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#01

SYSTEMIC INVESTIGATION MODEL

Keys to turning accidents into lessons learned for safety

NORWEGIAN INVESTIGATION METHOD

Interview with one of the creators of the NSIA model.

RUNWAY STRIP

Optimization of infrastructure at airports according to each type of operation.

MATRIX SYSTEMIC REASONING

Methodological proposal for the analysis of rail transport systems.

JST | SEGURIDAD EN EL TRANSPORTE

Ministerio de Transporte
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Editorial

As President of the Junta de Seguridad en el Transporte (JST), I am proud to present the first issue of our RSO Safety Journal (Revista de Seguridad Operacional - RSO), published by the JST´s Editorial Department. The mission of this editorial project is to promote the dissemination of technical productions that contribute to the debate, exchange and improvement of investigation in safety, technological innovation, improvements and environmental care in relation to transport.

With the creation of the Junta de Seguridad en el Transporte, Argentina became the first country in Latin America to have a multimodal investigation body. By its responsibilities, within the framework of the 2030 Sustainable Development Goals (SDGs), it contributes to transport safety through the investigation of accidents and the issuance of recommendations and effective actions aimed at avoiding the occurrence of transport accidents and incidents in the future. Therefore, the training of professionals and access to knowledge and improvements in relation to this subject are closely linked to our work as a main reference for safety .

The Safety Journal "RSO", aimed at technical professionals, seeks to create and strengthen ties with national and international entities dedicated to transport safety, to encourage the participation of different disciplinary approaches (politics, economics, sociology, psychology, etc.) and to address the issues underlying all modes of transport: from gender policies, attention to relatives of accident victims, environment and training. In this way, it promotes and accompanies the global agenda on safety.

The RSO Journal receives collaborations from professionals and specialists of national and international level, with the objective of indexing them in the near future. This first edition of the journal contributes with proposals for the development of systemic-matrix reasoning in sociotechnical systems applied to rail transport; article on the optimization of airport infrastructure through the dynamic concept of strips of runways according to the type of operation; and, among other topics and references, brings interviews with personalities in the field of transport, and Jan Thore Mellem, referent of the Norwegian Safety Investigation Authority (NSIA), who provides us with information on the pillars of the accident investigation model in that country, and other cross-cutting topics of interest in all modes of transport.

Finally, I would like to highlight the importance of the systemic investigation methodology, an approach adopted by leading international bodies and by the JST; for this reason we have made a dossier on this matter. The reports and studies that emerge from the investigations thus move away from the approach focused on errors made by operators and technical failures: human error is not the cause of accidents, but a consequence of other factors independent of the time and place of the occurrence.

This Journal and the JST will always be open to the entire transport community that wishes to join us in this new challenge we have proudly decided to take on.

Dr. Julián A. Obaid
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SUMMARY

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THE CYMAT: REGULATIONS AND PERCEPTIONS OF KEY PLAYERS IN THE SECTOR

Workplace Environment and Working Conditions for Long-Distance Passenger Transport Drivers in National Jurisdiction Regular Services

The CyMAT of long-distance passenger transport driving employees in regular services of National Jurisdiction is generally described in this study, considering both the regulatory environment and the viewpoints of the many players.

Introduction

Long-distance passenger transport driving staff must be aware of the dangers involved in their work and know how to control them in order to conduct operations safely. The Working Conditions and Environment (CyMAT, in its Spanish acronym) of employees who perform these duties is a significant source of risks. These variables include everything from the minimum requirements for a driver to the duration of the workday, the use of new technology, the recruitment and training methods for driving staff, the layout and conditions of the vehicle, the location of the driver, and the state of the roads. Any of these components might serve as a defense or, on the other hand, show a weakness in the capacity to prevent accidents.

Within the framework of a comprehensive approach to operational safety, the Transportation Safety Board (Junta de Seguridad en el Transporte, JST) examines the CyMAT of people who operate long-distance vehicles. According to this concept, organizational choices connected to the system's design and operations are the cause of failures during employees' work activities. These choices are made in the case of long-distance passenger travel after debates and consensus-building among government, labor, and corporate organizations. Each party or actor involved thus contributes to the configuration of working conditions, the design of which may have an impact on both production and system protection.

Analyzing the rules governing the activity is one method to get a sense of the hazards related to working conditions and environment. Drivers can be safeguarded from situations that are likely to be dangerous by following laws, orders, resolutions, and conventions. At the same time, the way the system is now operating can be explained by how organizational decision-makers perceive their employees' working conditions. Regulations and views both take into account the requirement to increase operational safety by analyzing and improving some CyMAT components.

The research conducted by the studies division of the National Department of Road Occurrences Investigation of the JST is summarized in this article, along with the key findings. The Agency's official website has access to the complete study.

CyMAT regulations controlling drivers of long-distance passenger transport vehicles

The laws listed in Table 1 were discovered after a methodical examination of data pertaining to CyMAT's legal rules.

Table 1. Summary of regulations

Regulations	Title
Law 20744	Employment Contrac
Law 11544	Working Day
Law 24449	National Traffic Law
Decree 692/92	Working conditions, health care, hygiene, and workplace safety for public passenger road transport drivers
Decree 1335/1973	Workbook for public passenger transport employee
Decree 4257/68	Special retirement system (unhealthy work)
Resolution 239/1998	Timetable control
Resolution 1021/1952 and 115/2018	Two-up driving system
Resolution 149/2019	Safety protocol
Provision 207/2009 and 48/2019	System for acquiring driving licenses
CCT 460/1973	Collective labor agreement
2017 Act	Length of the working day and conditions to diagram trips under the two-up driving system
Standard 3810[1]	Road safety — Good practices in public passenger transportation
Standard 39001[2]	Road safety management systems

1. Regulations not mandatory for this type of transport.
2. Id. Note 1.

These rules are intended to establish basic criteria for how things should work and behave in order to provide guidance to the drivers.

The following sentences provide an overview of the most significant findings:

1. The driving staff, who are responsible for driving or accompanying their driving partner, are included in the traffic staff as part of the CCT 460/73. Other tasks, such as loading and unloading packages, are not governed by any rules throughout the service.

2. Having a driver's license is the primary requirement for employment. The National Traffic Law 24449, Sections 207/09 and 48/2019, and Decree 692/92 all govern this procedure. The standards for evaluating the well-being of drivers and their impact on safety are a matter that need consideration.

3. The responsibilities of those who drive are mainly regulated by Decree 692/92 and must comply with traffic regulations, keep the company's equipment in good condition, check the condition of the vehicle and communicate anomalies, facilitate the ascent / descent of the service users and transporting objects. Driving employees have responsibilities and obligations in the event of an accident, according to Law 24449. There are hardly any obligations related to health and safety.

4. Driving is viewed normatively as a group position or task. A dual conduction regime is used to provide long-distance transportation services, according to Resolutions 1021/1952 and 115/2018. Only services that don't exceed 200 kilometers must use the single-drive system.

5. A maximum workday of 8 hours (plus 4 hours of overtime) and a daily rest period of 12 hours are set down in Law 20744. The working day is limited to six hours each day in jobs that have been deemed harmful. Similar standards are proposed by Law 11544. Staff can cover a total of 200 hours per month, according to CCT 460/73. A maximum 8-hour workday or 48 hours per week with an extension of 4 hours, as well as daily breaks of 12 hours at home or 10 hours away from home, are added by Decree 692/92. The 2017–2019 Accord permits the diagramming of 16-hour routes using the two-up operation system, which includes 8 hours of actual driving and 8 hours of operational downtime on board.

6. Decree 692/92 states that drivers are allowed 20 minutes for breakfast and a snack, and 45 minutes for lunch and dinner. Breaks per two hours of driving are established by the 2017–2019 Accord (or every 3 hours in exceptional cases). The proposed criteria for both regulations do not reveal the degree of tiredness recovery.

7. According to Law 11544, the employer is required to post the hours of work and break times. The use of a workbook is mandated by CCT 460/73 and Resolution 239/1998 to duplicate the registration of entry and departure times. The 2017–2019 Accord promotes the use of technological systems, which implies some worry about developing better solutions to control working hours.

8. CCT 460/73 states that drivers receive 6 francs per month, although it is unclear how these breaks are allocated. Also, according to these regulations, employees are entitled to paid annual and exceptional leaves. The requirement for a weekly day off is outlined in the 2017–2019 Accord.

9. In accordance with Decree 692/92 and Article 48/2018, applicants must be at least 21 years old. The fact that this age is within the category of young people, who experience more road fatalities and injuries than other age groups, is an essential aspect of this age limit.

10. The maximum age for applying in this occupation is based on the fact that, in line with Decree 692/92 or Law 24449, respectively, professional drivers cannot receive licenses after they are 55 or 65 years old. Although there is no maximum age for employment permanence, the frequency of psychophysical examinations rises after age 65. (Law 24449)

11. The monthly compensation method mandated by CCT 460/73 is based on the quantity of hours worked. The remuneration of the activity “by laps” is prohibited by Decree 692/92. According to CCT 460/73, hourly pay for night work, which is performed from 9 p.m. to 6 a.m., is equal to one hour and eight minutes of daytime work.

12. Law 20744 views on-the-job training as a right to be provided by the employer with the assistance of governmental authorities in terms of training. Technological innovation may give rise to requests from the union sector for the employer to create training. There are specified topics that should be included in the training, according to Decree 692/92. Workers are required to enroll in refresher courses once a year, per Article 48/2019. The 2017–2019 Accord emphasiz-

es the value of training while also stressing the significance of rest and breaks.

13. CCT 460/73 is the only standard that regulates the possibility of workers participating in organizational decisions through a Complaints Commission comprised of three staff members.

14. According to Law 24449, the driver's seat must be ergonomically designed. The seat must be adjustable to the anthropometric characteristics of the driver, have adequate damping, anchorage, and structural rigidity, a three-point inertial seat belt with a quick opening lock, and a head restraint, according to Decree 692/92.

15. In terms of the vehicle, Law 20744 requires the employer to create a safe working environment. Law 24449 mandates general safety conditions (such as effective braking systems) as well as specific measures in passenger transportation (for example, emergency exits consistent with the number of seats). Decree 692/92 establishes environmental regulations concerning noise, lighting, and air quality. According to this Decree, the manufacturer is first responsible for the vehicle's safety conditions (must comply with certain safety devices) and then the companies (must carry out the Mandatory Technical Review).

16. In terms of road infrastructure, Decree 692/92 mandates that road structure works adhere to basic road safety standards. If an unusual obstacle is discovered, the agencies in charge of the road must resolve the issue as soon as possible. This Decree also requires companies to provide sanitary and rest facilities in their terminals, headers, and hostels. Regarding road infrastructure, Decree 692/92 establishes that road structure works must comply with basic road safety standards. If an abnormal obstacle is found, the agencies responsible for the road must solve the problem quickly. This Decree also requires companies to offer sanitary and rest services in the headers, terminals and hostels.

17. IRAM Standard 3810 recommends good road safety practices for organizations involved in passenger vehicle transportation. This standard suggests some guidelines for specific aspects of working conditions, such as management's commitment to road safety policies, the definition of a driver profile, personnel evaluation, training content, unit inspection and maintenance, and service layout. ISO 39001 is intended to supplement IRAM 3810, which has a broader scope and establishes requirements for developing a road safety management system.

Perceptions of key industry players

Another goal of this research was to learn about the perceptions of some representatives of central organizations in the sector about the working conditions and environment of the driving staff. To answer this question, 8 virtual interviews were conducted with 7 relevant actors for the activity: National Commission for Transport Regulation (CNRT), Automotive Tramway Union (UTA), Long Distance Business Chamber (CELADI), Business Chamber of Passenger Road Transport (CEAP), Argentine Chamber of Automotive Passenger Transportation (CATAP), Argentine Association of Automotive Transport Employers (AAETA) [in their Spanish acronyms], and a former driver as a key informant.

The interviews were organized into 13 thematic blocks that represented each actor's perceptions of CyMAT (see Table 2). Each section is summarized below, along with the main perceptions identified during the interviews.

Table 2. Synthesis of the perceptions of the actors interviewed

Perception of the CyMAT	
Block	**Ideas and opinions**
Required qualifications	Previous experience • Lowered requirements during periods of increased demand
	Theoretical-practical training • More emphasis on hands-on training
	Deficit of theoretical knowledge • Attributed to licensing limitations

Worker's responsibility	Safety and care of the vehicle • These are not fulfilled due to disinterest or lack of professionalism • Opposing perspectives on mechanical activities • Loss of professional control scheme vs. non-liability
Working time limit	Excessive working hours • Companies' pressure • Failures in route layout • Increasing compensation • 8 hours (plus 4 hours overtime) Law • Impractical and non-specific 2017-2019 Accord • More adapted and beneficial
Pauses, rest and tiredness	Differences between legally required and actual rest • It is the driver's responsibility to get proper rest 2017-2019 Accord • Decreases rest opportunities • Different perceptions about maximum driving time before a break Variations in the quality of rest depending on the place • Lower level of recovery on board vs. outside the vehicle Extreme tiredness (white sleep) • Deficiencies: difficulty perceiving signs of fatigue, lack of technologies and control errors • Defenses: training and cooperative two-up couple
Personnel recruitment and selection	Recruitment • Labor market for workers with shortages Selection of driving staff • Evaluation: psychological, theoretical, and practical • Others: knowledge of the routes, history of infringements, employment references from other companies. • IRAM 3810 standard as a standardization strategy
Induction for personnel	Initial instance • Provides safety and customer service information • First outing with the vehicle • Assigning a driving partner
Driving staff training	Necessary, beneficial, and permanent space • Focused on sharing theoretical knowledge • Driving simulators' relative usefulness • Need to improve content on traffic laws and rest • While being limited in scope and efficacy, this resource is crucial for addressing technological advancements • Need for training provided by government organizations
Road infrastructur	The route as a complex environment • Diversity of terrain types • Road congestion • Low maintenance Increased risk in adverse weather conditions • Driver-dependent service suspension

Vehicle	Vehicle safety • Unwillingness to adopt new technologies • Heavy usage • Superficial controls • "Fixed car" impossibility Control improvements • Mainly those certified by IRAM 3810 Standard
CNRT control body	Perception of shortcomings • Inequalities in controls according to the country area and type of service • Fines for collection purposes • Workbook and tachograph limitations Limitations of the CNRT • Scarce inspectors and lack of training • Increase in fines • Lack of control at other points of the trip • Discontinuity of control and oversight policies Usefulness of Psychophysical Control Units • Control, promotion of health, and safety
Work book	A tool that is prone to failure Suitable for: • Rigid rules • Actual operation of the services Overcoming limitations through the digital notebook • Registration of more information • Better quality of controls • Creating a single system Problems deploying the digital work book • Regulatory framework's rigidity
IRAM Standards	Management tools • Improve road safety • They are a "quality seal" • Standardize procedures • Establish a common framework of good practice Questioning about a private entity's evaluation of a public service
CyMAT basics aspects	Link between working conditions, health and safety Collective and multidisciplinary approach Variability of the CyMATs

1) Qualifications needed for the job

- Previous driving experience, whether in passenger or cargo transport, is regarded as a critical factor, though this requirement tends to decrease during times of increased demand for services.

- The importance of understanding road rules and safe driving, as well as perceptual-motor skills, is emphasized, but practical learning is given more weight.

