the fundamental lines of investigation, development and performance of the aviation sector.*** ”

Propulsion-Focused Innovation Overviews

Developments related to engines are focused, among other things, on improving the processes associated with combustion, propulsion efficiency and thermodynamic fluid, weight reduction and neutralization of pollutant inputs.

In this context, and in relation to polluting products, work is being done on biofuels, alternative fuels and other means of propulsion that are under study and development:

- **Biofuels:** Among them, we have first, second, third, and fourth-generation biofuels, with third-generation biofuels being those derived from aquatic plants. These do not require direct land use and can be cultivated in bioreactors or directly in the sea. The fuel obtained has the least resource competition in terms of the amount of fuel produced. This classification of biofuels has been introduced by the aviation industry in recent years, and studies have already been conducted regarding the feasibility of large-scale production to meet the requirements of civil aviation. On the other hand, there are those known as fourth-generation biofuels, which can be produced without using land and do not require the destruction of biomass to be converted into fuel.

- **Photobiological fuels and electrofuels**: These terms refer to production processes. Among them is "green hydrogen," which is obtained through the electrolysis of water using electricity from renewable energy sources.
- **Other hydrogen sources:** Currently, approximately 95% of the world's hydrogen production is derived from fossil fuels and is known by various names, such as gray hydrogen (obtained from steam methane reforming) or blue hydrogen, which involves carbon dioxide capture during production.
- **Other propulsion methods:** Among them is the development of lithium-ion batteries and other types of batteries, with the aim of using them as energy sources for propulsion. This way, aircraft would have a wide range of torque and power options for different flight levels.

One aspect to highlight regarding fuels is their energy density, as it indicates the amount of energy they possess per unit of volume or weight. Lower energy density necessitates the consumption of more fuel (both in terms of volume and mass) to produce the same amount of work. The current approximate average values for this relationship can be seen in the following reference data:

FUEL	ENERGY DENSITY
Gaseous fossil fuel	13,000 Wh/Kg
Liquid fossil fuel	12,000 Wh/Kg
Hydrogen	34,500 Wh/Kg
Lithium battery	300 Wh/Kg
Lead-acid battery	30 Wh/Kg

Clearly, it can be observed that the fuel of the future will be centered around hydrogen, or more precisely, green hydrogen, even though this technology is still in its infancy for application in the aviation transportation system.

Aspects Related to New Trends in Air Mobility

In recent years, there has been significant progress in the development of electric vertical take-off and landing (eVTOL) vehicles, which are associated with urban air mobility (UAM) and advanced air mobility (AAM). It is estimated that these aircraft will replace and complement a portion of the current general aviation. An example of the increasingly widespread use of these drones can be seen in the use of radio aids verification aircraft, which are replacing traditional aircraft in this activity, or in the replacement of helicopters for inspecting high-voltage power lines.

However, beyond the drones that we are all familiar with, there are several questions arising regarding the new air mobility: How will cargo be transported? How will passengers travel? Will they use the same vehicles, or will they be specific to their needs? What will their characteristics be? Will they be autonomous or piloted? What additional services will they require? What will their propulsion methods be? What aeronautical infrastructure will they need? What will their terminals look like? What features will the support elements have? How will they integrate with other air, land, or maritime/river transport modes? And so on, we could continue with numerous questions that still have relative answers or, in some cases, no answers at all.

> ***"You can see that the fuel of the future will be focused on the hydrogen, or rather, in green hydrogen, even though this technology is still embryonic for application in the air transport system."***

The fact is that, as of today, we have more questions than answers, but this is precisely what planning is about—anticipating possible scenarios that, with a certain level of certainty, may become a reality.

In this regard, the new vehicles are still in the development phases, as is the regulatory framework itself. An example of these AAM vehicles can be seen in the following image:

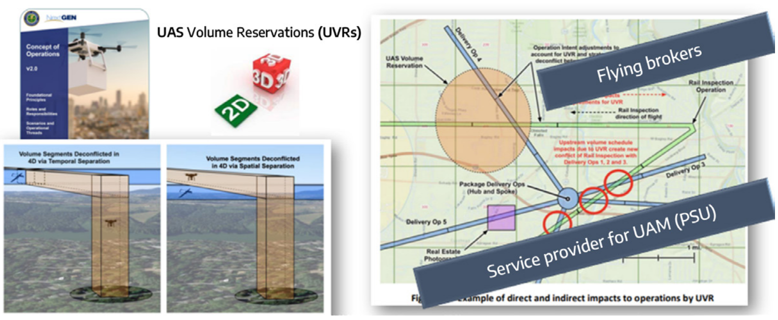
Source: ICAO + GTA UIDET "GTA-GIAI" UNLP.

Additionally, beyond what has been published by ICAO, you can observe developments and trends related to these types of aircraft and their systems on the official websites of the Federal Aviation Administration (FAA), the European Union Aviation Safety Agency (EASA), or even on the National Aeronautics and Space Administration (NASA) website.

By exploring these websites and analyzing their contents, we can say with a certain level of certainty that soon, the skies will be filled with electric aircraft of the Electric Vertical and Short Takeoff and Landing (eVTOL or eSTOL) type. These aircraft may be autonomous or piloted (either directly or remotely controlled) and will operate within controlled or uncontrolled airspace but always within their specific corridors, as per their assigned activity.

It is reasonable to assume that the network of ground infrastructure for general aviation will no longer only include traditional aerodromes and heliports but will also encompass vertiports or stolports located within aerodromes or independently situated in urban or suburban areas.

This will lead to envisioning cities where transportation will no longer be primarily 2D but 3D, utilizing different networks and subnetworks for passenger or cargo services, all in compliance with the rule of law, sustainability, and safety as fundamental pillars of specific development. An example of this can be seen in the following image:



Source: FAA.

For this transformation to become a reality, it will be necessary to integrate and strengthen various aspects, such as Big Data, 5G technology, the Internet of Things (IoT), airspace management services, multimodal transportation system management services, and infrastructure, all in alignment with the principles of Smart Cities. These Smart Cities should prioritize sustainability and inclusivity while emphasizing the integral multimodality and complementarity of transportation.

In this context, the Air Transport Group (GTA) of the "GTA-GIAI" research unit at the Department of Aerospace Engineering of the Faculty of Engineering at the National University of La Plata has been working on the development of aerial mobility networks and vertiports. Examples of these can be visualized in the following illustrative images:

Source: GTA-UNLP, 2022.

At this moment, pausing the discussion of the points, I invite the reader to consider where a vertiport for the operation of eVTOL aircraft intended for AAM could be located within an airport.

The core idea here is related to the concept of creating a complex within an airport, thereby allowing for a new mode of accessibility to the airport site using eVTOL aircraft and the corresponding infrastructure and facilities.

Furthermore, this airport vertiport will be connected to an urban network of vertiports, each with its own criteria for location and design. In both cases, the best solution and location will be determined through the analysis of variables, indicators, dimensions, and decision matrices.

Within the typical dimensions of decision-making, we will encounter the boundaries of "aeronautical operability," "economic and financial viability," "anthropic impact," "natural impact," and "social perception."

Ultimately, the final solution will depend on the perspective through which the operational context is viewed, whether it is located at an airport or within an entirely urban area. Additionally, this perspective will be shaped by various variables and constraints, including social, cultural, strategic, environmental, technical, political, economic, financial, and legal factors, among others. The determination of precedence will be a matter of political, strategic, and technical/sustainability considerations.

ICAO and Innovation at the Heart of Global Aviation Development

Finally, beyond eVTOL, UAM, and AAM, it is worth mentioning that ICAO has created a dedicated website[7] for innovation.

In this context, ICAO has launched a global competition[8] aimed at young enthusiasts, inviting them to participate and present ideas aimed at finding and developing new solutions or services that support ICAO's five SOs.

These efforts to seek and develop innovative technologies and solutions are also reflected in ICAO's "2023-2025 Activities Plan[9]" This underscores the organization's ongoing commitment to promoting innovation and advancing aviation worldwide.

CONCLUSIONS

The industry is making significant efforts to pursue technological innovation and align with the United Nations' SDGs and ICAO's SOs. It's easy to appreciate the innovations implemented in recent years that have contributed to environmental goals while keeping a focus on other SOs, such as safety.

It's also true that this is an ongoing journey, and it's in this context that eVTOL aircraft designed for both passengers and cargo within the framework of UAM and AAM are gaining momentum, soon to become a reality, even though there is still much development and certification work ahead.

Indeed, as Eric Hoffer aptly said:

> "In times of change, those who are open to learning will own the future, while those who think they know it all will be well equipped for a world that no longer exists".

Finally, I would like to close with two phrases from Albert Einstein: "We cannot solve problems by thinking the same way as when we created them" and "The mind is like a parachute; it only works when it's open."

In summary, substantial contributions have been made, but there is still much to devise and do. The ceiling of innovation only lies in our imagination.

7. Available in <https://www.icao.int/innovation/Pages/default.aspx>
8. Available in <https://www.icao.int/Meetings/InnovationFair2022/Competion/PAges/default-es.aspx
9. Available in <https://www.icao.int/Meetings/a41/Documents/Cao%20Plan%202023-2025%2DV1.0%2025%20July%202022.pdf>

OCCURRENCES MAP

The JST developed an interactive map of accidents and incidents investigated by the Agency

It allows to visualize the occurrences that happened in the different modes

- Road occurrence
- Maritime and inland waters occurrence
- Aviation occurrence
- Rail occurrence
- Multimodal occurrence

- Based on this information, from the JST we can promote Safety Studies to evaluate if the repetition of occurrences is related to possible failures in the transport system.