- It is argued that those who drive have a theoretical knowledge deficit due, in part, to the lack of rigor in the driver's license application process.

- According to some participants, the difficulty in defining what constitutes a professional driver has an impact on qualification and training content.

2) The worker's level of responsibility

- Those who drive are perceived to be responsible for both passenger safety and vehicle maintenance. Although the trainings reinforce this aspect, some say worker may still refuse to take on these responsibilities due to disinterest or a lack of professionalism.

- Some actors argue that drivers should be able to fix basic mechanical flaws. It is perceived as a loss of "the professional part" if the driver is not capable of covering such tasks.

Other actors believe that those who drive have no mechanical responsibility or resources to solve this type of problems.

3) Working time limit

- Excessive working hours, whether daily or monthly, are regarded as common practice. The causes of this excess can be found in the pressure on companies to cover all services during times of increased demand, the layout of routes without considering intermediate stops, and the motivation of driving staff to increase their remuneration.

- The law, which mandates a daily working day of 8 hours plus 4 extra hours, is viewed as impractical and insensitive to the specifics of the activity. The 2017–2019 Accord, which allows for a 16-hour workday under a two-up driving system, is envisioned as a step forward in trip planning (it is a regulation more adapted to the extension of the country and avoids the limitations of the relay system).

- The actors express dissatisfaction with the current regulatory framework for regulating the working time limit. Some claim that the 2017–2019 Accord is the main regulation, while others claim that it is not in effect.

4) Breaks, resting and tiredness

- There are perceived differences between the legally required daily rest and the actual rest. It is assumed that the latter may include activities that do not promote recovery, which is dependent on the driver's individual responsibility.

- Because those who drive can work continuously for days, exchanging driving times with operational breaks on board, the 2017-2019 Accord is viewed as a regulation that reduces rest opportunities.

- Different perspectives exist on how to regulate breaks under the 2017–2019 Accord. Some claim that they must drive for 2 hours before taking their first break, while others believe that they can be extended to 4 or 8 hours, and a final group believes that those who drive freely choose how to organize their breaks.Some actors argue that on-board operating breaks do not allow for the same level of recovery as off-vehicle breaks or breaks.

- According to some actors, on-board operating breaks do not provide the same level of recovery as off-vehicle breaks or breaks.

- The concept of "white sleep," defined as "sleeping with your eyes open," is mentioned as a state of extreme exhaustion. To explain this phenomenon, the failures in subjective tiredness detection, the lack of technologies to identify this state, and the control of rest hours without taking into account working hours are highlighted. Training and the presence of a cooperative partner are perceived as risk factors for tiredness.

5) Personnel recruitment and selection

- According to the participants, the search for personnel takes place in a labor market populated by driving personnel with training deficiencies and socio-family issues, which has a negative impact on the workplace.

- The selection of driving personnel is viewed as a stage that is based on three evaluations: psychological, theoretical (road safety knowledge), and practical (road tests with an expert driver or use of driving simulators).

- Other factors considered in the selection include route knowledge, a history of infringements, and references from other companies.

- Other factors considered in the selection include route knowledge, history of infringements, and references from other companies.

- Some businesses use the IRAM 3810 Standard to standardize their recruitment and selection processes.

6) Staff induction

- This stage is considered an initial instance, providing information to drivers about road safety, basic mechanics, customer service, first aid, and accident response.

- The first outing with the vehicle in the company of an expert driver who serves as an evaluator, as well as the assignment of a driving partner to deepen the practice of the task, are perceived as important moments during this stage.

7) Driving personnel training

- Training is seen as a necessary and beneficial space that should be maintained throughout one's career. Continuous training allows employees to adapt to changing workplace conditions.

- Trainings, it is argued, deepen the learning of basic task knowledge (e.g. customer interaction, safe driving).

- Despite the emphasis on practical learning, training is primarily concerned with the transmission of theoretical knowledge. The use of driving simulators attempts to balance this imbalance between practice and knowledge, but it is insufficient to achieve learning that can only be accomplished in a real vehicle.

- According to the participants, road rules and rest should be addressed more aggressively.

- Training is perceived as an important resource in situations of use of new technologies incorporated into the workplace. However, it is argued that sometimes these trainings are aimed at a part of the driving staff and are not completely effective.

> ***"This study suggests that existing legislation should be strengthened, as it assumes that regulations are an important protection strategy against both foreseeable and active dangerous situations."***

- Training implementation is viewed as a strategy that directly falls on companies. This results in variations in the training of those who drive. There is a need for government institutions to develop training that includes the entire sector.

8) Road infrastructure

- Because of the variety of terrain and road congestion, the route is perceived as a complex environment. Participants claim that the environment has deteriorated and is out of date.

- Because of the variety of terrain and road congestion, the route is perceived as a complex environment. Participants claim that the environment has deteriorated and is out of date.

- It is assumed that the levels of attention and tension are affected by certain characteristics of the route (e.g., monotony of the route, signaling).

- Adverse weather conditions are perceived as a major risk. In these situations, it is pointed out that the suspension of the service depends exclusively on the driver (that is, there are no organizational mechanisms to make this decision).

9) Vehicle

- Participants point to some factors that influence the safety of the vehicle, such as the reluctance to incorporate new technologies in the workplace, the intensive use of the unit, the existence of surface controls at times of increased demand and the deterioration of driving performance due to the impossibility of maintaining a "fixed car".

- Controls are thought to have improved, though only those with IRAM 3810 certification have a standardized procedure. It is stated that these companies use three forms to record vehicle information obtained through the maintenance sector's control. It is also mentioned that in some cases, a "witness report" (copy of the recorded data in the driver's possession) is used.

10) Perceptions about CNRT

- While participants report progress in the CNRTs' actions, a perception of their shortcomings prevails. Among the issues raised are the disparities in the rigor of controls based on the location within the country (lower requirements in the rural areas) and service type (absence of control in tour-

"The identification of these issues nor their resolution depend on the accountability of a single party, nor can they be boiled down to a particular cause. To the contrary, increasing the operational safety of drivers necessitates the joint engagement of all sectors that affect one of the fundamental criteria."

ism services), the use of fines for collection purposes or to "demonstrate management," and the limitations of the workbook (vulnerable registration, obsolete, inconvenient, and expensive) and the tachograph (leads to errors when assigning speeding tickets).

- There are perceived barriers in the CNRT's tasks, such as the small number of inspectors and their lack of training, the increase in fines caused by "one to one" control, the absence of control at non-terminal points of the trip, and discontinuities in control and control policies. Because of changes in government management.

- One of the CNRT's actions that was specifically mentioned was the control of driving personnel in Psychophysical Control Units. This action is perceived not only as an instance of control, but also to improve their health and promote the service's safety

11) The workbook as a control tool

- The work book is viewed as a fallible control mechanism, but also as adaptable to the actual operation of services. The workbook, as opposed to rigid rules, is a flexible control tool that adapts to the current working conditions.

- Participants mention the digital workbook as a resource that could overcome the difficulties of the traditional strategy. The ability to record more data on working hours, the strengthening of controls, and the configuration of a single system for different jurisdictions stand out as perceived benefits.

- The rigidity of the regulatory framework is a barrier to implementing the digital workbook, as a more demanding control mechanism would result in an increase in infractions. As a result, any changes to the control tool must be accompanied by a regulatory update.

12) Perception of IRAM Standards 3810 and 39001

- The interviewees regard IRAM Standards 3810 and 39001 as management tools aimed at improving road safety and increasing a company's quality. These standards allow for the standardization of security procedures and the creation of a common framework of good practices.

- The state is viewed as a body responsible for ensuring mandatory certification of these standards in order to reduce the risks associated with driving. The necessity of relying on a private entity to ensure the quality of a public service is called into question.

13) Basic aspects of CyMAT

- The interviews yield a series of insights into three fundamental aspects of the CyMAT, indicating that working conditions:

1. have an impact on driver health and safety;
2. they must be understood and modified through a collaborative and multidisciplinary approach capable of considering the various factors that influence driving (e.g. social, emotional, contextual); and
3. they change over time, as evidenced by variations in transportation policies caused by changes in government.

CONCLUSIONS

This work attempted to provide novel answers and raise new questions about two major issues: (1) what is the regulatory framework that governs CyMAT in long-distance passenger transport driving personnel of regular services in national jurisdiction? and (2) how do the various system actors perceive the drivers' CyMATs?

Concerning the first question, this study reports on a broad regulatory framework aimed at regulating technical, social, organizational, and environmental aspects of management personnel's operations. However, certain evaluation criteria for obtaining the National Interjurisdictional Transportation License (LiNTI); the definition of driver responsibilities, the clarification of work and rest times, and the search for a more consistent control tool have been identified as legal components that could be improved. As a result, this study suggests that existing legislation should be strengthened, as it assumes that regulations are an important protection strategy against both foreseeable and active dangerous situations.

Regarding the second query, actors express different perceptions about the characteristics,

problems and risks associated with the working conditions. If one considers the existence of the various interests between the parties, this is to be expected. There are a number of misconceptions that have been noted, including the inconsistencies in determining the requirements to hold the position, disagreements in defining an ideal working day and its breaks or rest periods, a lack of clarity regarding the tasks that a driver must perform while at work, the presence of environmental risks, the limitations of the audit and control body, and the contributions of the IRAM Standards. If these results are compared with data obtained in previous similar studies (Neffa, 1986; SRT, 2009; Diez et al. 2019) is observed that:

- CyMATs contribute to the fact that worker health is still a significant problem.

- The activity is characterized by excessive working hours and the resulting reduction in rest possibilities, which is supported by organizational and personal objectives. One of the most significant issues is this one, which calls for adjustments based on judgments that include the activity's range of interests and cultural specifics in addition to scientific and normative requirements.

- The routes are still seen as having a high frequency of vehicles and a poorly maintained environment. This paper adds worry about the excessive usage of vehicles, which is different from earlier studies. The workload and task risks may rise as a result of these environmental conditions.

- Although efforts are still needed to establish standard training commensurate with the intended professional profile, training bodies have made positive progress.

The answers obtained to the two questions that gave rise to this work indicate that the CyMAT of drivers had certain flaws. A systemic perspective views these flaws as hidden (or less obvious) organizational factors that tend to have a detrimental impact on the management team's decisions and decrease operational safety. Overcoming these flaws rests on those players with more autonomy in decision-making, such as the state, company, and union, due to the organizational nature of the system. By altering normative, technological, socio-organizational, and environmental factors, these players, who are situated at the highest levels of organizations, can optimize the CyMATs. In this sense, neither the identification of these issues nor their resolution depend on the accountability of a single party, nor can they be boiled down to a particular cause. To the contrary, increasing the operational safety of drivers necessitates the joint engagement of all sectors that affect one of the fundamental criteria.

In conclusion, this research makes significant strides toward identifying potential elements that can weaken or boost the system's defense mechanisms.

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Interview realized by
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INTERVIEW WITH SENATOR ANTONIO JOSÉ RODAS

Extension of the JST's Competences to Pipelines and Other Energy Conveyances

This initiative, which has legislative status, aims to offer a technological foundation for a topic of major public concern due to its implications for public safety and the environment.

The Argentina National Senate is now considering a bill to broaden the competences of the Transportation Safety Board (Junta de Seguridad en el Transporte, JST), with the goal of securing pipelines and other energy transportation networks of all shapes and sizes.

The proposal, which has already received parliamentary approval, aims to expand the Agency's authority under Law 27 514, which created the JST, to include all national means of passenger and cargo transportation. in all its forms and sources.

The bill's sponsor, Senator Jorge Rodas of Chaco, believes that incidents involving energy transportation ought to be looked at by a multimodal technical organization like the JST, not just for their effects on safety but also, and most importantly, for the environment.

"We believe that all safety-related issues in the transportation of energy, which is primarily transported and stored from production to consumption centers by different means such as gas pipelines, oil pipelines, polyducts, power lines, aqueducts, etc., contribute to the welfare of the population, to the conservation of the environment and to the sustainable development of production. Therefore, we believe it was appropriate to develop a proposal to extend the competence of the JST to those incidents and accidents resulting from the transportation of electrical, gaseous, or liquid fluids; this would enable the JST to function as a tool that enhances safety in energy transport operations, regardless of their form, by turning to the model that has been successfully applied in comparative Law studies," said the senator.

The goal is to give a technical foundation in an issue of great importance for the public, such as energy transportation, which is today viewed as a human right due to its significance in everyday, productive, and environmental life.

"Moreover, nature has given us some indications of systemic harm at this unique period in history. It would be simple to recall occurrences that had a significant negative influence on both safety and the environment in the transportation of gas and other hydrocarbons, as well as in the mining of pipelines. In addition to blackouts and other unforeseen circumstances that emphasize the value of safety in the conveyance of energy," he stated.

The initiative then affects safety and broadens the JST's range of capabilities, right?

That's correct. It conceptualizes, expands, and modifies articles, which creates a framework for the extension of the JST's competencies in addition to its current ones.

So it is founded on the reliable availability of energy as a service and on the widespread trust that people have in all modes of mobility?

We think that a "common good" comes before a "economic good" when it comes to having secure access to energy. It has long been recognized as a human right and is protected by our Constitution as such. But in addition, the entire project is designed to serve as a bridge between the State and the market, preventing this crucial issue (the management of energy distribution and transportation) from being left up to the market and businesses without giving way to a technical and investigative support; for which the JST is the right organization.

"Nature has given us some indications of systemic harm at this unique period in history. It would be simple to recall occurrences that had a significant negative influence on both safety and the environment in the transportation of gas and other hydrocarbons, as well as in the mining of pipelines. In addition to blackouts and other unforeseen circumstances that emphasize the value of safety in the conveyance of energy."

Does the proposal use any other foreign models as a guide when it was being created?

We are aware that the American National Transportation Safety Board (NTSB) and the Canadian Transportation Safety Board (TSB-C), both stand out when it comes to international issues.

Other States realized that combining everything into a single organization with the goal of promoting the greatest levels of safety in transportation networks would be more efficient than multiple organizations working independently. These nations determined that accidents in transportation systems might point to flaws in system defenses, compliance, and efficiency —all of which, by definition and conception, fall under the responsability of the authorities who are qualified to control and manage those systems, including pipelines and transmission lines.

The aforementioned organizations consequently believed that creating an independent institution to carry out investigations and offer recommendat6ions from a technical and objective standpoint was essential.

Others went even further, such as the Kingdom of the Netherlands, where the Dutch Safety Board (DSB) included the occurrence investigations in the chemical industry, petrochemical industry, the construction sector, and the health sector, when their relevance and/or exceptionality warrant investigation, in addition to investigating road, air, maritime, rail, and pipeline transport events, concentrating on situations when people's safety is depended upon by organizations, businesses, or governmental bodies.

> ***"This would enable the JST to function as a tool that enhances safety in energy transport operations, regardless of their form, by turning to the model that has been successfully applied in comparative Law studies."***

It is along these lines, based on the lessons learned from comparative norms and the impulse to investigate the increasingly frequent exceptional events, that we not only seek to find the direct causes, but also to consider systemic failures in the definition of the processes that have an impact on the security of citizens.With this objective in mind, we suggested this enlargement of the aspects and investigation methods. As the first public multimodal investigation agency in Latin America and the third overall in the Americas, behind the Unitades States of America and Canada, we feel proud to have the JST in Argentina today. This serves as an example of our abilities.

What effects or difficulties do these kinds of projects have for the strategic positioning?

Climate change, energy, and the influence on population health present difficulties that call for careful, independent management with a solely technical focus that is motivated by the most effective initiatives of the top accident investigation agencies. And energy is a component of that common good of fundamental rights, just as are the availability of drinking water, natural gas, etc.

We are aware that Law 27514, was principally responsible for establishing the protection of people, their property, and the environment on national territory as a matter of national public interest.

The author is optimistic that it could be addressed next year, but even if the proposal already has parliamentary status, the treatment in Precinct still has no imminent date, at least for the time being.

Under the systemic research paradigm, which aims to enhance the transportation system as a whole, the JST would contribute energy to the modes of air, road, rail, sea and inland waters, multimodal, and environment if the bill were to become law.

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Ministerio de Transporte
Argentina

Germán Goñi
Railway Engineer, Investigator at DNISF-JST.

ESSAY ON THE ORIGINS OF THE RAILWAY SAFETY SYSTEM

From Railway Inertia to Blocking System

What happened formerly when a train came to a stop because of a malfunction? Could the following train stop before catching into it? How were accidents prevented? These are some of the inquiries that serve as the basis for this reading.

You may have experienced the discomfort that comes with pedaling on deflated wheels while riding a bicycle. Low air pressure can distort a wheel, creating "rolling resistance", which can happen in larger vehicles with rubber tires, similar to a bicycle. What about rail transportation? This land conveyance has one of the lowest rolling resistances due to the use of steel wheels on steel tracks. This is as a result of the wheels exhibiting extremely little deformation due to the stiffness of the steel surfaces.

> ***Obviously, it is essential to make sure that no train touches another in order to achieve the circulation of enormous masses with a reasonable level of risk. This justification required years of practices that emphasized the significance of scheduling trains, restricting their movement on each section of track, and implementing blocking mechanisms".***

Yet, it is important to remember that a railway vehicle must be suitably hefty in order to draw without slipping on steel. A tractive vehicle (of great weight) can tow a large number of cars without traction, as is most often understood. Nevertheless, this benefit of the train also carries a risk because it is exceedingly challenging to stop due to its mass and the inertia created throughout its circulation. Can the safety of a vehicle's circulation be correlated with its mass?

Obviously, it is essential to make sure that no train touches another in order to achieve the circulation of enormous masses with a reasonable level of risk. This justification required years of practices that emphasized the significance of scheduling trains, restricting their movement on each section of track, and implementing blocking mechanisms.

Trains were initially dispatched based on intervals of time. But what would happen if a train was stopped because of a malfunction? Might the following train stop before joining it? Because of the aforementioned inertia, trains frequently collided, leading to catastrophic mishaps. As a result, in the first half of the nineteenth century, a method or process was put in place to lessen this risk. In other words, starting to think about safety before the idea became formalized.

In order to prevent frontal collisions between trains or the possibility that one train could reach into another, the blocking system was first applied to communication blocking devices used between station operators at two different locations.

After initially being referred to as the "signaling block system", this technology evolved into the "automatic traffic protection system" over time. Nowadays, it is feasible to read a train's speed and evaluate the features of an incoming train to automatically apply the brakes or reduce the speed of the approaching train in order to prevent a collision between the two vehicles on the same track.

Ultimately, three factors that are intimately associated to one another are the mass of the train, its inertia, and the safety management of its circulation. From the perspective of the systemic accident model, we could say that the blocking system, which was created more than 200 years ago as a practical method to manage the risks associated with the movement of trains in various sections even before safety was thought to be important today, serves as a crucial system defense barrier. Likewise, its ongoing evolution (manual blocking, Direct Traffic Control (DTC), automatic blocking with fixed and moving blocks) elevates it to the status of the primary determinant of the lines' ability to operate at full capacity.

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Anthropologist, MA in Social Policies (UBA).

Laura Luna Dobruskin
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PRACTICES AND STRATEGIES TO MANAGE THE CRISIS

Lessons Learned in the Transport System in the Aftermath of the Covid-19 Pandemic

We interviewed the JST investigation team that conducted the agency's first study of an exceptional event. The task, which began in 2020 and ended in 2022, addresses crisis management practices in each mode of transport.

How and when did the Agency identify the need for such an investigation?

The declaration of a pandemic by the World Health Organization (WHO) led the Argentine State to take exceptional and emergency decisions. When the National Executive Branch ordered by decree the adoption of measures to contain the spread of the new coronavirus in the country, among other things, transport drastically decreased its frequency and even interrupted its continuity.

In this context, the Transportation Safety Board (Junta de Seguridad en el Transporte, JST) initiated a study in October 2020, and set out to know and systematize the crisis management strategies and practices implemented by the constituent organizations of multimodal transport to maintain the operational continuity, and the safety and health of workers in Argentine public transport.

What does it imply that this was the first JST's study linked to an exceptional event?

It was not only the first exceptional event investigated by the JST, but also the first wide-ranging study. Particularly, in the context of the health crisis faced by the international community, our agency identified the need to carry out a study that extends its field of application to exceptional events, in line with the activity carried out by accident investigation agencies, and studies carried out by other countries, such as Finland and the Netherlands.

When we talk about an exceptional event, we refer to an event of unusual gravity (which may or may not be an accident), with consequences that impact on the basic functions of society, such as operational continuity and the provision of essential services: ensuring safety, health protection and environmental care, among others. In the face of these events, governments can define states of emergency, which involve restrictions that limit, among other things, people's freedoms of movement, assembly, and transport.

How were the team and the primary working tools created?

The team responsible for the project was formed with members of the Studies Area of the National Department of Accidentological Evaluation and Monitoring of the JST. The primary lines of work, the methodology, the conceptual framework, and the study's goals were then outlined. Even though the COVID study (as we refer to it informally) began as a fledgling, constrained initiative, we quickly understood that its scale would exceed the abilities of the coordinating team. As a result, representatives from all of the Agency's modal departments were included.

We can name the "Collaborative Network" and the "Lessons Learned System" as the study's two key constituent tools. The first speaks of a network of players who are included in the investigation in order to cooperate and contribute their skills and information. The key players in the Argentine transport system were identified for this purpose using the actor mapping technique. Normative, regulatory, and supervisory organizations, public and private service providers, transportation chambers, and labor unions were all included as network actors. Over 25 public and private organizations currently make up the network.

Closely related to the network, the Lessons Learned System was the study's other innovative methodological tool. The lessons learned that were identified throughout the days of articulation between the JST and the network's actors represent the expertise and knowledge that these actors have gained with regard to managing pandemic crises. It is an open information system that records and makes organizational experience accessible to support efficient management in events with comparable characteristics in the future.

What was the theoretical framework used for the study?

The investigation found several ideas that were crucial to completing the various stages of the work, in addition to the idea of "exceptional event" (mainly the survey, systematization and analysis). The assumption used at the outset was that the epidemic was a "regular accident". Normative or systemic accidents, in the opinion of sociologist Charles Perrow, are characterized by being unanticipated and unavoidable.

In addition to the concept of "exceptional event", the research recovered various notions that were central to carrying out the different stages of the work (mainly the survey, systematization and analysis).

The starting point was to consider the pandemic as a "normal accident". According to sociologist Charles Perrow in his book Normal Accidents: Living with High-Risk Technologies, normal or systemic accident is characterized by being unpredictable and inevitable. Unexpected couplings and interactions are common in complex systems, which suggests that sociotechnical systems are naturally prone to them.

Analysis models for systemic accidents must be sensitive to their characteristics. Systemic accident analysis departs from linear cause-effect models and accident explanations based on single failures or a fault tree, as proposed by Charles Perrow and Erik Hollnagel.

The system is described in analyses based on the systemic model, followed by the circumstances that may lead to accidents. With the help of this model, we may comprehend the idea of "accident" as an occurrence brought on by the unforeseen combination of several failures in a complicated system. Instead of focusing on identifying the reasons behind accidents or pursuing people at fault, the type of analysis under consideration looks for structural circumstances that explain the triggers.

Figure 1. Process of documenting lessons learned

Source: JST, 2022.

Which were the study's key conclusions?

We can highlight the following important conclusions:

- The importance of having a scientific and technological system, as well as a health system, which can serve as pillars in the creation of plans and responses to this kind of events.
- The significance of state service providers, whose presence allowed to respond to the logistical needs of the populace based on government strategies.
- The lack of crisis plans to cope with events with the characteristics of the pandemic pushed actors in the transportation system to establish emergency plans, which at first lacked —at least in part— standardized training and procedures to manage this type of crisis.
- The crucial role of press and communication departments of organizations and providers in educating the public about the official health policy; providing them with resources and trained professionals is key for the development of clear and efficient strategies.

Figure 2. Main actors of the collaborative network developed for investigation.

Source: JST, 2022.

- The positive effect of decentralizing Operations Control Centers—which are typically found in urban regions with dense populations—helped to ensure service continuity. These centers are places where service-related information is monitored in order to respond quickly to crises, damages, etc.
- There were numerous instances where service providers, the government, and other agencies (including the Argentine Ministry of Security) did not coordinate to establish the criteria of stay, access to services, accommodation, and circulation of essential workers. Because of this, it was difficult for key personnel to move about, stay, and access basic services.
- The positive effect of the existence of spaces of articulation between the public and the private, which contributed to the fulfillment and operationalization of government measures by the providers.
- The importance of control bodies and providers having risk management strategies that accompany the regulations issued during the pandemic.
- The structural hazard posed by fatigue in all modes of transport. Given this, the implementation of strategies based on a fatigue risk management system would be essential.
- The negative effects of the crisis on the mental health of workers, who had to face situations of fear, anxiety and stress. In this context, psychological cabinets within organizations became of central importance. In addition, the trade union organizations articulated various lines of action aimed at the psychological accompaniment of the staff.
- Serious difficulties, particularly in road and rail modes, in meeting the maximum limit of people transported, social distancing and the exclusive transport of essential workers. This showed that any restriction of access to public transport should be based on the presence and control of security force personnel, which did not happen in all cases.

Finally, what elements of the study can serve as a basis for contributing to similar events in the future?

We believe that all the findings and results of the study can contribute to addressing, in a better way, the occurrence of events with characteristics similar to the crisis we experienced. We highlight those elements or conclusions involved in the preparation of crisis plans, establishment of public-private articulation instances, residual risk management systems that accompany the formulation of regulations, development of ad hoc fatigue management systems, the virtualization of training, and the development of psychological support devices for workers by public bodies and providers, among others.

Likewise, we understand that this work and the different lines of investigation that make it up should not be read as a final study of the coronavirus crisis in Argentine transport. On the contrary, two of the constituent tools of this study —the collaborative network and the system of documentation of lessons learned— are operational, as continuous strategies for collecting, analyzing and sharing information and experiences.

In turn, the study intends to be sent to the Ministry of Transport including recommendations, in order to contribute to the design of transport policies aimed at optimizing crisis management in the face of future exceptional events, as well as promoting opportunities for improvement in the design of future crisis plans and risk management of the Argentine transport.

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An article published for the 6th Sessions on Research, Transfer, Extension and-Teaching (JITEyE) at the UNLP School of Engineering, 2021.

OPTIMIZATION OF AIRPORT INFRASTRUCTURES

A Dynamic Concept of Runways Depending on Type of Operation

Airport infrastructure optimization is becoming increasingly important from a variety of angles, including operational, environmental, and economic ones. This applies to runway strips as well. While an airport, given its physical infrastructure, offers an "available" runway, operational needs imposed by traffic mixes due to aircraft combinations, propeller types, and operating weights sought for origins/destinations by airline business schedules demand a specifically "required" type of runway.

Introduction

For the objective of optimizing the airport system, the ability to make the most of the available infrastructure through an examination of its declared distances is crucial.

To accomplish this, it is necessary to adhere strictly to the written regulations in place, keeping in mind that all operations on runways must be carried out in accordance with the required safety specifications.

In this context, is a single runway the only suitable physically determined by the existing infrastructure? or is there any possibility to determine different runways strips for each type of operation? Thus, the concepts of an "operative runway" and a "dynamic runway" become relevant.

The purpose of this article is to show practical application approaches to the concept of "operative" runways in line with a more dynamic idea, taking advantage of the existing airport infrastructures, considering that paragraph 3.4 – Runways, Annex 14 to the Agreement on Convention on International Civil Aviation of the International Civil Aviation Organization (ICAO) makes reference to strips in plural and to a runway in singular, thus making room for a supplementary interpretation differing from the habitual customs and usages.

The scope of this article is focused on the analysis of the application pursuant to the definitions and characteristics of a runway set out in Annex 14, 8th Edition, 2018.

Development and discussion

Strips are areas surrounding a runway and its staging areas, if any, that must have characteristics such as to reduce damage to aircraft transiting the runway in the event of a possible runway departure and must provide an obstacle-free area in order to protect the aircraft flying over them during takeoff and landing operations.This brief document is intended to illustrate options for the safe implementation of runway strips according to their definitions, without overlooking the type of operation conducted there, with the view to avoid penalties imposed on account of the infrastructure and to allow for a more flexible implementation.

Under international regulations, the following definitions of a strip are associated to a runway and its staging area. (Annex 14, 2018).

Runway strip. A defined surface including the runway and its staging area, if any, intended to:

a) minimize the risk of damage to aircraft running off strip limits; and to

b) protect any overflying aircraft during takeoff or landing operations.

Runway. A rectangular area defined in a ground aerodrome, prepared for aircraft takeoffs and landings.

Precision Approach Runway. See "Instrument Flight Runway".

Takeoff Runway. A runway exclusively reserved for takeoffs.

Instrument Flight Runway. One of the following runway types reserved for aircraft operations using instrument approach procedures:

a) Non-precision approach runway: A runway supported by visual and non visual aids reserved for landings after a Type A instrument approach operation and with a visibility of not less than 1000 m.

b) Category I Precision Approach Runway. A runway supported by visual and non visual aids, reserved for landings after a Type B instrument approach operation with a decision height (DH) not lower than 60 m (200 ft) and with a visibility of not less than 800 m or a visual range on the runway of not less than 550 m.

c) Category II Precision Approach Runway. A runway supported by visual and non visual aids, reserved for landings after a Type B instrument approach operation with a decision height (DH) lower than 60 m (200 ft) but not lower than 30 m (100 ft) and with a visual range on the runway of not less than 300 m.

d) Category III Precision Approach Runway. A runway supported by visual and non visual aids, reserved for landings after a Type B instrument approach operation up to the runway surface and along the same, and

A — used for operations with a decision height (DH) lower than 30 m (100 ft), or with no decision height and with a visual range on the runway not lower than 175 m.

B — used for operations with a decision height (DH) lower than 15 m (50 ft), or with no decision height, and with a visual range on the runway lower than 175 m but not lower than 50 m.

C — used for operations with no decision height (DH) and no visual range restrictions on the runway.

Note 1.— Visual aids must not necesssarily adjust to the scale characterizing the non visual aids provided. Visual aids are selected on the basis of the relevant operational conditions.

Note 2.— Go to Annex 6 — Aircraft operation for instrument approach operation types.

Visual Runway. A runway reserved for aircraft operations using either non-instrument procedures or an instrument approach procedure at a point beyond which the approach may continue under weather conditions fit for non-instrument flights.

As can be seen, the definition of strip is associated with the runway and the stopping zone, and the definition of runway is associated with the runway according to the type of operation in which it is carried out.