JST | SEGURIDAD EN EL TRANSPORTE

Ministerio de Transporte Argentina

primero la gente

Eng. Roberto Domecq
Mechanical Engineer (UTN), international consultant, and university lecturer.

COMMERCIAL SPEED: AN IMPORTANT PARAMETER IN A MODERN MOTOR VEHICLE FREIGHT SYSTEM

Does the Power-to-Weight Ratio Have Anything to Do with Safety?

Argentine regulations, starting from Decree 779/95 (regulatory of the Traffic Law 24449), have established an improvement in the power-to-weight ratio for vehicles involved in freight transport. The implementation is a process that requires a substantial investment from the private sector to replace older units with modern and powerful trucks. This article analyzes the strengths of having a better power-to-weight ratio.

In general, the power-to-weight ratio reminds us of a useful indicator for evaluating sports cars or motorcycles, and consequently, we think of brilliant accelerations or high-top speeds.

In the realm of light vehicles, the engine power is chosen freely by manufacturers and generally ensures that all modern cars have a high power-to-weight ratio, allowing them to circulate with acceptable performance, most of the time, without utilizing all the available engine power.

"The speed difference between vehicles traveling on a route is an important factor in accidents."

Let's say that in this segment, the power-to-weight ratio is not linked to safety, except for the driver who uses that power availability for reckless driving. In such a scenario, the problem lies not with the vehicle but with the driver's behavior.

However, in the realm of freight transport, the power-to-weight ratio has a direct connection to various aspects of road safety, greenhouse gas emissions, pollutant emissions, the reliability of vehicles, and even the productivity of road infrastructure.

Firstly, it's interesting to evaluate different modes of road transport and observe the power-to-weight ratio each of them possesses.

As we can see, the power-to-weight ratio varies significantly from one mode of transport to another. Many of the listed vehicles in Table 1 can legally operate on public roads.

The power-to-weight ratio directly impacts the following vehicle variables:

- Ability to ascend inclines
- Acceleration
- Maximum speed
- Ability to maintain a reasonable speed on a given incline

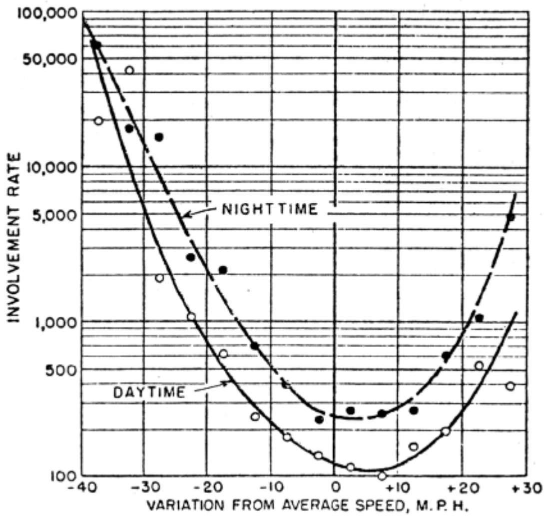
Road Safety Conditions

The speed difference between vehicles traveling on a route is a significant factor in accidents. Indeed, this phenomenon has been studied by road safety researchers such as Salomon and Cirillo, who have observed variations in accident rates based on the speed difference between the involved vehicles and the route's average speed.

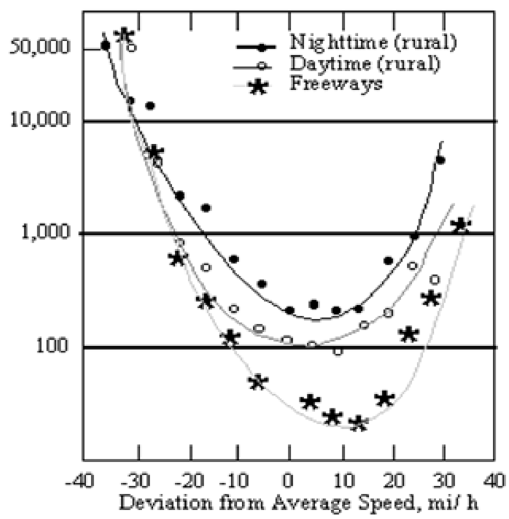
Table 1. Power-weight ratio in various means of transport

Transport unit	Power [hp]	Total or total gross weight combined [t]	Power-to-weight ratio [cv/t]
Cart with ox team	1,8	3	0,6
Passenger carriage	0,8	0,8	1,0
Amateur cyclist	0,2	0,08	2,5
Truck MB L1114	135	45	3,0
Ford cargo 1719	192	45	4,3
B-train 75 tn	506	75	6,7
Low floor bus (11 m)	210	16	13,1
Long-distance double-decker bus	400	24	16,7
4 tn light truck	160	8,3	19,3
Citroën 3 CV	32	1	32,0
Modern van 15 m3	150	5	30,0
Motorcycle 150 cm3	15	0,3	50,0
Std double cab pickup	180	3	60,0
Midsize sedan std.	100	1,5	66,7
Premium midsize sedan	140	1,8	77,8

Figure 1. Accident involvement rates are based on speed variation.



Accident involvement rate by variation in average speed, by section, day, and night (Salomon, 1964[1])".



Crash involvement rate by deviation from average travel speed (Salomon, 1964 & Cirillo, 1968).

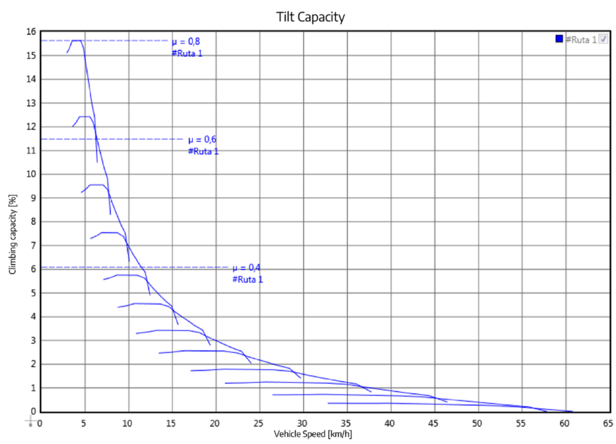
This analysis presents a 'U' shaped curve, where vehicles traveling below or above the average speed of a particular road increase their probability of accidents.

This study confirms a subjective perception that is generally held by motorists regarding road safety.

Figure 1 indicates that a vehicle traveling at 20 mph (32 km/h), below the average speed on a rural road during the day, increases the accident rate nearly tenfold.

Next (Figure 2), we present the performance curve at different speeds for an older tractor-trailer truck carrying approximately 45 tons with a 150 hp engine.

Figure 2. Performance curve of tractor-trailer truck (45 tons, 150 hp).

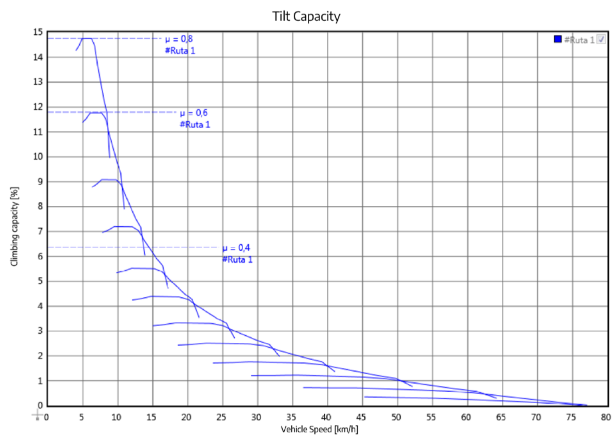


The graph shows that at full power, the truck reaches a little over 60 km/h, but if it must travel on a road with a modest 1% incline, for example, the speed will be 38 km/h, and the driver will need to downshift three gears to maintain the maximum possible speed. Additionally, headwinds or crosswinds can significantly affect the traveling speed.

As we can see, under these conditions, this tractor-trailer truck operates on a highway or a route where the normal flow of commercial vehicles travels at around 80 km/h, and cars travel at 100 km/h or more.

Now, let's analyze, in Figure 3, the behavior of a conventional truck, which has a power-to-weight ratio of 4.25 hp/t.

Figure 3. Performance curve of conventional truck



1. Solomon D. 1964. Accidents on main rural highways related to speed, driver and vehicle. Washington, DC: US Department of Commerce & Bureau of Public Roads

As observed, in this case, the maximum speed is 80 km/h, and when faced with a 1% incline, the truck will be able to maintain a speed of 52 km/h.

Clearly, it's not optimal, but considering that Argentina is a predominantly flat country in the areas where cargo transportation is extensive, it represents a reasonable ratio.

For a transportunit with these characteristics, if it operates in mountainous terrain, its performance will be poor, and it will achieve very low, unsafe, and uneconomical commercial speeds.

In Argentina, there are some equipment configurations authorized to carry larger loads, reaching a Gross Combination Weight (GCW) of up to 55 tons.

To illustrate, let's consider an example: a tractor-trailer truck with a 3.80-meter-high Side semi-trailer, similar to new hopper grain carriers, with a roof and side deflector, a 6x2 tractor axle configuration, with a 1+2 trailer.