> ***"Strips are areas surrounding a runway and its staging areas, if any, that must have characteristics such as to reduce damage to aircraft transiting the runway."***

Case Studies

According to the parameters described above, runway strip dimensions are determined as follows:

Case A: An airport with 2 runways

A generic airport with two parallel runways of identical dimensions and segregated operations (simultaneous operations where one of them is to be exclusively reserved for landings and the other one, for takeoffs). In both cases, the airport reference code shall be "4E," and the runways shall have neither a SWY (staging area) nor a CWY (obstacle-clear zone). Besides, the landing runway shall be reserved for CAT I precision approach operations. (Note: in the following charts, the aircraft represents the runway use direction).

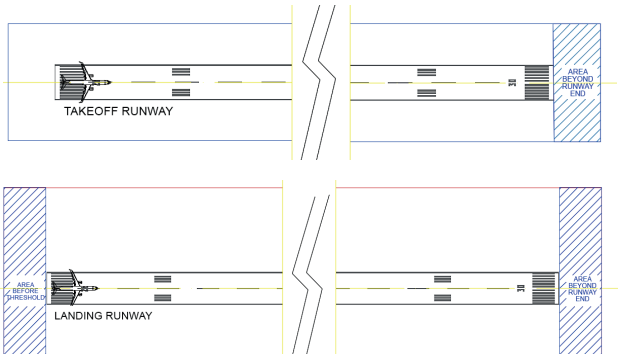
The length of a strip is defined by:

> 3.4.2 Every runway strip shall extend before the threshold and beyond its end (or beyond the parking area end), up to a distance of at least:
>
> — 60 m when the code number is 2, 3, or 4;
>
> — 60 m when the code number is 1 and the runway is used for instrument flights; and
>
> — 30 m when the code number is 1 and the runway is used for visual flights.

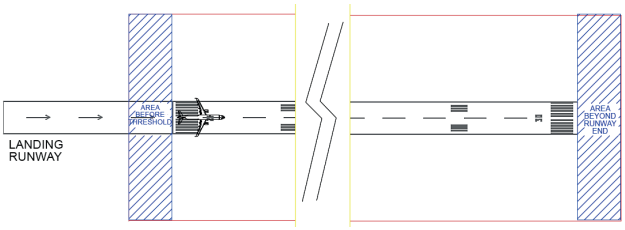
In 1.1. of Annex 14, a definition may be found of the strip threshold, though not of its end:

> **Threshold.** Commencement of such part of the runway as may be used for landing purposes.

An area before the runway threshold and beyond the runway end is thus determined, in the understanding that such end is a limit opposed to the threshold, that is, the end of both takeoff roll and landing rollout operations; in other words, no area is defined before the runway outer edge coinciding with the commencement of the takeoff-roll runway. The next chart illustrates these concepts:



A runway with displaced threshold would look as follows:

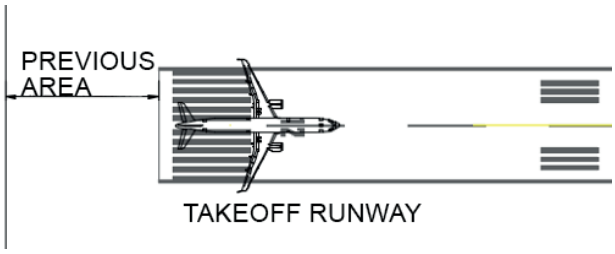


The runway width is determined according to the approach category and the airport reference code.

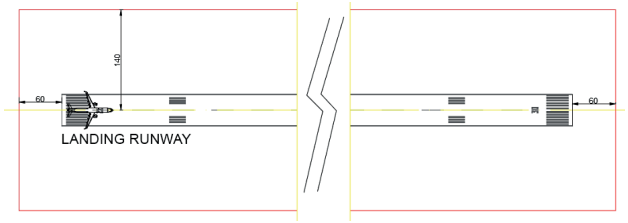
> **Runway Strip Width**
>
> 3.4.3 Where possible, every runway strip including a precision approach runway shall extend sideways up to a distance of at least:
>
> — 150 m when the code number is 3 or 4; and
> — 75 m when the code number is 1 or 2;
> on each side of the runway centerline and of its extension along the strip.
>
> 3.4.4 Recommendation — Every strip including a non-precision approach runway should extend sideways up to a distance of at least:
>
> — 150 m when the code number is 3 or 4, and
> — 75 m when the code number is 1 or 2;
> on each side of the runway and of its extension along the strip.
>
> 3.4.5 Recommendation.— Every strip including a visual flight runway should extend on both sides of the runway centerline and its extension along the strip, up to a distance of at least:
>
> — 75 m when the code number is 3 or 4;
> — 40 m when the code number is 2; and
> — 30 m when the code number is 1.

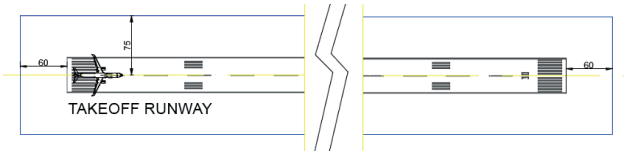
For landing runways, you might ask why is it that a runway strip which is only used for landings is determined according to its code number? [being that the latter is directly related to the field length reference (LCR), that is, to the length required by an aircraft to take off under certain conditions]. In other words, why is it that some characteristics of a strip are defined in accordance with a specific type of operation, with no direct reference to takeoffs?

Furthermore, in the case of takeoff runways, why should there be a strip portion or area before the commencement of the threshold if the runway is used for takeoffs only?



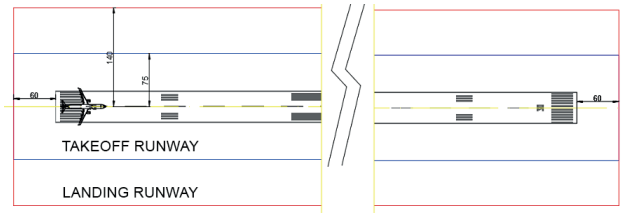
Depending on the type of operation involved, the strips would look as follows:





Case B. An airport with a runway deriving from Case A

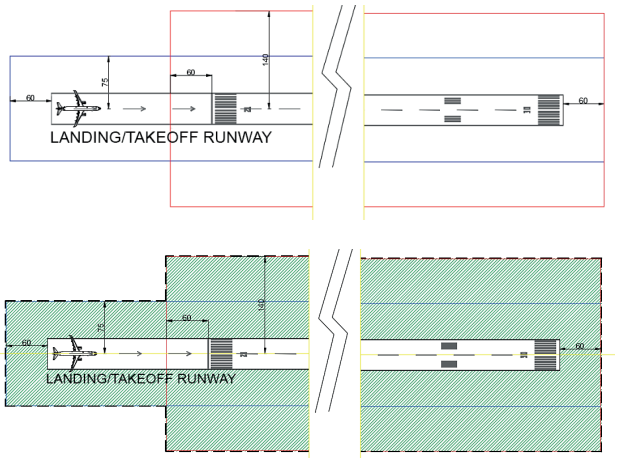
Based on the previous case, what would happen if, due to specific requirements, one of the runways must be closed and the operations moved to the remaining operative runway? The next following chart illustrates this scenario:



Logically, being that there is only one strip, we would have the wider (red) one available, since the other one is contained there.

Case C. An airport with a runway deriving from Case A and with a displaced threshold

Following the previous line of thought, the next chart illustrates the case of airports with only one runway, but with a threshold displaced at a certain distance:



The strip would no longer have a fixed width; part of it would be determined by the requirements of the type of operation to be performed there.

Furthermore,

Strip Leveling Off

3.4.8 Recommendation — The part of a strip comprising an instrument flight runway should provide, from the runway centerline and its extension and up to a distance of at least:

— 75 m when the code number is 3 or 4; and of at least
— 40 m when the code number is 1 or 2;

a leveled off area taking into account the aircrafts for which the runway is reserved, in the event of landings off strip limits.

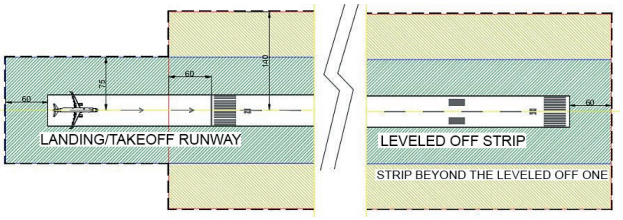
Note.— Appendix A, Section 9, provides several guidelines for the leveling off of an area wider than a strip, comprising a runway for precision approaches, when the code number is 3 or 4.

3.4.9 Recommendation.— The part of a strip for a non-instrument flights should provide from the runway centerline and its extension and up to a distance of at least:

— 75 m when the code number is 3 or 4;
— 40 m when the code number is 2; and
— 30 m when the code number is 1;

a leveled off area for the aircrafts for which the runway is reserved, in the event of an aircraft runway extrusion.

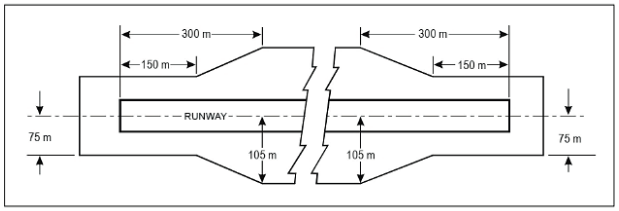
The areas to be leveled off are associated not to a type of approach but to a type of (instrument or visual) flight for which runways are reserved, and, of course, to the type of aircraft through the pertinent code.



In addition to the abovementioned provisions, Appendix A, Section 9 states the following:

> 9.3 A strip leveling off for precision approaches.
>
> Chapter 3, 3.4.8 recommends that the part of a strip comprising an instrument flight runway identified by a 3 or 4 code number be leveled off up to at least 75 m from the runway centerline. If runways reserved for precision approaches are involved, it would be advisable to
>
> adopt a greater width if the code number is 3 or 4. Chart A-4 illustrates the form and dimensions of a wider strip that could be considered for such runways. A strip of these characteristics has been projected according to data on aircrafts that run off its limits. The part to be leveled off extends sideways up to 105 m from the runway centerline, but such distance is gradually reduced to 75 m on both ends of the strip, along 150 m distance from the runway end.

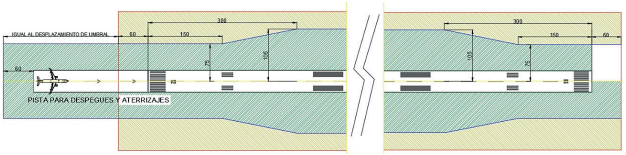
Chart A 4: Leveled off part of a strip for 3 or 4 code precision approaches.



The abovementioned chapter states that in the event of a recommendation, it should have a wider scope, thus indicating that there could be a recommendation within another more convenient one (paragraphs 3.4.8 – 3.4.9 and section 9 of Appendix A) always refers to a lateral distance; however, in connection with a longitudinal distance, reference is always made to the extension of the runway centerline.

It is also mentioned that such recommendation considers that aircrafts may run off strip limits, so that reference is made to events known as overrun (exit at runway end when landing or taking off) veer off (lateral exits when landing or taking off) and undershoot (when landing).

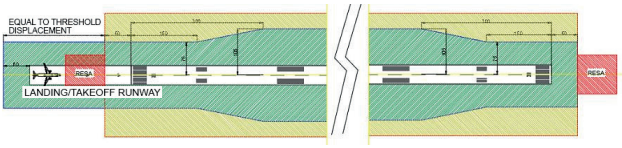
Thus, if runway thresholds coincide with runway ends, no problems would be encountered. However, if runways with a displaced threshold are involved, the following situation could take place:



Even if we apply the runway end safety area (RESA) definition:

> **Runway End Safety Area (RESA).** An area adjacent to the runway end that is symmetric with respect to the extension of the runway centerline, the area's main function being to reduce the chance of an aircraft being damaged in the event of an undershoot or a strip end overrun.

The chart would be the following:



CONCLUSIONS

The possibility to determine "dynamic" strips in line with the type of operation conducted there, considering, in all cases, the available declared distances, clearly stems from the three case studies described above and their respective notes and remarks.

This concept clearly deviates from the traditional, commonly used approach regarding wraparound, static strips, which does not take operational requirements into consideration.

The difference between a traditional concept and the dynamic one proposed here may solve the usual problems arising at many airports where the available spaces must be optimized in order to declare strip dimensions in full agreement with Annex 14, but with a differentiating operational approach.

The ideas described above entail a greater flexibility and a possibility to take advantage of available infrastructures, being the decision to adjust and adequate them to international regulations in the hands of upper management levels.

JST | SEGURIDAD EN EL TRANSPORTE

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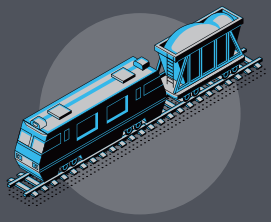
REMEMBER THAT IN LEVEL CROSSINGS...

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

BEHIND THE DATA: INEQUALITIES AND POWER STRUGGLES OF OUR SOCIETY

Why do we Need Gender-Sensitive Data and Statistics in Transport?

The study of mobility from a gender perspective aids in the creation of public transportation regulations that assure everyone's safety, are socially responsible, and do not sustain inequalities.

Ivana Feldfeber
Executive Director of DataGénero Civil Association

Nowadays, large amounts of data are produced, and more and more organizations and governments are using them to analyze historical data and make strategic decisions as well as to project their growth and development. But little is said about data with a gender perspective. Thus, the question arises: "What is data with a gender perspective?"

To respond to this query, we could remark that data are conceptually developed as tools using a specific technical methodology, but it does not actually have any intrinsic gender perspective. So, when we discuss data from a gender perspective, we are referring to the procedures used to plan, gather, analyze, and communicate data as well as the individuals who carry out these procedures. The mainstreaming of the gender perspective is necessary at this point. When discussing statistics from a gender perspective, it is important to consider whether data is accurate and whether factors like gender, identity, and biological sex have been taken into account.

Data-driven analytics and solutions have real implications in our daily lives. For instance, algorithms that can detect human faces are created today using data, which can aid in making decisions about the economy (e.g., whether a certain person should receive a loan or not, depending on certain variables). So, cisgender women and LGBTQ+[1] people will continue to be at a disadvantage, compared to cisgender men, if gender biases are perpetuated throughout.

1. This acronym correspond to Lesbians, Gays, Bisexual, Trans, Transvestite, Intersex, Non-Binaries, and more.

The information we have and the things we do with it matter a lot when we focus on the public sector. And for this reason, it is crucial to teach government employees and give them the resources they need to develop data systems that are considerate of social issues and do not reinforce disparities.

This is why it is crucial to address the mainstreaming of the gender perspective in public policies. To implement a gender-sensitive strategy that takes into account gender as an exclusionary factor in all state public policies, not just those that pertain to women and those who identify as LGBTQ+ (ECOSOC, 1997).[2]

Gender perspective can be used in all contexts, even in the less obvious ones, like whick sidewalks to clear after a snowstorm. Caroline Criado-Perez, in her book The Invisible Woman[3], relates some cases where the gender perspective was not taken into consideration in governmental decisions, product design, or space definitions. According to the author, Sweden launched an audit of all its existing policies in 2011, to see if they took the gender viewpoint into consideration. "At least the audit isn't going to meddle with the work of removing snow from roads and sidewalks," said a little drained government representative, supposing this activity had nothing to do with any gender-related issues.