Image 1. Semi-trailer with a GCW of 52.5 tons and a power-to-weight ratio of 6 hp/t

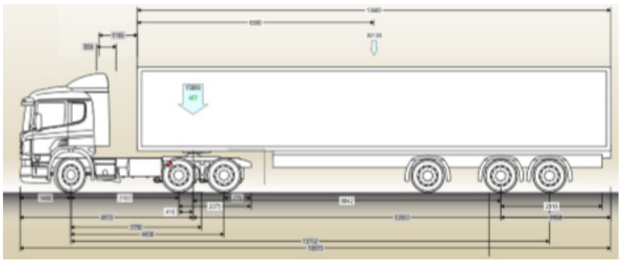
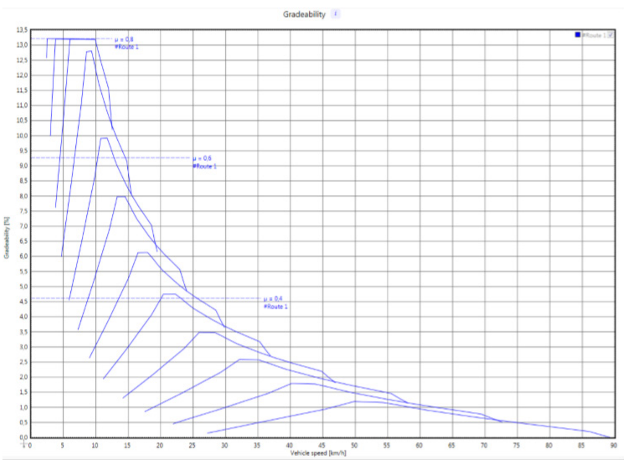


Figure 4. Performance of the described semi-trailer as an example



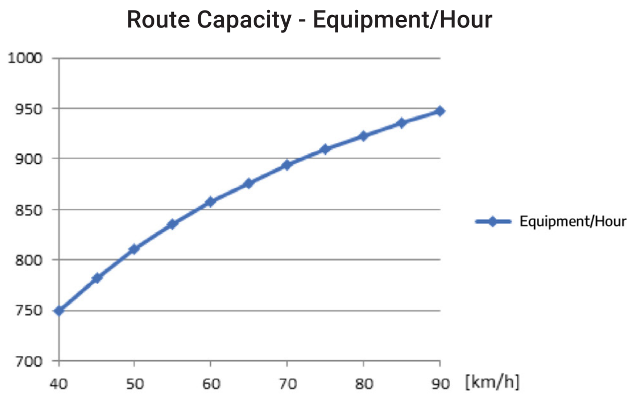
In this case, we can see that the transportation unit is capable of reaching a maximum speed of 90 km/h, meaning it can travel at the legal speed limit (80 km/h) even when the road gradient reaches 0.5%. With a 1% incline, it can maintain a speed of 65 km/h.

In summary, this unit can maintain its legal speed without pushing the engine to its maximum power.

Economic Performance Conditions on the Roads

Each roadway has a traffic capacity, and this capacity is reduced by vehicles traveling at low speeds. Let's assume, theoretically, a single-lane road where only tractor-trailer trucks circulate. In this case, the traffic flow will depend directly on the travel speed. Let's look at a graph calculated based on a 20-meter unit and a 3-second following distance between one unit and the next.

Figure 5. Relationship between vehicular traffic capacity and speed on a road



Source: Author's own work.

As we can see in the previous figure, if all the units were traveling at 80 km/h, the theoretical flow would reach approximately 923 units per hour. However, if the speed were reduced to 50 km/h, this number would decrease to 811 units, representing a 12% reduction in the theoretical capacity of the road. It's evident that the productivity of road infrastructure is impacted by the average speed of the vehicles in circulation. It's important to note that even if most of the units could travel at the maximum commercial speed set by the road, a few slower-moving trucks would significantly affect the pace and productivity of the road, leading to numerous overtaking maneuvers, which increase the risk of accidents.

Ultimately, this translates into longer travel times, less capital turnover, increased labor hours, and, in the end, higher transportation costs.

As an example, a theoretical calculation exercise is presented to assess the parameters required for transporting the soybean harvest at two different commercial speeds on the road segments. The exercise considers an average trip distance of 260 km, a unit's load capacity of 30 tons, and a soybean harvest of 59,374,021 tons for the year 2017.

Table 2. Example of variation according to commercial speed

Commercial speed [km/h]	50	70
Average distance [km]	260	260
Circulation hours [h]	5,20	3,71
Trips to move the soybean harvest	3.958.268	3.958.268
Hours to move the soybean crop	20.582.994	14.702.139
Equipment/hour per roadway	811	894
Tons per hour [t/h]	24.330	26.820
Hours of route use to move the harvest	2.440	2.214

Source: author's elaboration, 2023.

While the example has its limitations, it clearly illustrates the importance of providing cargo transportation services at an appropriate commercial speed.

Limiting Greenhouse Gases and Environmental Pollution

Engines have characteristic curves that allow us to understand their performance based on the load they are subjected to (how much we press the accelerator) and the revolutions per minute (rpm) at which they operate. Let's take a look at one of these curves for a 9-liter diesel engine.

As we can observe in Figure 6, this unit can generate a maximum of approximately 310 kW at 2,300 rpm (blue point). In this situation, the engine consumes about 220 g/kWh.

Let's assume that we must operate under this condition at full power to allow our transport unit to travel at a certain speed. As a result, our engine will be operating far from its optimal point of maximum efficiency.

Now, let's consider, using the same curve, that to cruise at a certain speed, I need 230 kW, which is 74% of the engine's maximum power.

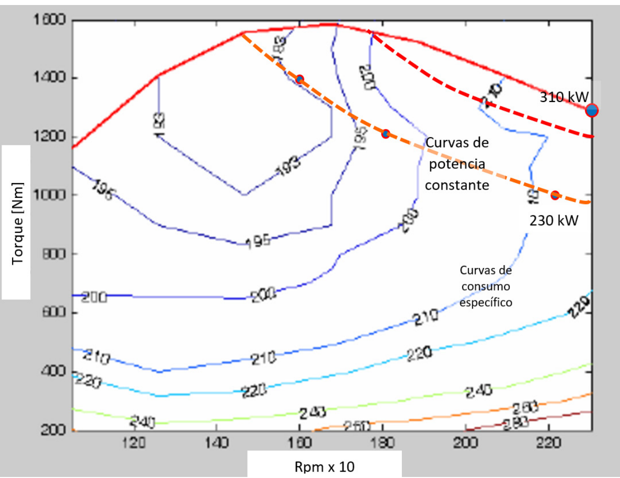
In this case, I can work along the 230 kW curve (orange line), and depending on the gearbox and differential ratio applied, I can obtain those 230 kW between 1,350 rpm and 2,300 rpm. Clearly, gear ratios are finite, and the final gear will provide the optimum. Suppose in our hypothetical case, the engine operates at 1,600 rpm to achieve the desired speed. In that case, the equilibrium condition is achieved with a fuel consumption of 193 g/kWh, which is 12% lower than when operating at its maximum power.

Indeed, these curves explain why it is advantageous to work with engines that have greater power than the maximum required for traveling at commercial speed. This allows the engine/transmission to operate at a lower rpm range and with significantly lower fuel consumption.

It's also worth noting that when the power train operates at partial power, it is subjected to less stress, which increases its lifespan.

Argentina has a fleet (stock) of cargo units, and modernizing it is neither an easy nor a quick task. However, from the perspective of efficiency, safety, and environmental impact, if the country aims for a modern transport system, policies should be implemented to facilitate the modernization of the fleet of motor vehicle cargo transportation units.

Figure 6. Illustration of a diesel engine curve case



CNRT | CONTROL DEL TRANSPORTE

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SEGURIDAD VIAL

Ministerio de Transporte Argentina

Alejandro Covello
Multimodal Investigation Advisor for the Transport Safety Board (JST)

MAJOR INDUSTRIAL ACCIDENTS AND STATES OF EMERGENCY

Investigation of Exceptional Events

In recent years, the magnitude of the consequences resulting from accidents has increased in parallel with technological progress. This has brought new challenges to safety, requiring accident investigation boards to broaden their cognitive capabilities towards exceptional events.

On July 10, 1976, the Italian city of Seveso, located 22 km from Milan, was engulfed by a cloud of dioxin due to a major industrial accident. The toxic cloud also spread to neighboring cities such as Cesano Maderno, Desio, and Meda. Months later, newborn babies exhibited deformities, and residents of the city suffered from skin and liver diseases. Additionally, 3,300 animals that had been abandoned were found dead from consuming contaminated plants, while another 80,000 animals were sacrificed to prevent them from contaminating the food chain. The inhabitants of Seveso were forced to leave their homes, and many could not return as their houses were destroyed during the cleanup efforts. The impact of the dioxin toxic emission on the health of the population is still being studied.

The contamination of an entire city and its population was an unprecedented event, only comparable to the use of chemical weapons in World War I. Seveso marked a further escalation in the scale of consequences resulting from major industrial accidents, introducing what we could call *fourth-order victims*

With the advent of the steam engine came industrial accidents in the realm of railway and maritime transport. These accidents resulted in *first-order victims* (workers in the industry where the accident occurred) and *second-order victims* (workers in the supply system and service users, such as passengers on a ship or train). Later, *third-order victims* emerged, those who do not voluntarily participate in the production system, such as the residents of a city. The characteristics of the accident in Seveso inaugurated consequences with *fourth-order victims,* including embryos in gestation at the time of the accident, children born dead or with deformities conceived after the incident, or children of affected parents who cannot conceive[1].
A few days after the Seveso accident and considering the risk of congenital malformations, the Regional Council of Lombardy and the Italian Parliament passed an exceptional abortion law for pregnant women exposed to the toxic cloud. Hundreds of pregnant women were considered at high risk and subjected to abortions

Such accidents have occurred in the subsequent decades, from Bhopal (1984) and Chernobyl (1986) to the Coronavirus pandemic (2019)[2], among others, and they share a common characteristic: they lead to states of emergency. This means that governments can enact exceptional laws that, in certain circumstances, involve restrictions on freedom of movement, the right to assembly, the circulation of people, isolation, mandatory evacuations, or, as in the case of Seveso, the extraordinary suspension of existing laws (the law penalizing abortion).