"The information we have and the things we do with it matter a lot when we focus on the public sector. And for this reason, it is crucial to teach government employees and give them the resources they need to develop data systems that are considerate of social issues and do not reinforce disparities."

Data demonstrate that women generally use public transportation or walk more than men, even when the available worldwide transportation data are still insufficient. Women make up about 63 % of public transportation users in the USA compared to 2/3 of users in France. Men are typically the ones who drive cars because they are the "heads of household".

This instance highlights the significance of travelers' motivations in addition to their modes of transportation. Males typically follow a set travel schedule, travelling daily to work and returning home almost always through the same route. But women provide 75 % of the world's unpaid domestic duties, hence their travel habits are typically more complex. Dropping off children at schools or daycares, heading to work, driving elderly patients under their care to doctor appointments, and then going grocery shopping at a supermarket or convenience store are typical travel patterns for women. As multiple trips are chained together, this pattern is known as trip chaining. Women all over the world use this travel scheme.

In Europe, women who have children under the age of five are 54 % more likely than men to make these linked journeys (vs. 19 %). As women must be able to move safely, walkways and roadways are given high priority when clearing snow, transforming what started out as a lighthearted remark by a government employee.

According to Prachi Shukla, in a review she posted on the *London School of Economics and Political Science* blog: Catherine D'Ignazio and Lauren Klein (2020)[4] in their book Data Feminism4 apply an intersectional feminist lens to examine the unequal power structures governing the realm of data and highlight some attempts that are being made to rectify them. The authors demonstrate with numerous examples how the data we gather is indicative of our unequal society. They also provide numerous examples of activists and non-governmental organizations fighting against this and highlight the negative effects of unfair practices.

2. Source: Economic and Social Council, United Nations (1997). Agreed conclusions 1997/2 on "Mainstreaming gender perspective into all policies and programmes in the United Nations system." Geneva: ECOSOC.
3. Source: https://carolinecriadoperez.com/book/invisible-women/
4. Source: https://data-feminism.mitpress.mit.edu/

They present a paradigmatic case in particular that took place in the United States:

> In 1971, the Detroit Geographic Expedition and Institute (DGEI) released a provocative map, *Where Commuters Run Over Black Children on the Pointes-Downtown Track*. The map (figure 1) uses sharp black dots to illustrate the places in the community where the children were killed. On one single street corner, there were six Black children killed by white drivers over the course of six months. On the map, the dots blot out that entire block.
>
> The people who lived along the deadly route had long recognized the magnitude of the problem, as well as its profound impact on the lives of their friends and neighbors. But gathering data in support of this truth turned out to be a major challenge. No one was keeping detailed records of these deaths, nor was anyone making even more basic information about what had happened publicly available. "We couldn't get that information," explains Gwendolyn Warren, the Detroit-based organizer who headed the unlikely collaboration: an alliance between Black young adults from the surrounding neighborhoods and a group led by white male academic geographers from nearby universities.[5]
>
> Through this collaboration, the young people learned cutting-edge mapping techniques, and guided by Warren, leveraged their on-site knowledge to produce a series of comprehensive reports; covering topics such as social and economic inequalities among neighborhood children. They also made proposals for new school district boundaries that would be more racially equitable. (Data Feminism. MIT Press, 2020)

"We need to pay attention to data since, behind it, we can get a glimpse of our society's inequalities and power conflicts."

Both in this and the Sweden case, it is obvious that we need to pay attention to data since, behind it, we can get a glimpse of our society's inequalities and power conflicts. The duty of working with population data, or data that impacts individuals in some way, is a huge responsibility. And part of that responsibility is to gather data in a sensitive manner, conduct studies that take into consideration the various forms of oppression that exist in our society, and can effectively communicate the findings.

When it comes to data gathering, it's crucial to understand that more data isn't necessarily the solution. At DataGénero's Observatory of Data with Gender Perspective, we always insist on asking what is the data we are collecting going to be used for. Reflecting on the "what for" incorporates the ethical dimension to the analysis. We often listen to programmer groups excited by the level of detail of the information obtained —or crave for higher levels of capillarity in the information— so, here we want to make a call for attention. First, regarding the current regulations, and the duty of protecting personal data provided by Law 253267[6]; and second, on the ethical considerations. People may be at risk when data is used to "individualize" them, especially when it comes to minoritized groups. Although it is a nice illusion to think we will solve all the problems with highly detailed data, we can never be certain who will ultimately have access to this data. It's clear that this wasn't our initial objective, but such information could be used to track, harass, or even harm someone.

As a result, we offer the following suggestions to help the gender perspective become more widely accepted in the statistics world:

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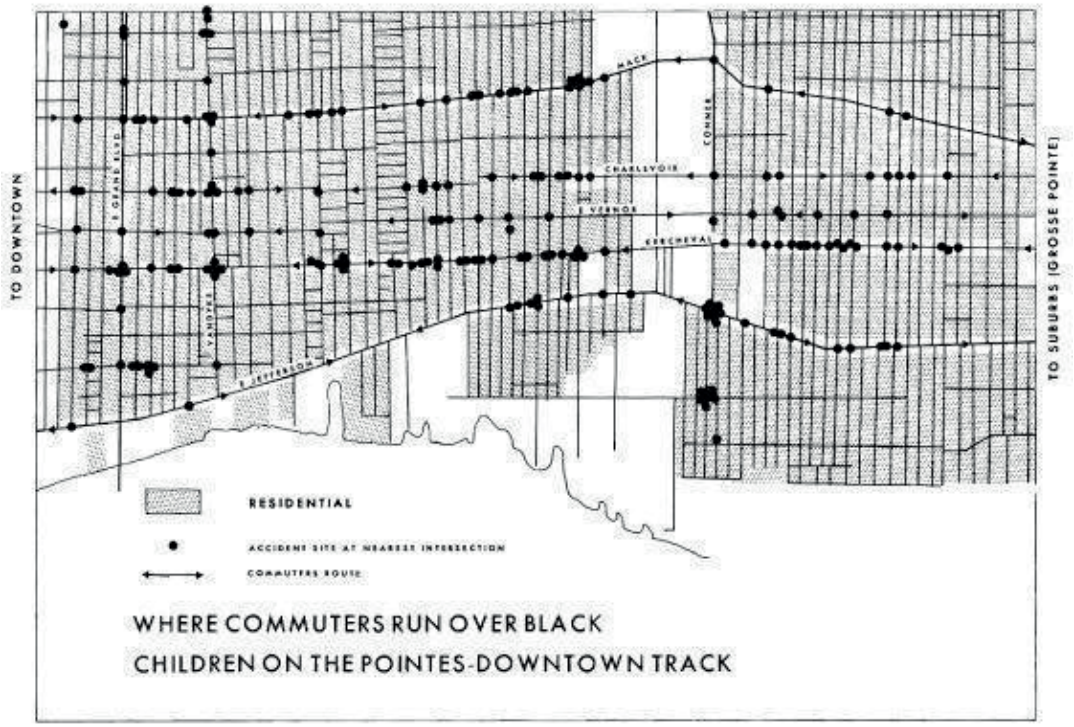
5. About the Work in Detroit, Gwendolyn Warren, Field Notes No. 3: The Geography of Children, Part II (East Lansing, MI: Detroit Geographical Expedition and Institute, 1971), 12. The report also includes data that Warren and his team collected, and quantified, on factors as specific as the amount of broken glass found in white children's playgrounds as compared to that found in neighborhoods of Black children, as well as rehearsals of other members of the DGEI.

6. Source: http://servicios.infoleg.gob.ar/infolegInternet/anexos/60000-64999/64790/norma.htm.

Figure 1. Image from a report documenting racial inequalities in Detroit's childhoods. The map was created by and administrative director of the Detroit Geographic Expedition and Institute (DGEI), Gwendolyn Warren, in a collaboration between black youth in Detroit and white academic geographers.



Source: Gwendolyn Warren, "About the Work in Detroit", Field Notes No. 3: The Geography of Children, Part II (East Lansing, MI: Detroit Geographical Expedition and Institute, 1971). Credit: Courtesy of Gwendolyn Warren and the Detroit Geographical Expedition and Institute.

1. Mainstream gender perspective at all stages

We refer to integrating the gender perspective across all data-related activities. From the design of the data collection process to the analysis, visualization, and presentation of the results. This process must be gender-sensitive and mindful of racial, class, and ableist prejudices, and it should not restrict inquiries into whether this perspective is present solely under certain circumstances, such as algorithm training. The method must be built around the gender perspective.

2. Permanent training in gender and social problems

Unavoidably, work groups with ongoing training in gender issues are much more aware of the injustices and marginalization experienced by cisgender women and LGBTQ+ people, and they are typically able to produce tools, analysis, and policies that are more inclusive and devoted to creating a better world.

3. Interdisciplinary teams

Multidisciplinary teams are the best for handling data that has an impact on society since they will thoroughly handle the issues at hand while taking into account a wider range of issues.

4. Contextualize the data

The context of the data is necessary, thus it must include metadata about the sources, definitions, and other specific factors that help to understand who, what, when, and why the data we are dealing with was created.

"The original data's production process and formula are described in the metadata, which also warns us about important factors to be taken into account when analyzing data."

"Metadata is context information: as to where it comes from, who collected it, with what tools, and for what reasons," according to DataGénero; "why is it crucial to acquire this knowledge? because without the context of the data, we are missing important information."[7]

The original data's production process and formula are described in the metadata, which also warns us about important factors to be taken into account when analyzing the data.

5. Responsibility, accountability and ethical considerations

In addition to other ethical considerations when working with data, it is crucial to consider the funding and finance used to produce such data. For whom and for what purposes are these surveys being funded? This information may provide us with a hint as to the motivations behind the generation or collecting of such data and may alert us to potential biases or anticipated outcomes that may skew the data's interpretation.

While they are necessary to ensure adherence to individuals' rights and the availability of high-quality data, privacy of information, protection of databases and sources, as well as their anonymization, must always take precedence.

7. Source: https://datagenero.medium.com/el-contexto-de-nuestros-datos-una-herramienta-Illuminator-3CBD5FBF6766

INTERVIEW WITH JIMENA BONDARUK[1]

Gender Perspective Mainstreaming in Transport: State Challenges

Currently, half of the world's population are women. Nonetheless, women make up fewer than 15 % of the entire workforce in Latin America and the Caribbean (LAC) transport and infrastructural services. Women are overrepresented in low-paying occupations like cleaning and signaling, where they earn one third of what males do in those fields and underrepresented in technical and leadership positions.

In this regard, ECLAC asserts that most of the public gender equity or equality policies in the region explicitly call for the adoption of a gender-based perspective in all governmental policies.

Have you observed any developments in the previous few years regarding the expansion of rights in the context of transportation regarding this issue? Which ones?

The workplace has evolved and been reinvigorated. There has been an effort to provide more effective and efficient outcomes that have a direct impact on increasing job productivity.

Although there is progress, this is very recent, these are battles that have to be fought one by one; therefore, we will be able to measure the results in perhaps one or two years.

What are the most pressing public policies that the present administration needs to address considering this development, in your opinion?

I think that we must work on two topics. The first one is the inclusion of women in historically male-dominated jobs. The second one is working in top management jobs. There is a ceiling that we, women, have been unable to break through, i.e., having women in decision-making positions. When women are in decision-making positions, we make transformations. But I also understand that we must be prepared for that, to incorporate different tools to strengthen leadership, which is still challenging.

Which of the policies that you are now implementing or planning to implement can set a clear path towards mainstreaming gender perspective and diversity in transportation?

First, when we think about mainstreaming gender perspective and diversity in transportation, we should be able to think about transportation infrastructure. This helps and assists with providing a better transportation service. Working with sensitivity and awareness has a positive impact on women, young people, and children. Therefore, we are preparing a guide on station settings, trains, transfer areas, and bus stops.

Then, we need to examine how women and diverse people move around.

We are also developing a guide to address violence on medium and long-distance buses. This means submitting this matter for discussion to trade unions in order to start identifying these situations.

Finally, together with the National Ministry of Labor, we are creating a guideline, a program related to female drivers. It is a number of incentives for transportation chambers to hire women to drive medium and long-distance buses.

The Ministry of Transport is working jointly and strategically on gender issues in air, vessel, land and train transportation companies.

The inclusion of women and diverse people in the transportation setting is very important since they come with a history, a cultural background, and experience, thus leading to internal changes in organizations. They not only become more sensitive, but they also adopt a strategy that can have a beneficial effect on transportation.

1. Head of Gender and Diversity Policies at the Ministry of Transport. Feminist activist. Political Scientist. Education expert. Former coordinator of the Gender and Diversity Area in Trenes Argentinos. Councilwoman for the 3 de Febrero District.

INTERVIEW WITH JAN THORE MELLEM

NSIA Method: What Are the Pillars of the Norwegian Accident Investigation Model?

We met with Jan Thore Mellem, an expert in human factors and industrial and organizational psychology who is a member of the Advisory Department of the Norwegian Safety Investigation Authority (NSIA). Mellem, who has been co-creator of the model, nowadays supports all of the Agency's divisions from his position in this Department.

The Advisory Department was tasked with developing the project when NSIA determined the need for its own accident investigation tool. The interviewee notes that Ingvild K. Ytrehus, the NSIA Method's primary proponent and original originator, collaborated closely with Jan Thore Mellem. After this new model was approved, they concentrated on the training and coaching of the agents in addition to creating the groundwork for it.

Could you provides some general considerations to keep in mind when using the NSIA method?
One the one hand, the model is applied to every manner or area of the Agency, including defence. Each candidate interested in working with us should read the comprehensive explanation on our website as a basic introduction to the process. Next, as part of their first assignments —a typical place for any investigator to start— whoever is hired by NSIA will go even farther into the process.

Yet, we would like to point out that a model is always a simplified version of reality; the real world is typically considerably more complex. The world cannot be expected to perfectly match the model. Like any other model, this one can only aid in our comprehension of the intricacies of reality. We usually opt to make a

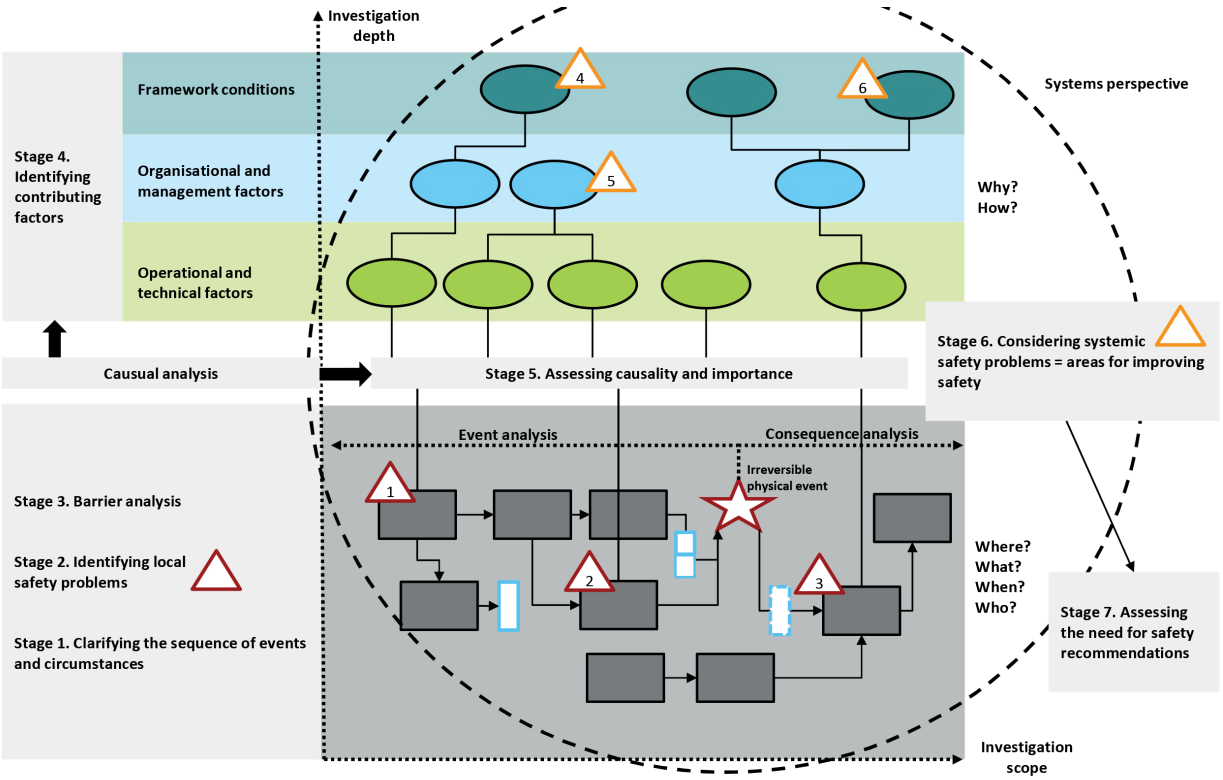
call for attention here even if this may seem evident to some individuals but not to others. Ignoring this aspect could lead investigators to adopt a strong belief in the hypothesis, which is extremely risky.

The visual representations that the model produces have two portions, as may be seen by looking at them. One lower section for the first three stages and a higher one for the final four. Everything that progresses to the fourth level is automatically regarded as systemic. We classify the model as a systemic approach method since it forms a complete circle.

When we teach this methodology, one of the things we always stress is that iteration is a process. That is, it repeatedly travels around the same aspects. It's not a case of doing everything we can in the beginning and then never again; quite the contrary. The circle needs to be repeated numerous times because as the accident is examined and comprehended more fully, new issues come up and fresh data is provided. You might need to revise your hypothesis of what transpired in light of this new information, repeatedly returning to each phase.

"The circle needs to be repeated numerous times because as the accident is examined and comprehended more fully, new issues come up and fresh data is provided.

Figure 1. Visual representation of the seven stages of the model



Source: NSIA document "How we investigate accidents in Norway", 13/09/2022.

Why did you decide to develop your own investigation methodology?
The technique first aids in information prioritization. As you are aware, a lot of different information is gathered during accident investigations from a variety of sources, thus it is crucial to arrange it according to its importance. There might be a lot of material that we find fascinating, but that doesn't necessarily mean it has anything to do with the disaster. Prioritizing is crucial because if you examine unrelated material, you will be squandering time and resources.

Second, models created for understanding accidents can be used in a variety of settings, such as technical or academic research, preventive safety work, power plants, and other high-risk settings. To give our inspectors a step-by-step manual

on how to conduct an accident investigation, we wanted a model created specifically for the purpose.

Last but not least, the NSIA employs investigators and analysts from a wide range of subjects and specialties. Occasionally, this makes it more challenging for people to understand or agree upon one another, primarily due to the absence of common vocabulary. We considered developing a system that could be understood and utilized by everyone, regardless of academic training, field of application within the agency, or level of professional experience, precisely because of this and in order to do our work more effectively. The goal was to create a common language so that communication within the investigator teams and between divisions of our company would be easier. As a result, we would have a similar starting place, a shared vocabulary, and a similar way of thinking.

How did the development of the NSIA Method go?

"Prioritizing is crucial because if you examine unrelated material, you will be squandering time and resources."

The Advisory Staff department in our organization is a group of experts who support every other department. Ingvild K. Ytrehus held a specific position within the Advisory Staff that was devoted to safety approach and technology. She is the method's primary developer and proponent, so it's important that she receives credit. I was there from the beginning when the model was being developed with her as part of the advisory staff, so I can describe how it went.

Ingvild, who held that post for a long time, recognized the need for such investigation instrument. She therefore conducted a thorough assessment of the professional literature on methodology and even got in touch with a number of inquiry boards. It is fair to say that one of the primary references used by NSIA in developing our method was the methodological framework employed by the Australian Transport Safety Board (ATSB). I also want to give them praise for it.

As I previously mentioned, Ingvild prepared the method's initial draft before convening a working group with two or three investigators from each department of the organization. Through numerous sessions, the model was explored and developed. We had a lot of insightful conversations during which different concepts were born. After gathering and processing these comments, Ingvild included them in the method's first complete version, which was published in 2017. The Management has discussed, reviewed, and approved this issue. The technique was subsequently included into our management system.

Also, in 2017 all investigators were trained to use the model. A second edition was published in 2018 and a third edition was then published in 2021 with some minor changes to the approach. It is critical to note that successive editions have refined primarily technical issues, such as the use of colors to visually categorize information, rather than making fundamental changes to the methodology.

In general, this is the tale of how it all started and how it progressed.

How long did it take to really put the Method into practice after it started being developed?

I'm not sure exactly, since it can be challenging to accurately segment procedures over time. But as a generalization, I'd say it took several months. Meetings of the working group and the creation of the final proposal were rushed only in a few months because the method's development was a top priority. And between management's acceptance, the system's implementation, and everyone's training for its use, maybe another six months.

Would you say that the NSIA technique was designed utilizing a consultative manner based on what we have discussed?

Indeed, I do. Naturally, the goal was to catch the attention of investigators and

ensure that they found it useful when implemented for use. In my opinion, that procedure was actually very significant. If this had been forced upon them, I believe the outcome would have been very different.

When was it initially put into practice? Was the process easy or did you encounter any obstacles? What, if any, components of the NSIA technique met with the most resistance when it was first introduced?

It was initially put into use in 2017. The adoption, in my opinion, was gradual. I am unable to cite any instances of active resistance. I believe the gradualness was necessary in order to maximize the model's potential and turn it into a useful tool rather than a burden.

What techniques did the organization employ before the NSIA method was developed?

Actually, no single model was being used consistently at the time. Nonetheless, the writings of authors like Rasmussen, Hollnagel, and Reason undoubtedly had a significant impact on our agency for many years. I'm sure some of that has made its way into our model. Although I believe the model is a significant advancement for us, we still rely heavily on the work of outstanding authors and researchers.

"We considered developing a system that could be understood and utilized by everyone, regardless of academic training, field of application within the agency, or level of professional experience."

Can you briefly describe the NSIA method' and its stages for us?

Of course, the following seven stages make up the NSIA model. Let me go over each step with you.

1. First stage is to clarify the sequence of events and the accident's conditions. This is where we build a step chart. This means creating a systematic way to visualize who did what, what happened, and when, and then translating it into a cartesian coordinates axis. With this model you can see a representation of what led to that irreversible physical event (the accident), and also what happened afterwards. In other words, it is as much about the analysis of the event as it is about its consequences. Questions such as where, what, when and who are predominant at this stage. The participants in the circumstance being analyzed—i.e., any person or thing that has been involved in the accident—are positioned on the vertical axis to create a step chart. On the other hand, the horizontal axis dislpays when each actor performed what, using the information that is now accessible. This provides a clear visual depiction of the case's complexity.

2. The second stage entails identifying local safety issues. The reverse of systemic safety issues are these local safety issues. A local safety issue could be one of three things:

    a. *The barrier approach. When there was a chance that the course of events could have changed or that there might have been interaction.*
    b. *The control approach. When a lack of control or very poor control is involved in the course of events*
    c. *Non-conformity or deviation approach. When a series of events didn't follow a safe or expected pattern.*

As soon as we come across any of these potential circumstances, we flag them as local safety issues, which may be useful to learn what caused the accident. Furthermore, a unique tool is required to be able to record all the information and organize it for particularly complicated or extensive investigations where numerous things occur and a large number of individuals are engaged. You undoubtedly need a tool if, for instance, there are 25 or 35 local safety concerns. Specifically, we have created a chart of safety-related risks for this.

3. The third stage is the analysis of barriers. Three subcategories can also be used to examine barriers in this case:

a. Barriers that were present and effective. Hence, nothing negative occurred there.
b. Existing barriers did not function properly, which allowed the accident to occur.
c. There were barriers that, in our perspective, should have been there but weren't, which led to a safety issue.

4. The identification of the factors influencing each safety issue is the fourth stage. Here, we start with causal analysis by posing the why- and how-questions. We try to comprehend why someone did what they did and why it made sense to them from various points of view, such as the operator's. Investigations into human factors are helpful in this situation.

The elements that might have an impact on safety issues are recorded. Three levels can be used to categorize these factors:

a. Operational and technical aspects
b. Variables at the management or organizational level
c. Contextual conditions

"The writings of authors like Rasmussen, Hollnagel, and Reason undoubtedly had a significant impact on our agency for many years. I'm sure some of that has made its way into our model."

It is convenient to use a real-world example based on an actual event to help clarify this. At one airport, a truck entered what was known as the Papa taxiway after crossing a red line and being in an area that was off-limits to vehicles. For being there, it collided with a plane that was using this Papa taxiway.

The truck driver's inability to hear communications between the control tower and the plane in this case would make it impossible for him to know that the plane would use the Papa taxiway —where the truck was parked in violation of the regulations— would be a technical aspect. Naturally, the truck's drivers anticipated that the plane would use a different runway.

On the other hand, an organizational and managerial component relates to the perception of overwork among drivers at that company due to a perceived staffing shortage. Additionally, they reasoned that since nobody could see them or control them there, they could do whatever they pleased in the vicinity of the Papa taxiway. Since no one intervened to stop the drivers' negligence while jeopardizing safety, this would be an organizational factor.

Finally, a possible factor at the level of contextual conditions may be the fierce competition in the airline business in general. This competition could explain why the company where the truck driver worked was, in the opinion of the drivers, understaffed, perhaps as a measure by the company to lower its costs and thus be more competitive.

Using this classification, it is able to clearly distinguish how the various components are related to one another at different levels and even within each level, which will help us better understand the accident. We should also point out that the three various degrees of investigation pertain to what we typically refer to as the "depth" or "scope" of the investigation. "Depth" refers to how much we investigate organizational and contextual factors (upward in the investigation model). "Scope" refers to how much of the sequence of events we investigate in depth (from left to right in the model). The levels on which we choose to concentrate will then dictate how much of the sequence of events and consequently of the step diagram we will study; meaning, where will we start and where will we finish.

5. Examining importance and causality is the fifth stage. We obtained this information from the ATSB. Let's say we've already found a factor that piques our

Figure 2. Table of safety problems between Boeing aircraft and truck

SAFETY PROBLEMS						
	SAFETY PROBLEM	**FACTUAL INFORMATION (EXISTENCE)**	**INFLUENCE / RELEVANCE**	**WHY?**	**TOPICS TO BE INVESTIGATED**	**Main topics**
1	The driver of the de-icing truck crossed the red safety line without permission from the tower, and parked the truck close to taxiway Papa	The driver acknowledged violating the traffic regulations. CCTV and recordings of tower communications confirm the violation.	If the truck had not violated the traffic regulations, the collision between the Boeing 737-800 and the de-icing truck would not have happened.	Possible explanations for why the safety problem occurred: - The driver was unaware of the traffic regulations - The driver was aware that he violated the regulations, but did it anyway	What do we need to clarify through investigation? - If the driver were unaware of the traffic regulations, had he received adequate training? - If the driver were aware of violating the regulations, for what reason would he do that? What was his situational awareness at the time, leading to this behavior?	Human Factors: training, drifting into failure, situation awareness Infrastructure: Airport design

Source: NSIA´s document, How we investigate accidents in Norway, September 9, 2022.

curiosity. At this point, we pick whether to dig deeper and keep investigating it or, on the contrary, we should discard it. For that, a series of questions should be asked:

- Does this factor really exist? If so, how can its existence be verified or documented? If the response is negative, the specified component is immediately disregarded. We ask the next question if the answer is yes.

- Was there any observable impact of this factor on the course of events? If we must admit that we do not have enough data or that we do not believe that the factor has had an important influence, the answer is no, and so we discard it. But, if we can identify a causal link, we take it into account in our investigation and it will likely be noted in the final report.

- Is this aspect significant? In other cases, we may come across a factor that did not significantly affect the course of the accident or its conclusion, but that we nonetheless feel is essential enough to mention in the final report because of its potential safety implications that go beyond the accident in question. If the response is negative, the factor is categorically eliminated from the analysis. If we answer affirmatively, we include it, but we are very cautious to note that even though it hasn't been proven to have an impact, we still discuss it because it's significant.

6. The sixth step is when systemic safety concerns are taken into account. These are the topics where learning about safety has the most potential. The difficulties we can identify are, like in previous rounds, recorded into a table that describes the problem, the demonstrable facts, what we should look into, etc.

Also, we may utilize the same test with the three questions we asked about the contributing elements in stage five for systemic safety issues (examining causality and importance). This examination frequently assists us in prioritizing the systemic safety issues we will emphasize for correction.

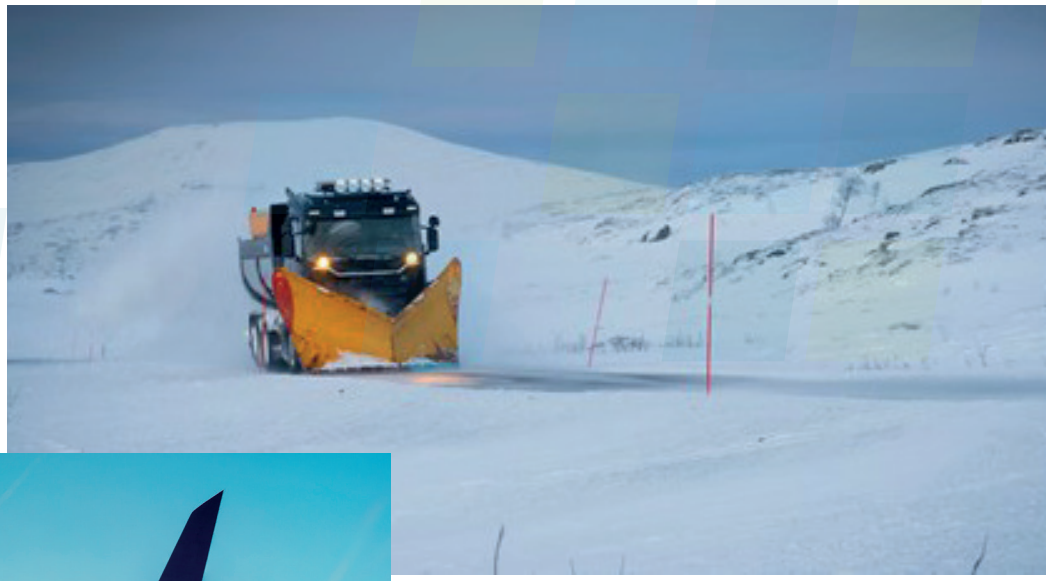
7. The necessity for safety advice is assessed at the seventh step. These suggestions are supported by the data gathered and worked on during the first six phases.