Furthermore, due to their magnitude and complexity, when investigated, these events yield new perspectives, models, and explanations that serve as cognitive openings. Politicians, specialists, and investigators in safety and risk management find more effective prevention and mitigation strategies.

Charles Perrow, when analyzing the Three Mile Island nuclear accident (1979), wrote *"Normal Accidents"* in 1984. Later, James Reason, in his book *"Human Error"* (1990), developed the epidemiological analysis of accidents and the concept of latent conditions through the analysis of Three Mile Island and other disasters such as Bhopal, Challenger (1986), and Chernobyl. Diane Vaughan continued with her book *"The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA"* (1996), in which she describes the concept of normalization of deviance in a comprehensive study of the Challenger space shuttle accident. Scott Snook, in his book *"Friendly Fire: The Accidental Shootdown of U.S. Black Hawks over Northern IRAQ"* (2000), somewhat revisits this concept to introduce the concept of practical drift. And so, the last century ended with a scale jump in terms of the number of disasters and fourth-order victims, but at the same time with entirely new theoretical and conceptual frameworks for analyzing accidents that cause "exceptional events."

Sidney Dekker, in his book *"Foundations of Safety Science"* (2019), tells us that these types of accidents constitute a turning point in thinking about explanations for accidents and disasters. In particular, the accident in Seveso was a determining event for the definition of new European regulation on risk management in certain industrial activities. This directive was known as Seveso 1 (1982), and later modified in 1996, Seveso 2, with its most significant additions focusing on the environment.

In 2003, the European Parliament modified Seveso 2 following the events at the AZF chemical factory in Toulouse, France (December 2001). This catastrophe was caused by the explosion of ammonium nitrate and resulted in the death of dozens of people, thousands of injuries, and a significant social and political impact. The new modifications, known as Seveso 3, included the inclusion of processing and storage operations of mineral substances and dangerous substances, to which was added an extension of the obligations of the Seveso directives to subcontracted companies.

1. For fourth-order victims, refer to Perrow, Charles (1984). "Normal Accidents."

2. Muro, Marcelo y Covello, Alejandro (2020). Análisis sistémico de la pandemia. Un accidente normal. Available at https://alejandrocovello.com/2020/08/14/analisissistemico-de-la-pandemia-del-coronavirusun-accidente-normal/

Investigation of Exceptional Events

Understanding, providing new explanations for accidents, and developing policies to prevent and mitigate their consequences is the task of the Transport Safety Board (Junta de Seguridad en el Transporte, JST) in Argentina. This organization, starting in 2020, expanded its factual competence to investigate exceptional events. An exceptional event refers to an event of unusual severity whose consequences impact the basic functions of society, such as operational continuity, the provision of essential services, operational and health safety, the environment, and ecosystems, among others. In response to these exceptional events, governments can define states of emergency[3].

"An exceptional event refers to an occurrence of unusual seriousness, whose consequences impact the basic functions of society, such as operational continuity and the provision of essential services, operational and health safety, the environment, and ecosystems, among others."

In the initial context of the global health crisis caused by the coronavirus pandemic, the JST identified the need to expand its field of investigation to exceptional events, in line with the activities carried out by other safety investigation boards around the world, such as the Finnish Safety Investigation Authority (SIAF) in Finland and the Dutch Safety Board (DSB) in the Netherlands. Therefore, the JST initiated an investigation into an exceptional event impacting the Argentine transport system.

Within this framework, the organization produced its first report[4] on an event of this nature, which constitutes both a descriptive and analytical approach to the handling of the coronavirus crisis within the Argentine transport system. The work was supported by contributions from a collaborative network established ad hoc, consisting of national transportation entities, including regulatory and supervisory bodies, operators, transportation chambers and associations, as well as health insurance providers and labor unions representing sector workers.

3. Definition adopted by the JST for its first investigation of an exceptional event.

What is the value of accident investigation, particularly the analysis of exceptional events? Paul Virilio, a French intellectual who wrote about technology and accidents in his book "Original Accident" (2010), states: "Without the freedom to criticize technology, there is no technical progress, only conditioning." Accident investigation is a critique that arises from an undesirable event. Accident investigation allows us to unveil the specific accidents of new technologies: inventing the ship is inventing the shipwreck; inventing electricity is inventing electrocution; inventing DNA recombination and the gain of function in lethal viruses is inventing an unknown pandemic.

For Virilio: "Every technology carries its own negativity, which emerges simultaneously with progress (...) We do not progress through a technology but by recognizing its specific accident, its specific negativity" (2010). New technologies, climate change, close couplings between different production systems, among other factors, carry a certain type of accident that is no longer local or specific – like the sinking of the Titanic or the derailment of a train – but are general accidents that immediately affect an extensive geographic region or the entire world – like the coronavirus pandemic – and lead to states of exception.

Therefore, working on exceptional events is essential. We are living in the age of the technocene. Flavia

4. Available in: https://www.argentina..gob.ar/sites/default/files/2001/10/resumen_ejecutivo_covid.pdf

Costa defines it in her eponymous book as "the implementation of highly complex and highly risky technologies, leaving traces on the world that expose not only today's populations but also future generations for thousands of years to come" (2021). That's why investigation boards in Finland, the Netherlands, and Sweden expanded their scope of competence and gained experience in investigating exceptional events related to the coronavirus pandemic. Furthermore, at the last meeting of the International Transport Safety Association (ITSA) held in Finland, the investigation of exceptional events was added to the agenda[5].

"Accident investigation allows us to unveil the specific accidents of new technologies: inventing the ship is inventing the shipwreck; inventing electricity is inventing electrocution; inventing DNA recombination and the gain of function in lethal viruses is inventing an unknown pandemic.

CONCLUSIONS

According to Virilio, "The principle of responsibility towards future generations requires exposing the accident and the frequency of its industrial and post-industrial repetitions now" (2010). International experience and our first investigation into exceptional events highlight the need to expand the competencies of accident investigation organizations to include these types of events. This paves the way for cognitive openness and the generation of new policies for safety and risk management to prevent and mitigate unusually severe accidents.

5. "Experiences in the investigation of non-transport-related incidents/exceptional events: 'Some of us have expanded our scope of investigation to so-called incidents and accidents unrelated to transportation. It would be interesting to hear how 'these branches' fit into more traditional transportation safety investigations. Additionally, we would like to discuss how you have accommodated your respective legislations and prerogatives to investigate these non-transport-related incidents' (ITSA, 2022)."

References

Costa, Flavia (2021). Tecnoceno. *Algoritmos, biohackers y nuevas formas de vida*, Taurus.

Dekker, Sidney (2019). *Foundation of Safety Science. A Century of Understanding Accidents and Disasters*, Routledge.

Perrow, Charles (1984). *Normal Accidents. Living with High-Risk Technologies*. Princeton University Press.

Reason, James (1990). *Human error*, Cambridge University Press.

Snow, Scott (2000). *Friendly Fire. The Accidental Shootdown of U.S. Black Hawks over Northern IRAQ, Princeton University Press*.

Vaughan, Diane (1996). *The Challenger Launch Decision. Risky Technology, Culture and Deviance at NASA*, University Of Chicago Press.

Virilio, Paul (2010). *Accidente original*, Amorrortu.

Marcelo R. Lucero
Master Mariner and Fisheries, Licensed in Maritime Transport, University Professor of English, and University Teaching Specialist.

AN UNUSED TOOL IN OUR MARITIME WATERS

The Use of Vessel Traffic Separation (VTS) Devices for Navigation Safety

In 1972, the International Maritime Organization (IMO) approved the International Regulations for Preventing Collisions at Sea (COLREGs), which came into force in 1977. One of the most significant innovations of this convention was the establishment of devices aimed at substantially reducing the risk and number of accidents resulting from collisions and groundings in maritime traffic.

Introduction

There is no doubt about the wisdom in drafting the COLREGs as one of IMO's key conventions and the validity of its recommendations regarding the prevention of collisions between vessels, including the continuous assessment of navigational circumstances to estimate safe passage distances among those sharing the same areas of navigation.

From my first encounter with this international regulation during my nautical training, I have been intrigued by the concept of Vessel Traffic Separation (VTS) devices. These are defined navigation areas at sea, established by coastal authorities of each State to regulate the direction of vessels transiting, departing, or heading to their ports. They aim to reduce collision risks caused by indiscriminate use of maritime space and serve to channel vessel traffic in conflict-prone areas.

While practicing my profession as a merchant ship captain on long-haul voyages, I could appreciate the convenience of having these aids as traffic organizers, especially in areas that were less familiar to me. Immediately, I tried to understand why our country did not have this tool, a question that still lingers.

Additionally, IMO has issued clear design guidelines for States to respond to the recommendation of establishing VTS in their waters in favor of maritime safety and better control of maritime traffic.

The establishment of VTS not only requires a comprehensive study of the geographical area and the traffic within it but also an understanding of the practices and customs of vessels calling, transiting the coast, entering, or departing ports in the region. Following this analysis, a report must be submitted to IMO for recognition and validation of each VTS in accordance with international standards.

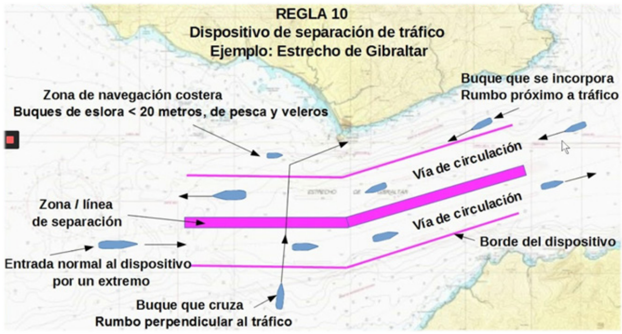
Advancements in onboard technologies now enable vessels to continuously determine their position anywhere and at any time. This capability allows them to navigate within the boundaries of the corresponding traffic lanes without the need for additional marking or beacons[1].

Therefore, the implementation of each VTS, its publication on nautical charts, and other navigation aids essentially involve a decision by the respective authorities.

The current proposal for the port of Mar del Plata in Argentina is merely a graphical exercise in the application of VTS in that area. It is not the result of a comprehensive study as mentioned previously.

1. Buoyage can include, in addition to lighthouses and buoys, static or dynamic virtual aids as needed for the area.

Figure 1: Traffic Separation Device in the Strait of Gibraltar



Source: www.navegantesoceanicos.com

"The establishment of VTS involves not only a thorough study of the geographical area and the traffic within it but also an understanding of the practices and customs of vessels calling, transiting the coast, entering, or departing ports."

Maritime Traffic Separation Devices (TSDs)

Rule 10 of COLREGs describes the obligations of vessels navigating using the device or in proximity to one.

While the text of this convention does not include illustrations, it is common to accompany it with graphical examples of devices in use to understand this rule better. It's important to note that such illustrations, like the one added below (Figure 1), are merely examples of the design possibilities for TSDs, depending on the specific characteristics of the navigational area and the studies conducted by the involved States.

Rule 10 specifies, among other concepts, that vessels using the device must:

- Navigate within the appropriate traffic lane according to their direction of travel.
- Keep clear of separation lines or zones.
- Enter or exit the device through its ends or, if using its lateral limits, do so at the narrowest possible angle relative to the direction of traffic.
- Avoid the adjacent coastal navigation zone, except when heading to or from a port or another place within it, or to avoid an immediate danger.

Similarly, Rule 10 states that vessels not using the device must:

- Keep clear of it with as much clearance as possible.
- Avoid crossing it, or if forced to do so, cross it at right angles to the traffic[2].
- Use the adjacent coastal navigation zone if they are vessels less than 20 meters in length, sailing vessels, or fishing vessels[3].
- Enter the interior of a separation zone only in case of an emergency or for fishing within it.

TSDs as Components of the Operational Context

Maritime navigation takes place in restricted geographic areas as the operational environment. These areas present various geographical scenarios related mainly to the presence of navigable waters, proximity to coasts, and areas with higher navigation risks.

Based on my personal experience, I identify three primary operational scenarios for this mode of transport.

The first scenario is open-sea navigation without obstacles, with sufficient depth, ample maneuvering space, and low traffic density.

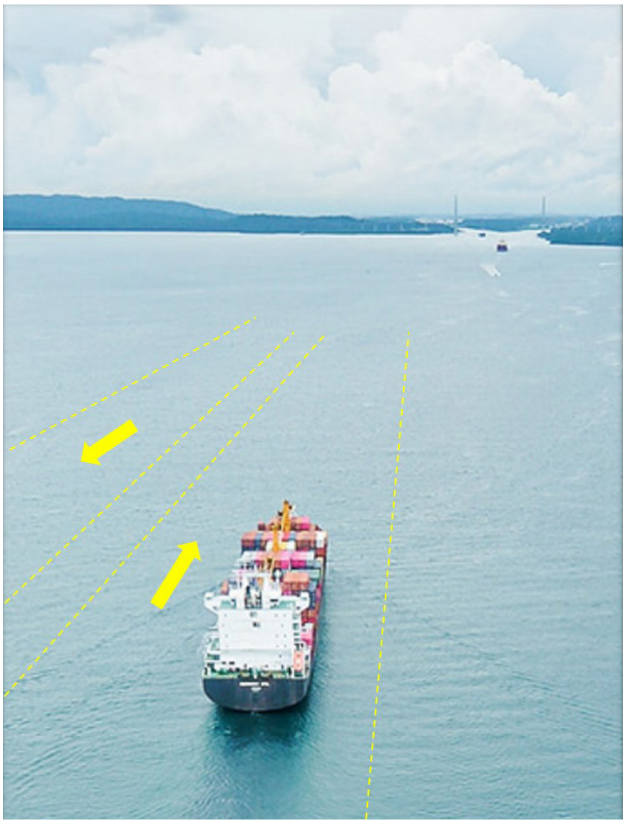
In this context, maritime routes are defined as long trajectories where the primary concern is to avoid adverse hydro-meteorological conditions such as strong winds, high waves, cyclones, etc. In this scenario, there is no need to establish VTSs (Vessel Traffic Separation) zones.

When navigating in "open seas," there is ample space and time to detect other vessels at a great distance and maneuver in advance. Vigilance and the ability to "keep a good lookout" day and night are our primary concerns.

The second scenario is coastal navigation, characterized by shallower depths and higher traffic density.

Approaching the coast after crossing the open ocean or coming from a distant fishing area demands greater

Figure 2: Aerial view of navigation via TSD



Source: https://pancanal.com/es/cuenca-hidrografica/

attention, with all alerts in place. Vessels require ample space for maneuvering, and when there is an obstacle ahead, inertia doesn't allow for immediate stopping, requiring several ship lengths to do so.

The third scenario involves navigating in restricted waters with limited space and depth.
In this context, vessels require proper and meticulous marking of the area, indicating navigation channels, and essential traffic organization and control by local authorities. In such cases, VTSs alone are insufficient to manage traffic.

Navigating in restricted waters truly tests a mariner's skills, and we appreciate the presence of buoys, beacons, and other means to recognize the area and navigate safely. In foreign ports, it's often essential (and usually mandatory) to take on a local pilot when navigating restricted waters.

The second scenario is clearly where VTSs play a crucial role, acting as transition zones or interfaces between open-sea navigation and restricted navigation in inland channels.

2. While vessels should strive to respect the traffic using the device, this does not imply that the device alters the maneuvering priorities indicated by COLREGs in its rules on steering and sailing.

3. Vessels dedicated to fishing are defined as such only when they are engaged in fishing operations. When a fishing vessel is in transit without conducting such activities, it is considered a power-driven vessel. Fishing vessels dedicated to fishing can only carry out their fishing operations within a separation zone.

Recommendations to States on the Implementation of VTSs

On November 20, 1985, the IMO approved Resolution A.572 (14) "General Provisions on the Organization of Maritime Traffic."

The goal of this resolution is to "enhance navigation safety in convergence zones and areas with heavy traffic or where vessel freedom of movement is restricted due to space limitations, navigational obstacles, depth limitations, or adverse weather conditions."

To achieve this, each State's traffic organization system should consider the possibility of:

1. Separating opposing traffic streams to reduce the frequency of vessels on collision courses.
2. Reducing collision risks between vessels crossing established traffic lanes and those navigating within these lanes.
3. Simplifying traffic flow characteristics in convergence zones.
4. Organizing safe traffic in areas with high exploration or offshore exploitation activity.
5. Organizing traffic within areas where navigation is dangerous or not advisable for all vessels or certain classes of vessels, or around these areas.
6. Reducing grounding risks by providing vessels with special guidance in areas where water depth is uncertain or critical.
7. Directing traffic away from fishing grounds or organizing it through these areas.

These purposes are directly related to the existence of appropriate VTSs.

Any devices that a coastal State establishes for its waters must be approved in advance by the IMO, the only international body with recognized competence to establish and recommend internationally relevant measures related to the organization of maritime traffic.

Appropriate Use of VTSs by Sailors

The presence of VTSs along the route facilitates our navigation watch duties by providing route guidance in areas of coastal transit, port access, or departure. For example, foreign vessels entering a port in another country, unfamiliar with local traffic, find VTSs very useful for providing them with traffic guidance before reaching the pilot station or outer anchorage. Likewise, domestic vessels experience reduced risk of collisions in these areas and can enter or leave the port with greater safety.

For this to happen, like any onboard regulation, it is essential for the crew responsible for navigating the vessel, i.e., the navigation watch, to be knowledgeable and practically trained in the use of traffic separation devices.

As a personal experience, I have felt the relief of navigating merchant vessels through VSTs in densely trafficked areas like the entrance to the Mediterranean Sea or the English Channel, among others. These traffic lanes are the best allies for navigating without conflicts alongside vessels of all nationalities.