So, those are the seven stages of our model. It should be highlighted how helpful it is, especially when it comes to drafting the final report because it makes the process much simpler.

"We find the model to be a beneficial tool, both in the investigation process and while writing the accident report. As a result, you may break down each factor and bubble into its component parts and explain in plain language how each one affects the other factors and conditions of the event."

Could you provide further details on this final issue regarding the editing?
Naturally, the approach works best when trying to explain what happened and what factors led to the accident. As you are far more likely to be able to explain things in a clear and straightforward manner by following this model, we find the model to be a beneficial tool, both in the investigation process and while writing the accident report. As a result, you may break down each factor and bubble into its component parts and explain in plain language how each one affects the other factors and conditions of the event.

Do you have any further information regarding this model or any other subjects you would like to discuss with us?
I have nothing else to say but thank you, both for the interview and for your interest in our method. It has been a pleasure to share this with you, and connect with other investigation organizations, which is essential for the continual improvement of our everyday practices.



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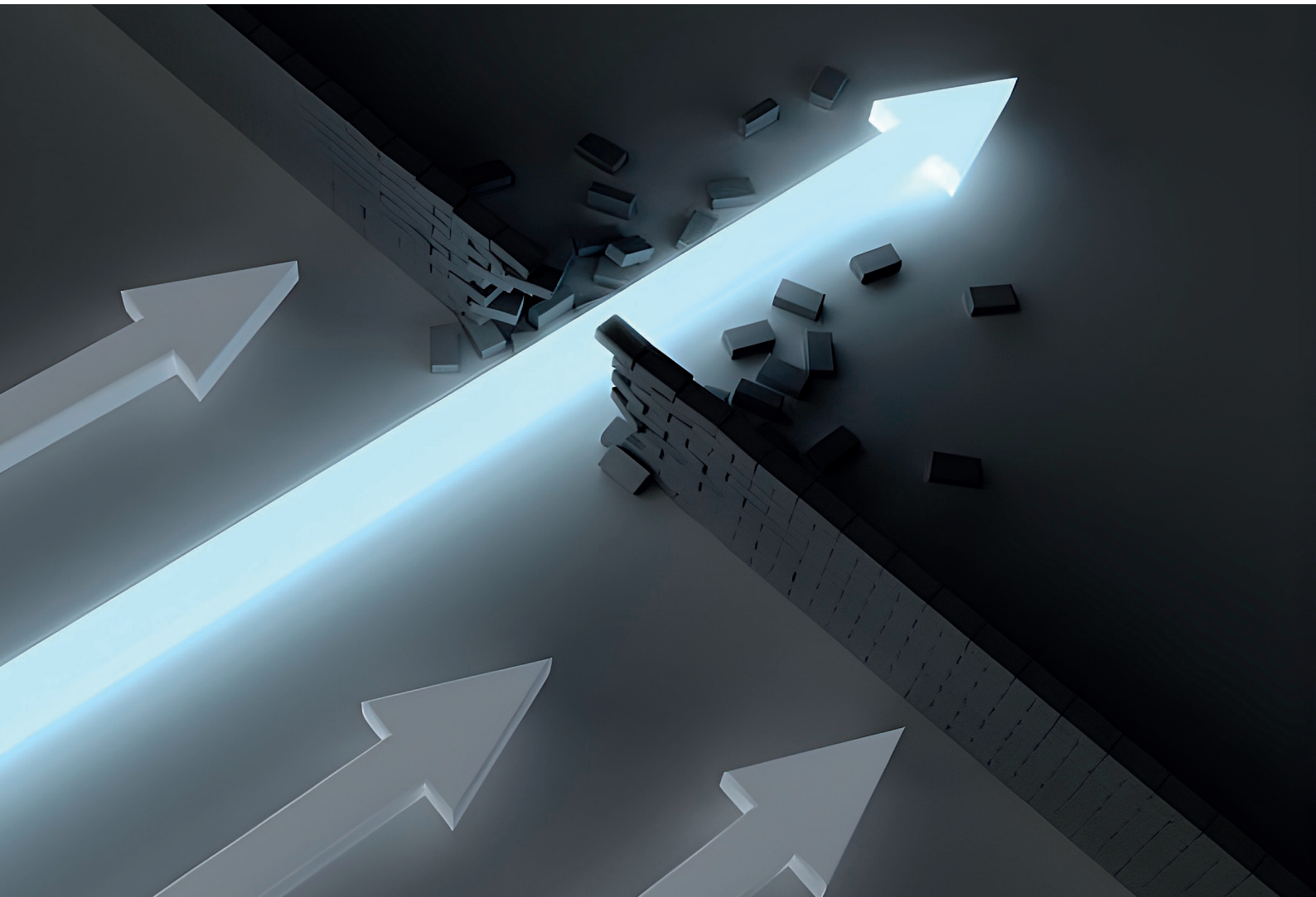
DOSSIER

MULTIMODAL

A VISION TO TURN ACCIDENTS INTO LESSONS LEARNED

Systemic Investigation Model: Four Essential Keys to a Paradigm Shift

Alejandro Covello
Multimodal Research Advisor to the Transportation Safety Board.



Changes to organizations and business models are feasible. It is essential that accident investigation identify and enhance its approach for it to occur. In order to answer what were the conditions of possibility that contributed to the accident, the systemic model of investigation suggests getting beyond the legal prejudice and the single failure-typically attributed upon workers with direct interaction with the processes.

1. The split with the judicial and economic compensation model

Transport accidents will be the subject of our analysis in these pages. For every time an accident occurs, at least two or three investigations require to be initiated: a criminal and/or civil law investigation; another one in terms of financial compensation and insurance; and a third one, the technical safety investigation. From this classification, we can refer two major competences for the investigation of transport accidents: the judicial, economic, and administrative; and the safety investigation.

For the first group, the focus and purpose are to identify accountabilities and issue penalties, acquittals, economic compensation and/or fines and sanctions. Entities responsible for these are the judiciary system, insurance companies, and—regarding breaches of rules and regulations—regulatory and supervisory bodies; which in the case of transport in Argentina are the National Civil Aviation Administration (ANAC); the National Commission for Transport Regulation (CNRT), in its railway and automotive modes; and the Argentine Naval Prefecture (PNA) [Spanish acronyms], among others. To this should be added the investigations that a transport service provider can conduct, in terms of an internal summary of workers involved in the accident. All these organizations have due power to carry out an investigation seeking knowledge, truth related to a crime, misdemeanor, indiscipline, and non-compliance with rules and regulations.

In relation to safety investigation, as in any judicial investigation, the requirement of independence is critical to achieving the objective. In case of safety investigations, independence is in relation to the judicial system and regulatory and oversight bodies. To demonstrate, let's consider the Law 27514 by which the Transportation Safety Board (Junta de Seguridad en el Transporte, JST) was created in Argentina, with the mission "[...] to contribute to transport safety through accident investigation and the issuance of recommendations." Article 2 states: "The following constitute principles of transport safety policy; (a) Independence, based on delimitation between the functions of regulation, provision and control of transport services (...) Investigation must guarantee impartiality, transparency, and scientific rigor."

Now, the first fire hoop to jump through in safety, for a systemic investigation, is to NOT identify the workers as accountable, nor judge their acts under legal terms. For a long time and still today, negligence, recklessness, indiscipline, etc., can be read as causes of accidents. These are legal terms that shouldn't be deployed in safety investigation reports.

> ***The first fire hoop to jump through in safety, for a systemic investigation, is to NOT identify the workers as accountable, nor judge their acts under legal terms".***

In Argentina, we can cite as a reference the attributed cause to the Argentine Private Airlines (LAPA, Spanish acronyms) flight 3142 accident, occurred on August 31, 1999, identified and described by the public agency responsible for the investigation of air accidents at that time (the former Civil Aviation Accident Investigation Board, Junta de Investigación de Accidentes de Aviación Civil, JIAAC) as: "Lack of discipline of the crew, who did not execute the logical reaction of aborting takeoff, and checking the fault signaled by the sound alarm that began to be heard when giving engine and continued until the attempt of rotation." (Safety Investigation Report, JIAAC, 1999)

But this sort of bias did not just occur in Argentina but was rather a global problem. To illustrate this with an example, Sabey and Taylor (1980) analyzed the results of a study conducted by the britishTransport and Road Research Laboratory, whose main objective was to identify the main contributing factors involved in road accidents. The laboratory study covered a total of 2.130 accidents. Based on the analysis of the data obtained, Sabey and Taylor identified that:

- 41 % of drivers involved in the studied events were classified as at-fault for the accident.
- In 95 % of the studied accidents, driver and pedestrian error and lack of aptitude were identified as the main contributing factors.

> ***It becomes evident that the split with the judicial model and economic compensation, sets safety reporting on the right trail, moving away from the partial duality that identifies human error and technical failure, shall also make for the investigation to consider the context."***

Examples such as the above abound in safety investigation by virtually every agency during the twentieth century. In short, the work of the different boards of investigation was biased by the judicial and economic registry, identifying the operators as accountable, or else, qualifying their acts with judicial terms. Below we can see a table from the 1951 Yearbook of the JIAAC, which eloquently illustrates the problem:

Table 1. Accident Causes

Technical deficit	29,3
Material failure	15,9
Neglect	13,8
Poor maintenance	9,8
Fortuitous	7,3
Misjudgment	4,8
Reckless flight	4,8
Imprudence	3,7
Negligence	3,7
Precautionary landing	1,2

Source: 1951 Yearbook, JIAAC

If safety investigation does not overcome that initial hoop, two problems emerge: first, the organization responsible for conducting the investigation will be repeating reports subjects that belong to other bodies. This would put Government's investment in accident safety investigation to waste and spend resources in different organizations for the same task(s). And second, this would be like killing mosquitoes instead of fumigating the infested pond. In other words, the structural factors which triggered the accident would remain untouched.

The systemic model jumps right through the hoop, overcoming the challenge by adopting an analytical process with the following features:

- Describes the system and its conditions of possibility for the occurrence of an accident.
- Explains the gap between the desired performance of the system and the actual performance without identifying workers and without adjectivizations or value judgments.
- Includes an editorial quality and control phase, that reviews the final report and avoids judicial, economic or punitive compensation biases.

2. The systemic model includes a cross-sectional analysis that, starting from the triggering factor, reconstructs the context to the highest reasonably practicable level

Accident investigation, since at least the first Industrial Revolution, was biased by the judicial and economic register, as well as determined by the dualism "pay or stop paying", without any impact on accident prevention or safety. At the beginning of the twentieth century, we find the origin of accident investigations, the purpose was prevention. Many authors argue that the birth of occupational safety and health, as a scientific discipline, took place in 1931, and take the publication of the book Industrial Accident Prevention by the American author H. Heinrich as a milestone.

In this founding book Heinrich deployed three fundamental premises:

1. Unsafe acts of persons are responsible for 88 % of industrial accidents.
2. Accidents are the result of a single linear causality
3. There is a fixed relationship between major accidents, minor injury incidents and near-incidents/accidents without consequences. The well-known Heinrich Pyramid: 1, 30, 300.

The linear Heinrich model (cause-effect) and its variants, such as the cause tree, are analyses that identify a root cause, deposited to a greater extent in the operators (88 %) and to a lesser extent in mechanical or physical failure (12 %). This is a binary

bias which marks a clear separation between a human and a material cause. Thus, the "unsafe act of a person" was translated as human error, while the "mechanical or physical threat" was interpreted as synonymous with technical failure. This is inherited from a system representation of static relations that supposedly can be broken down into parts and reassembled; and from transport interpreted as a linear and non-complex system, subsequently assuming that there are only fixed relationships between components.

> ***"Systemic analysis model is the one that will allow us to settle the political debt, open the frontier beyond technology and science, and explore the political dimension of safety."***

Evidence is irreducible, we are bombarded by statistics that tell us that human error is the cause of 70, 80, 90 or even 100 % of the accidents —as already shown in previous examples.

Charles Perrow, in his book Normal Accidents, tells us that the tendency to attribute the cause to the operator is prominent and identifies that in maritime accidents human error is the cause of more than 80 % of accidents —conclusion reached after reading 200 accident reports which only judged the ship's captain and state "that he should have done zig instead of zag" (Perrow, 1984: 233).

Models help us discard the irrelevant to the problem that we need to solve (i.e., explain the accident) and put focus on what we need. Model explain how a system works, how things happen, and what were the conditions for possibility of the accident. They also predict the future, offering opportunities for improvement [Safety Recommendations] so that the accident doesn't happen again.

It is logical to require simple answers to our questions, although a model "should be as simple as possible, but not simpler" as Albert Einstein said. Using a linear model of accident analysis in a complex system is to give a "simpler" answer, that has no real impact on the problem we must solve. Therefore, models are chosen not because they are good or bad, but because of their usefulness. Although every model has limitations, some are more useful than others.

In this sense, linear models are limited in their usefulness, since:

- They don't help us think about what happened before the human error or mechanical failure that caused the accident.
- They consider the transportation industry a simple system.
- They can't address the complex systems' problems in accordance to their characteristics: interactive complexity and unexpected interactions.
- The idea of "root cause" is simplistic and cannot always be determined (what is the true root cause in complex accidents?)
- Consider that a cause per se causes the accident. In complex systems, "factors" related to the accident are listed, necessarily, but none is self-sufficient to cause an accident.
- They have little preventive power since they identify the symptoms but not the disease. They leave viruses intact.

What is this about viruses? The answer began to be given by Edwar Suchman in 1961, when he published A Conceptual Analysis of the Accident Phenomenon. He was the one to use the metaphor of disease (epidemiological model) to represent an accident. According to this approach, the author compares an accident with the occurrence of a disease, especially with contagious diseases where "infectious agents" enter a predisposed host with certain conditions.

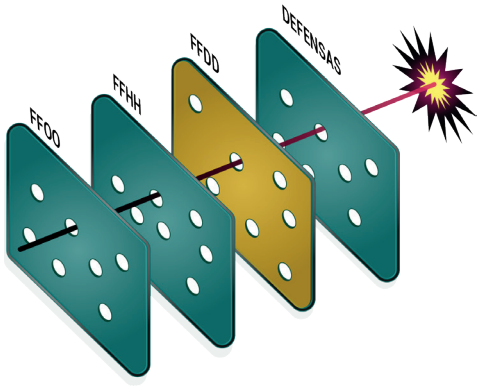
In the late 80s, J. Reason resumed the epidemiological model with the purpose of responding to catastrophic accidents of complex sociotechnical systems, such as those of Three Mile Island (1979), Bhopal (1984), Chernobyl (1986), Challenger (1986), Zeebrugge (1987), among others. In his book Human Error (1990) he explains the metaphor of Suchman's infectious agent (virus) as latent factors, and represents them as holes, categorizing them as the greatest threat to safety in a complex system. In this way, it moves away from the focus on errors made by operators and material or physical failures, which become only the hosts of the virus (triggers).

In reference to latent factors, Reason classifies them as human factors (HFs), organizational factors (OFs) and defense factors (DFs). Being the triggering factor (human or mechanical failure), now, a consequence:

> Human error is a consequence and not a cause [...] Errors are configured and caused by precedent factors rooted in the workplace (HF) and organization (OF). Identifying an error is simply the beginning of the search for causes, not its end. (Reason, 2010: 173)

Reason takes a Nietzschean hammer blow to Heinrich's model by saying that human error is not the root cause of accidents, and that it is not even a cause, but a consequence of latent factors that were generated upstream. In turn, the author introduces a new factor (unlike Heinrich and Suchman) to explain the accident: the defenses. Beyond the triggering, human and organizational factors, there must be a virus in the defenses (weak immune system) for the accident to occur.