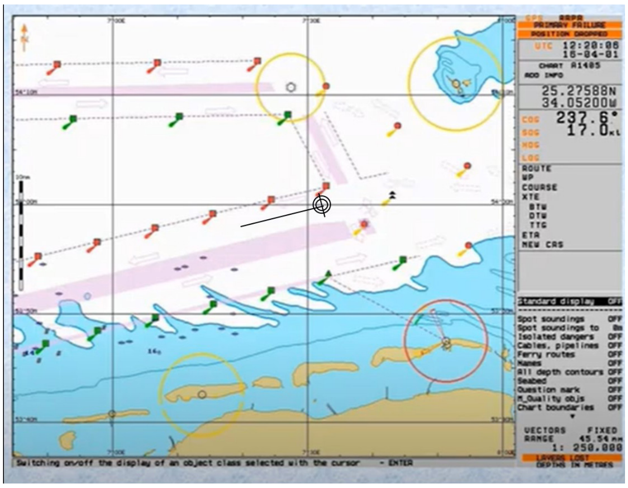
As for the means of orientation on board and maintaining a constant location to confirm the use of the correct traffic lane, following the issuance of Resolution A.572, complementing Rule 10 of COLREGs, new technological advances in electronic equipment assisting navigators have emerged, in addition to the use of radar and Automatic Radar Plotting Aids (ARPA) already associated with it.

Currently, the continuous position of the vessel is ensured using the Global Positioning System (GPS), and this position is directly displayed on the Electronic Chart Display and Information System (ECDIS) screen, alongside the image of theVTS zone.

This continuous positioning method has reduced the need to install additional physical marking near each separation device. Originally, it was essential to ensure tracking of the course of each vessel within it.

Additionally, the Automatic Identification System (AIS) has rapidly extended its use. This means that from each vessel in the area and from coastal control stations, it's possible to locate and identify other vessels that

Figure 3: SIVCE, Vessel Navigating through a VTS (Vessel Traffic Separation) Zone



are visually detected or tracked by radar, facilitating communications.

Regarding wireless communications between vessels and with coastal stations, while COLREGs did not explicitly incorporate the use of Very High Frequency (VHF) radio into collision prevention rules, it is undeniable that radio communication using VHF takes place during each approach between vessels to coordinate passages[4].

From the perspective of Vessel Traffic Management, technology has expanded its monitoring range beyond the reach of land-based radars. Simultaneously, the development of the Global Maritime Distress and Safety System (GMDSS) has provided secure communication equipment and protocols for both emergency and routine situations at sea.

"The presence of VTS along the route facilitates our navigation watch duties, as it establishes course guidelines in areas near coastal transit, port access, or departure."

VTS in the Port of Mar del Plata Area

The Port of Mar del Plata is located on the Buenos Aires Atlantic coast, running there in a north-south direction. Vessels arrive from the north, coming from the Río de la Plata, and from the south, arriving from the Patagonian ports and their fishing grounds.

Vessels arriving or departing to the north find a more direct access route, as the entrance alignment to the port between the north and south breakwaters is 028°/208°, similar to the coastal heading. However, they need to navigate properly to pass at a safe distance from Cabo Corrientes and then take an approach course to the breakwaters that avoids the sandbank at the end of the south breakwater. Additionally, the anchorage for deep-draft vessels is located on that same route, northeast of the latitude of Cabo Corrientes and 2 nautical miles from it.

Therefore, it may be useful to organize traffic from the north with a separation zone. This would help delineate the navigation routes to the port and the open coastal area for smaller vessels.

> **VTS 1:** Separation zone device, heading 050°/230°, width of navigation lanes 370 meters (0.2 nautical miles), length 3300 meters (1.8 nautical miles).

The Port of Mar del Plata shelters medium and small-sized vessels, particularly dedicated to fishing. These vessels typically operate east and south of the port. The final approach route and departure route from the mouth of the port follow a heading of 090°/270°, once the area of the sandbank at the end of the south breakwater is cleared, heading toward Cabo Corrientes.

Due to this, there is a suggestion for a second, smaller separation zone device for this traffic.

> **VTS 2:** Separation zone device, heading 090°/270°, width of navigation lanes 278 meters (0.15 nautical miles), length 2000 meters (1.08 nautical miles).

Traffic heading to or arriving from the south of the port encounters the Banco Pescadores, the greatest natural navigation risk in the area. A larger separation zone device with a safety distance and a separation zone is proposed for this traffic.

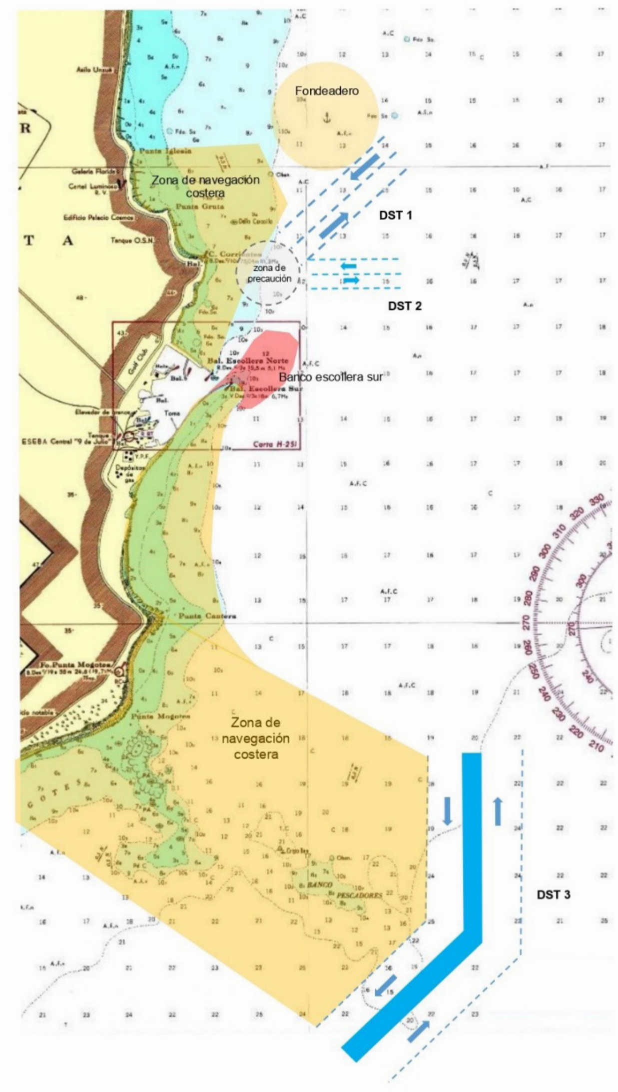
> **VTS 3:** Separation zone device, headings 000°/180° and 047°/227°, width of navigation lanes 740 meters (0.4 nautical miles), total length 7408 meters (4 nautical miles), width of separation zone 370 meters (0.2 nautical miles).

This scheme is complemented by coastal navigation zones dedicated to coastal recreational traffic, recreation, tourist excursions, minor fishing, and more, which are very common in front of the urban area.

The area is complex due to the diversity of traffic, as the Port of Mar del Plata accommodates shelter for cargo vessels, fishing vessels, naval vessels, sailboats, sports boats, and recreational boats. Hundreds of vessels enter and exit daily. It is vital to avoid the sandbank that forms at the end of the south breakwater, coordinate the use of the channel between the breakwaters, noting that many of these vessels do not require permission and often cross paths with larger vessels. Especially during strong winds from the east and northeast, maneuvers become riskier as the swell enters the inner harbor. In my experience, when using the port with cargo vessels, fishing vessels, fishing training ships, and finally, with a passenger cruise ship, I consider any additional assistance in the outer harbor to regulate the circulation of each type of vessel to be of great value.

4. Indeed, the use of VHF and other electronic aids, such as ECDIS, is understood to be included in the initial recommendation regarding the use of all available means to avoid a collision situation (COLREGs, Rule 5: Look-out).

Figure 4: VTS in the Mar del Plata Port Area.



CONCLUSIONS

Maritime traffic is of international nature and has clear regulations established for over 50 years. The International Regulations for Preventing Collisions at Sea (COLREGs) Convention of 1972 provides a common and comprehensive framework that is accepted and respected by vessels engaged in maritime navigation, both in national and international waters.

This regulation always requires meticulous analysis and study by both the ship's crew and maritime traffic control authorities to fully harness its potential for organizing and maintaining safety along coasts.

Within this framework, Vessel Traffic Separation (VTS) zones are valid instruments of organization. Their implementation should be considered not only in areas with very high traffic density but also in every coastal sector through which vessels transit and may encounter other vessels traveling in opposite directions.

VTS zones function as preventive measures within this operational context.

Bibliography

International Regulations for Preventing Collisions at Sea (COLREGs) Convention (1972), IMO, London.

General Provisions on the Organization of Maritime Traffic (1985), IMO, Resolution A.572 (14).

Velero la Argentina. Available at: <http://velerolaargentina.com/Ozi/Argentina/Argentina.html>

The interview was conducted by Mr. Diego Di Siervi, National Director of Railway Occurrences Investigation at JST.

RAILWAY DEVELOPMENT, INNOVATION, AND SAFETY

Accelerometry Technique and Brake Testing in the Railway Sector

We interviewed Mr. Mariano Fernández Soler, Director of the National Center for Railway Development and Innovation (CENADIF), to delve into the methodological measurement project being developed by this institution and its impact on railway safety.

The National Center for Railway Development and Innovation (CENADIF) was established by the Ministry of Transport of Argentina through Resolution 289 on December 3, 2020. Its mission is to drive technological and industrial development within the railway system, with the collaboration, integration, and participation of the railway industry, jurisdictions, universities, and public and private institutions. Working directly towards fulfilling the railway policy of incorporating new technologies and services, as enshrined in Law 27132[1] for the reactivation of freight and passenger railways in Argentina.

Within its field of action, CENADIF carries out the development and homologation of products, spare parts, components, and equipment related to the railway industry in accordance with applicable technical standards. It also undertakes tasks to promote and guide scientific and technological research, establish priority plans and programs, and collaborates in the development of regulations and technical documentation[2], including methodologies, plans, and technical instructions.

The Center is currently involved in more than twenty projects, among which the programs for rolling stock development, track and signaling infrastructure, homologation of synthetic sleepers, testing of alternative energy sources such as hydrogen, and the development of measurement methodology stand out.

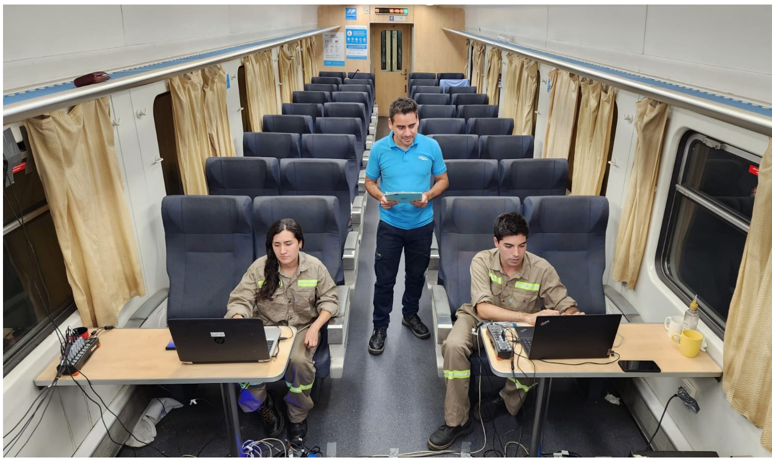
Within the last-mentioned program, the study of the accelerometry technique and brake testing is included. To learn more about this, we interviewed Mr. Mariano Fernández Soler[3], responsible for CENADIF, with an extensive background in both the public and private sectors, and expertise in railway engineering, development, and technical standards.

What applications does accelerometry have in the railway sector?

Accelerometry is a measurement technique that involves measuring accelerations using specialized sensors. It has several applications, such as measuring dynamic parameters of the rolling stock's behavior with respect to an onboard reference system. When we evaluate vertical and lateral behavior, it's because we are interested in the track-train interaction, where we observe both track irregularities and track geometry. When evaluating longitudinal behavior, one of the most important analyses we perform is brake testing.

What is the motivation for conducting brake tests? Why is measurement necessary?

There are several reasons motivating brake tests. Among them, one significant reason is the verification of a scheduled repair or a corrective intervention. Another reason is to assess if the train has the same braking performance capacity before returning it to service.



"Firstly, the advantage of conducting brake tests with suitable instruments and equipment is that the results obtained are not subject to biases and opinions but rather reflect the physical performance of the vehicles."

How can comparative values be obtained within a specific fleet?

Comparative values can be obtained through a protocol that clearly defines how tests are conducted, the steps for instrumentation, the sensors to be used, data processing procedures, variables under study, and the required conditions for the test track, among other considerations.

1. Resolution 289 of 2020 [Ministry of Transport of Argentina]. By which the National Center for Railway Development and Innovation was created. December 3, 2020. Available at: https://www.argentina.gob.ar/normativa/nacional/ resoluci%C3%B3n-289-2020-344821
2. Law 27132 of 2015. By which the policy of reactivating passenger and freight railways, the renewal and improvement of railway infrastructure, and the incorporation of technologies and services is declared of national public interest and a priority objective of the Argentine Republic. May 20, 2015. Official Gazette No. 33134. Available at: http://servicios.infoleg.gob.ar/infolegInternet/verNorma. do?id=247081
3. Industrial engineer specializing in railway engineering (UTNUBA). Interim full professor of Railway Dynamics, taught in the Railway Engineering program at the National Technological University - Haedo Regional Faculty (UTN-FRH). Manager of Innovation Management at Ferrocarriles Argentinos Sociedad del Estado (FASE) and head of the National Center for Railway Development and Innovation (CENADIF).

How can the behavior of a train be evaluated in relation to a fleet?

It can be evaluated through comparative tests among different vehicles within a fleet, carried out based on a standardized protocol. With a clear procedure, it ensures that tests are conducted identically for the same type of vehicle, and results are comparable.

What parameters of brake performance can be measured?

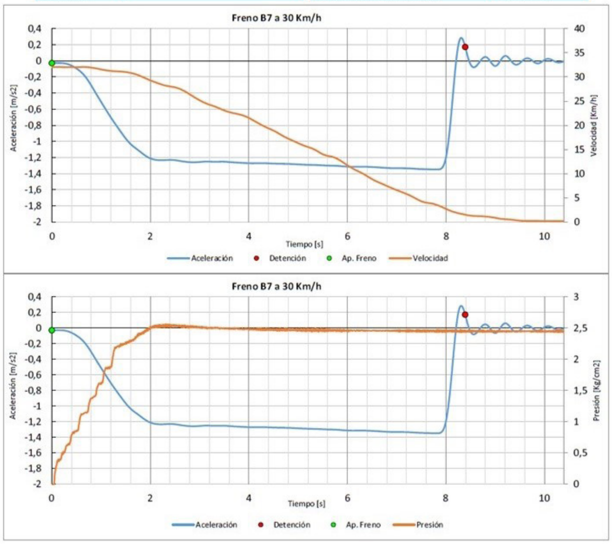
You can measure all magnitudes related to the dynamics during the braking process, such as accelerations, stopping distances, instantaneous speed, cylinder and pipe pressures, actuation mechanisms, and the temperature of linings and discs

What analysis can be derived from the measured data?

You can analyze the braking distances of train formations, the operation of the electrodynamic system, whether the pression in the pipe or cylinder application pressures are within the correct values, and more. Additionally, it is possible to evaluate whether the friction coefficients of brake shoes or pads from a specific manufacturer are comparable to the originals, providing a basis for homologation or certification.

DATOS DEL ENSAYO	
Fecha	5/10/2021
Registro	0007
Línea	Roca
Ramal	Const. - La Plata
Material Rodante	EMU CSR Zhuzhou
Zona de pruebas	Villa Elisa - La Plata
Condición de freno	B7
Velocidad Objetivo	30 [Km/h]
Conjugación de freno	EDB OFF
Observaciones	

DATOS DEL PROCESAMIENTO	
Velocidad en la aplicación	32,04 [Km/h]
Tiempo de detención (t_d)	8,39 [s]
Tiempo de respuesta equivalente (t_{re})	N/A
Distancia de detención (S_d)	44,62 [m]
Tiempo de alzada de aceleración (t_a)	N/A
Desaceleración eficaz (a_e)	1,15 [m/s2]
Desaceleración media (a_m)	1,06 [m/s2]
Tiempo de alzada de presión en cilindro (t_{ap})	1,58 [s]
Presión media en cilindro (P_m)	2,25 [kg/cm2]
Presión estabilizada en cilindro (P_e)	2,44 [kg/cm2]

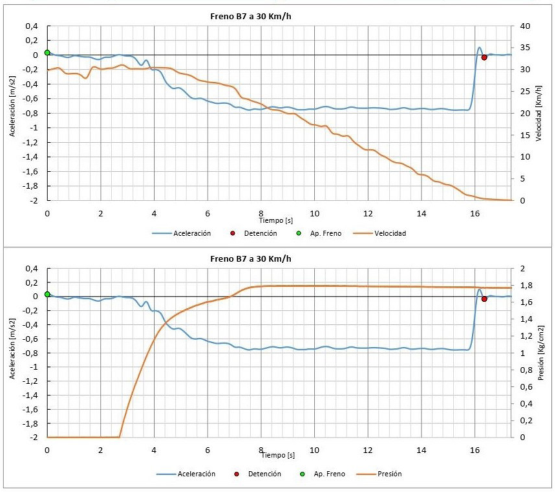


What can be done with the information obtained?

Expected operating parameters can be established to make future comparisons of each of the units with themselves and in relation to the fleet over their lifespan. For this, it is essential to use dynamics descriptors, such as braking distances or stabilized accelerations, and have a large number of recorded tests, so that a statistical analysis of the fleets can be outlined.

DATOS DEL ENSAYO	
Fecha	7/12/2022
Registro	0023
Línea	Roca
Ramal	Const. - A. Korn
Material Rodante	EMU Toshiba
Zona de pruebas	KORN - ADROGUÉ
Condición de freno	B7
Velocidad Objetivo	30 [Km/h]
Conjugación de freno	EDB OFF
Observaciones	

DATOS DEL PROCESAMIENTO	
Velocidad en la aplicación	30,00 [Km/h]
Tiempo de detención (t_d)	16,35 [s]
Tiempo de respuesta equivalente (t_{re})	N/A
Distancia de detención (S_d)	89,41 [m]
Tiempo de alzada de aceleración (t_a)	N/A
Desaceleración eficaz (a_e)	0,59 [m/s2]
Desaceleración media (a_m)	0,51 [m/s2]
Tiempo de alzada de presión en cilindro (t_{ap})	6,84 [s]
Presión media en cilindro (P_m)	1,35 [kg/cm2]
Presión estabilizada en cilindro (P_e)	1,77 [kg/cm2]



"The analysis of the integral behavior of the braking system is of significant relevance in the safety of railways since the data obtained can be applied to preventive maintenance tasks.

How can this information impact the railway safety field?

Firstly, the advantage of conducting brake tests with suitable instruments and equipment is that the results obtained are not subject to biases and opinions but reflect the physical performance of the vehicles. This data can be used in the development of preventive maintenance plans for rolling stock, especially concerning the effectiveness of brakes and their wear.

Another important aspect to highlight is that brake tests and trials can lead to an effective process for the certification and approval of modern brake systems, brake pads, and shoes.

In general terms, the analysis of the integral behavior of the braking system has significant relevance in the safety of railways since the data obtained can be applied to preventive maintenance tasks for both rolling stock and track infrastructure. The latter point is still under analysis.

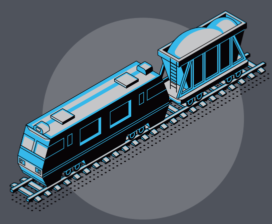
JST | SEGURIDAD EN EL TRANSPORTE

#SafeCrossing

REMEMBER THAT IN LEVEL CROSSINGS...

THE TRAIN ALWAYS HAS PRIORITY OF PASSAGE!

LEVEL CROSSING AWARENESS CAMPAIGN



MINISTERIO DE TRANSPORTE

GOBIERNO DE LA PROVINCIA DE BUENOS AIRES

Ministerio de Transporte Argentina

Professional and technical staff of the Environmental Safety in Transport Area.

MAJOR CHALLENGES AS A RESULT OF WEATHER EVENTS

The Impact of Climate Change on Land Transport Infrastructure in Argentina

By mid-century, an average temperature rise of between 0.5 and 1 °C is estimated in Argentina. If we consider that climate factors affect the structures of the road system, any uninvestigated climate change increases the risks of accidents and undermines roads and safety.

According to 2017 data from the National Institute of Statistics and Censuses (INDEC), the transport sector fulfills essential functions for Argentina's development as it promotes the mobility of people and goods, contributing 4.4% of the total national gross value added of the economy. It also generates approximately half a million jobs according to the Observatory of Employment and Business Dynamics of the Ministry of Labor, Employment and Social Security (MTEySS) based on the Argentine Integrated Social Security System (SIPA).

Regarding the freight sector, the preponderance of the road mode (92.7%), followed by the rail (3.7%) and the river-maritime mode in ships and barges (3.6%) stands out; air cargo has a minimal share (data collected from the National Action Plan for Transport and Climate Change -PANTyCC-, Ministry of Transport in 2017).

The PANTyCC represents the set of initiatives that Argentina has planned to contribute to the reduction of greenhouse gas (GHG) emissions and adapt to the effects of climate change in the transport sector, in accordance with the commitments assumed before the United Nations Framework Convention on Climate Change (UNFCCC).

Focusing on road transport, it can be observed that climatic factors generate negative impacts on road infrastructure, mainly due to the deterioration of the asphalt layer, subsidence, pothole formation, waterlogging, among others. This has a direct impact on road safety. Within the Action Plan for the mode of land transport, it is evident that climatic factors have a negative impact on the structures of the road system and on the performance of the cargo rolling stock. The latter increases GHG emissions and slows down the achievement of the mitigation objectives assumed by Argentina by 2030. The set of mitigation measures considered will contribute to the reduction of 5.9 MtCO2eq in 2030 out of a total of 54.2 MtCO2eq of emissions in 2016, according to the 2016 national GHG inventory (INGEI). Hence, 95% of emissions correspond to the road sector, according to statistics from the National Department of Climate Change of the Secretariat of Climate Change and Sustainable Development of the Ministry of Environment and Sustainable Development.

"Climatic factors generate negative impacts on the road infrastructure, mainly due to the deterioration of the asphalt layer, subsidence, potholes, flooding, among others.

The PANTyCC is also complemented by adaptation measures to address the impacts of climate change through a series of interventions, mainly in transport infrastructure. The goal in Argentina for the year 2030 is to implement:

> "(...) Policies, measures and actions in the field of transport to provide better conditions for the mobility of people and goods, reduce times and prioritize safety, comfort and sustainability, in order to substantially reduce greenhouse gas emissions and promote climate change adaptation mechanisms that reduce the vulnerability of the sector to the impacts of this phenomenon".

As for the National Road Plan 2025, it consists of the development of road works and the use of specific asphalt that improve flow and physical conditions resulting in greater efficiency in mobility and lower

Climate Change Mitigation Actions

FREIGHT TRANSPORT	Railway hierarchy (loads)	Freight Railway Investment Plan (PIF) - Cargo derivation from truck to railway
	Improved efficiency in road freight transport	Intelligent Transport Program
		Driver training
		Fleet renewal with truck scrappage
		National Road Plan to 2025
		Limited maximum speed for truckst
	Urban freight transport circulation improvements	Paseo del Bajo

Source: extract from PANTyCC.

energy consumption. As an example of actions to be carried out: the construction of 2,800 km of new highways, 2,500 km of safe routes, 13,000 km of rehabilitated routes and 2,000 km of new pavements to optimize the operation of combustion engines; the construction of overpasses to improve circulation and reduce fuel consumption by avoiding interruptions in vehicular flows and congestion caused by low barriers and the emission of pollutants, particulate matter and GHGs by idling engines. In addition, the development of overpasses and viaducts improves transport safety in areas where rail and road modes cross.

According to the studies of the Third National Communication (TCN) on Climate Change (2015), during the period 1960-2010 an increase in the average temperature was observed in most of Argentina of around 0.5 °C, exceeding 1 °C in some areas of Patagonia, and there was an increase in the number of days with heat waves and a reduction in the number of days with frost. In terms of rainfall, the largest increases occurred in the east of the country, causing floods with a major socio-economic impact. In semi-arid areas, a decrease in rainfall was identified in the mountain range and a decrease in the flows of the rivers in Cuya. In relation to the potential impacts of climate change for the rest of the 21st century, another increase in average temperature of between 0.5 and 1°C is projected in most of the country, implying an acceleration of the warming observed over the last fifty years.

As for average rainfall, no major variations are expected in the coming decades. However, in the same vein, increases in the frequency of heavy rainfall events. Faced with these scenarios, in the countryside the waters run quickly in search of their natural channels, but sometimes, transport infrastructure works, railway and road lines interrupt the runoff of water in the water basins and increase flooding problems in urban and suburban areas. Although there are systems of gutters and sewers, these were dimensioned, designed and built without considering future projections linked to climate change, which makes them scarce or undersized. Among natural disasters, floods are the greatest threat to the country, in terms of economic damage and the amount of population affected (World Bank, 2016).

The main impacts by region are evidenced, according to the TCN, from the Ministry of Environment and Sustainable Development:

- water stress due to rising temperatures in the north and west of the country,
- potential water crisis in Cuyo,
- retreat of glaciers in the Patagonian mountain range,
- retreat of the average flows of the rivers of the La Plata Basin,
- sea level rise (affecting points of the maritime coastline and the coast of the Río de la Plata), and
- high frequency of extreme rainfall and flooding in northeastern Argentina (NEA) and western humid region.

"In relation to the potential impacts of climate change for the rest of the 21st century, another increase in average temperature between 0.5 and 1 °C Is expected in almost the entire country, which would imply an acceleration of observed warming in the last fifty years.

The Environmental Safety in Transport Area of the Transport Safety Board (JST) is working to monitor these occurrences as we consider that we are facing the potential risk of an increase in accidents, given the effects on the structure of the road system and freight transport that, therefore, has an impact on road and safety.

Today we can see, for example, forest fires, caused in part by heat waves, and droughts that affect transport and damage road structures, which in turn increase the risk of accidents due to lack of visibility, the movement of animals or soil erosion, among others. High temperatures and heat waves can damage both asphalts, affecting its rigidity, as expansion, at bridge joints. In mountainous areas affected by torrential rains, the risk of accidents due to rockfalls increases. In addition, the lack of absorption of the asphalt system and the preparation of its structure for floods and frequent torrential rains can lead to deterioration of foundations and bridges. For all these reasons, we are obliged to think about strategies and policies to implement maintenance service levels of road structures appropriate to these new scenarios.

A risk-based approach is needed to identify appropriate mitigation and adaptation planning. The Permanent Observation Topics (TOP) will collaborate in the achievement of the objectives proposed in the PANTyCC to maintain safety at an acceptable level of risk. We believe that it is necessary to assess the effect of climate change on the national road network and to take corrective measures in terms of design, construction and maintenance of the road network. Along these lines, the PANTyCC proposes:

- The mapping of climate vulnerabilities and risks as a tool for diagnosing the situation and supporting the management of adaptation to climate change; Climate Change Risk Mapping System (SIMARCC), launched in October 2017.
- The economic quantification of the impacts of climate change and the implementation of adaptation measures.
- Capacity-building in human resources and improvement in inter-agency coordination for planning and management of climate change adaptation issues.

- The creation of multidisciplinary teams to support the various initiatives underway or planned. The development of structural and non-structural works to prevent floods, droughts and heat waves.

In summary, as the Second National Communication (SNA) on climate change describes:

> "The new infrastructure, both road and rail, must take into account the climate changes that have already been registered in recent decades and those that future scenarios project for the coming decades, both in its adaptation to the new water conditions in the design of bridges and other works and in its development as a network, because of the implications that these changes are having on the productive system" (Secretariat of Environment and Sustainable Development of the Nation).

RSO
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Call for papers for the Safety Journal

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The journal's editorial proposal gathers opinion articles, reviews and technical research articles related to operational safety in all modes of transportation, and its link with different disciplines and topics: environment, gender, victims, national and international interest, economics, management, sociology, among others.

We invite researchers, researchers and professionals to submit technical articles to be part of RSO, the journal on multimodal operational safety of JSTEdiciones.

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primero la gente

#02

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ediciones@jst.gob.ar