Figure 1. Reason's method.



Source: Prepared by the JST.

The Reason model was named the "Swiss cheese" model because it represents viruses as holes. Why does Reason introduce this new factor (defenses)? Because at the time he wrote Human Error, he was influenced by the third ongoing Industrial Revolution (and on the eve of a fourth), and one of the answers given to the accident problem in complex systems during this stage was to introduce "defenses-in-depth or automatic defense systems."

The concept of "defenses-in-depth or automatic defense systems" is based on a philosophy considering risk as "energy to be contained" through layers of defense, which channel the energy of the sources of danger. This concept was born in the nuclear industry, which considers that proper design of the atomic plant are the defenses that aim to contain the unwanted release of atomic energy and prevent catastrophe from occurring.

> Automatic Safety Devices (ASD) are created, which must cover the widest variety of accidents postulated by design. In addition to many support subsystems, there is a line of defense that is offered by ASD: devices that, after perceiving a state other than tolerated, automatically "trip" the reactor, shut down the turbines and/or reduce excess pressure. (Reason, 1990: 249)

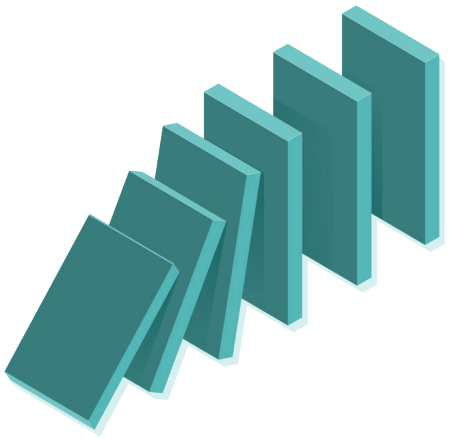
Another Nietzschean hammer blown by Reason occurred with the incorporation of defenses-in-depth in a model of accident analysis, since human error or mechanical failure not only ceased to be causes and became consequences, but the last line to stop the accident no longer was the human being but the defenses-in-depth.

> ***Human error is not the root cause of accidents, and that it is not even a cause, but a consequence of latent factors that were generated upstream. In turn, the author introduces a new factor (unlike Heinrich and Suchman) to explain the accident: the defenses".***

It was from the Swiss cheese model that, in 2013, Argentina began to design its own systemic model and apply it in accident investigation bodies. Thus, a cross-sectional analysis was initiated, which includes the deficiencies or absences of the defenses, the human factors (investigating in what aspects the technologies and systems influence the behavior of the frontline operator) and the organizational factors (intervention of the policies of the regulatory and supervisory entities, as well as the management of the organizations that provide such services in operational safety). Therefore, by "at the highest reasonably practicable level" we mean to allocate RSOs to transport entities and service providers, which are the organizations best positioned to implement mitigation measures to safety risks, and who have the authority and powers to act to the fullest extent possible.

In conclusion, just as it becomes evident that the split with the judicial model and economic compensation, sets safety reporting on the right trail, moving away from the partial duality that identifies human error and technical failure, shall also make for the investigation to consider the context. I used this adjective, partial, since duality holds one pan on the weighing scale too inclined towards human error.

Figure 2. Confrontation of the Linear model vs. Swiss cheese model



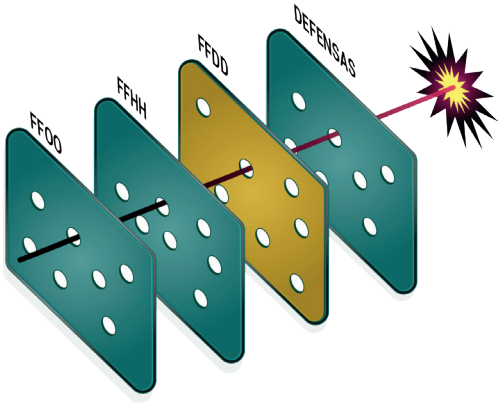
Heinrich concluded that 88 % of the unsafe acts were unsafe acts of first line operators. The human being became the last line of defense before the accident. Once the duality "human error or mechanical failure" was solved, the accident report concluded.

VS.

Where the Heinrich model concluded the accident report (human error - mechanical/physical failure), the Reason model begins and tells us that these are no longer causes, but consequences, and thus is the starting point of the accident report.

Then, we must look into the defenses that were absent or failed, and upstream we will find the factors (human and organizational) that provided the conditions of possibility for the accident to occur.

The last line to stop the accident are the defenses-in-depth, and not the human being.



Source: own elaboration.

3. The systemic model includes the new scale of the Fourth Industrial Revolution and complex socio-technical systems

In the description of the previous key, we expressed how Reason, by including the defenses in an accident analysis model, incorporated the new technology of the Third Industrial Revolution. Continuing the concept of the development of industrial revolutions to the present, Klaus Schwab, a German economist and founder of the World Economic Forum in 2016, characterized the Fourth Revolution as a "fusion of technologies and their interaction across the physical, digital and biological domains", which blurs the boundaries of traditional sciences or technologies, with great advances in artificial intelligence, robotics, nanotechnology, quantum computing, biotechnology, internet, 3D printing, autonomous vehicles, among others. This revolution is not limited to automation, but refers to industries 4.0, intelligent systems and/or smart factories.

Transportation, like any cutting-edge industry, lives and experiences this great Industrial Revolution. It is worth asking ourselves, then, what are the radical changes that have developed so far in the Industrial Revolution. Between the operator and the process or the consequence of the work, there are countless layers, systems or subsystems, with fused technologies. The direct human-machine interface disappeared and the SHELL interface shows a limited representation of complex sociotechnical systems. The essence of a sociotechnical system cannot be grasped by any simple representation.

Another major change has been the progressive distancing of operators from the processes they used to directly control. In the early days, between the human being and the physical task mediated tool; then machines; automatic systems; later, software, applications; and countless subsystems of increasing complexity. Currently, many competences and responsibilities of operators and supervisors are transferred to other systems.

From craftsmanship and manual labor during the First and Second Industrial Revolution, workers had direct manipulation of tools and machines, as well as immediate detection of results; it was seen and controlled. Today there are systems that act on their own, and the main task of the operator is monitoring. The new systems act beyond the worker: direct action on the tool, machine and production processes is eliminated. The worker's doing is replaced by monitoring and/or supervising, with access to information filtered by the system; The worker only accesses what he needs to know (need-to-know basis).

In this new systems scenario, continuing to identify the frontline worker and a single component failure as the root cause of an accident would give us not only a limited perspective, as explained in the second key, but we would be looking at a system that does not exist; the investigator would be carrying out his work in a parallel world of simple and direct relationships, identified in a stationary way. The systemic model considers the characteristics of the systems of the Fourth Industrial Revolution: interactive complexity, unexpected interactions, close coupling, opacity of the systems, human supervisory control and software safety, among other new concepts derived from current technological development.

> ***The systemic model considers the characteristics of the systems of the Fourth Industrial Revolution: interactive complexity, unexpected interactions, close coupling, opacity of the systems, human supervisory control and software safety, among other new concepts derived from current technological development".***

Before finishing the fourth key, allow me to make a "warning" to move away from (in Perrow's words) "the litany of complex systems vs. the advantages of simple systems":

> The litany of problems of complex systems and the advantages of linear systems might lead one to believe that they are far preferable and that complex systems should be transformed into linear ones. Unfortunately, this is not the case. Complex systems are more efficient (in the narrow sense of productive efficiency, which does not take into account the dangers of accidents) than linear systems. There are fewer downtimes, less underutilized space, less tolerance for low-quality results and more multifunctional components. From this point of view, in terms of design efficiency and installed equipment, complexity is desirable. (Perrow, 2009: 121)

Now, intervening in that parenthesis that Perrow leaves us, we can take as evidence that, thanks to complex systems, the aeronautics, nuclear and many industries have reached the status of ultra-safe.

The notion of ultra-safe systems was enunciated in the mid-1990s by Professor René Amalberti (2009) in his book Human Action in High-Risk Systems.

> The catastrophic accident percentage is around one accident per million movements (departure-arrival) (1 x 10-6) in air transport; This figure is also reached in rail transport, in the nuclear sector and other industries. This is an exceptional figure for the individual level considering that a professional pilot performs 100-200 movements a year, so in 30 years of profession he will have made between three to six thousand movements. (Amalberti, 2009: 32)

Back to present time (Fourth Industrial Revolution), the scientific discipline of accident investigation began to design analysis models beyond the well-known model of the Swiss cheese, emphasizing this model made it possible to develop new models, with the so-called systemic approach.

With his theory of normal accident, Perrow (1984) proposes to act on complex couplings, interactive complexity and unexpected interactions, changing the axes of risk management from severity and probability to severity and costs of alternatives.

Hollnagel (2004), in Barriers and Accident Prevention (2009), presents the Functional Resonance Analysis Method – FRAM, which is based on the phenomenon of stochastic and functional resonance.

Nacy Levenson (2004) develops the Systems Theoretic Accident Model and Processes – STAMP, an approach that considers accident as a control problem and not a failure problem, and that involves complex dynamic processes where there are no component failures. In this way, it considers individuals, organizations, and technology at the same level of granularity.

Lastly, it is worth noting again that since 2013 the JST developed its own model of accident analysis taking, as many authors did, the model of Swiss cheese with some adaptations towards systemic thinking. A brief description of the novel aspects of this mode, could be as follows:

- The concept of factor causes was eliminated.
- The individual level is a triggering factor and then the factors in the defenses, human and organizational factors are considered at the same hierarchical level.
- The Safety Recommendations (RSOs) are directed to the system.

4. The systemic model allows the design of safety policies at the highest level, causing structural changes

When making a systemic analysis of accidents, we identify structural factors and realize that this is not only a scientific technical competence, but also, that there still is a space slightly explored by investigators and safety specialists. I am referring to the "political dimension". The development of regulations issued by oversight and regulatory bodies is a political instance, and the practices of frontline operators are a consequence of these policies. Therefore, as described above, if RSOs are directed at the system, they translate into policies.

This approach moves away from "utilitarianism", which only tries to use technical-scientific arguments to answer the problem of risk management. Although accident investigation and analysis can be formulated in scientific terms, the correct response to how to affect the conditions that produced the accident is beyond the technical-scientific and is articulated with politics. The policies are general specifications of how management expects operations to be conducted, and that's where the RSOs go.

To boldly conclude this article, I'd like to say that the systemic analysis model is the one that will allow us to settle the political debt, open the frontier beyond technology and science, and explore the political dimension of safety. Just as it is not enough to train the worker or to add more layers of defenses, or to make promises that we will be better prepared to face the next catastrophe, it is not enough to focus exclusively on the technical analysis without introducing the political dimension. "Many organizational theorists who study safety problems have done so in this way: they have neglected power and interests in their studies" (Sagan, quoted in Jorge Walter and Francisco Pucci, 1994: 95). "Perrow suggests that, ultimately, the problem is not risk but power: the power to impose risks on the many, for the benefit of the few" (Perrow, quoted by Nancy Levenson, 1993: 17). The power to continue with the analysis of the single fault deposited in the operator or investigate the system. The results of the investigation of accidents in the systemic sense are intended to influence the agents that have the power to guide a change in the system, since, it is also

the power, that creates the conditions of possibility for catastrophe to be triggered in the system.

Finally, a reflection on ethics. And to do this, we will ask ourselves a question: what is the importance of defining an accident analysis model? The investigator goes to the wreckage of the accident with an uncertainty that he needs to quickly reduce to give some immediate answers, and the facts he validates are not independent of the accident model he adopts. If the organization does not explicit the model that shall be used to explain the accident, the investigator will use his own. Thus, each accident will be left to the discretion of each investigator and, as we said before, perhaps the simplest and most linear path is the one that will be taken.

I consider that an investigation organization should enunciate its model, and it is this enunciation that ensures the objectivity, the product of a sociotechnical study and a political decision. A state accident investigation cannot leave the accident explanation to each investigator. It is a state responsibility to define its public transport safety policy, and a safety model and strategy. If the model is not chosen, stated, and set forth for it to be apprehended, then there is no State policy.

The reconstruction of the accident in a final report must then be the alignment of the State's safety policy, with the accident investigation model adopted by the agency in charge. The model is a condition of possibility to change State policies related to safety.

> ***It is a state responsibility to define its public transport safety policy, and a safety model and strategy. If the model is not chosen, stated, and set forth for it to be apprehended, then there is no State policy".***

If we consider ethics as a practice that is evidenced in actions, the final report is the last and main action of an accident investigation body, by which many things are measured. The introductory note that the JST incorporates in its Safety Reports, which explicitly presents its model, is the organizational commitment to the model that has been chosen. This makes it clear, the model is the practice of the organization, with independence from any individual practice of the investigators. The ethical statement of the organization presented in the introduction is the ethical statement of all its members, and thus becomes an organizational value.

CONCLUSION

The present article, with which the JST's RSO Safety Journal is inaugurated, seeks to convey that, when thinking about events in terms of preventing their recurrence, there are some accident explanations that are more powerful than others; explanations that impact and strengthen the safety architecture of the system; explanations "that move the needle" of the safety reading. From the moment the JST adopted a systemic analysis, it disregarded the judicial register and the linear models, because these no longer have a place in complex socio-technical systems, in the Industrial Revolution, and in the management of large risks. Our dear reader, accident investigation is a major intellectual, ethical and political challenge.

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Alejandro Covello

Alejandro Covello (Buenos Aires, 1963). He is a military aviator, chronicler and investigator. He has been an airline pilot for more than two decades, and since 2013, he has been a transport accident investigation advisor. He has taught courses in Argentina and abroad and is a benchmark in safety investigation. He was founder of the Athenaeum Civil Association, dedicated to the study of Human and Organizational Factors in the aviation sector. He has coordinated and participated as author of different books on the subject, among which CRM stands out. *El despegue* (2001), which was translated into Italian (2001); Voando com CRM da filosofía operacional técnica a filosofía interativa humana (Brazil, 2004); Factores humanos, seguridad y calidad en la aviación (2005); Sistemas de seguridad operacional, compromiso aeronáutico del siglo XXI. (2011). He is co-author of Análisis sistémico de la pandemia del coronavirus. Un accidente normal (2020, with Marcelo Muro). He has been the author of the script and protagonist of Piloto de caza, la historia omitida del "muñeco" Adradas (2021), a documentary film based on his book Batallas aéreas. Aviación política y violencia (2018).

MARINE AND INLAND WATERS

Marcelo Covelli
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RISKS DERIVED FROM MINIMIZING THE OPERATIONAL CONTEXT

Systemic Research Model Applied to the Investigation of the Motor Vessel Strategic Equity

It is challenging to make concrete recommendations and prevent the recurrence of similar accidents when investigations are conducted solely with a human behavior emphasis, disregarding the operational environment.

A crew member of the motor vessel Strategic Equity was hurt on August 13, 2020, while attempting to free the forward spring line that had become stuck between the ship and a wharf fender.

During that attempt, the tension of the mooring line caught in the fender suddenly released and impacted the face of the crewman who was acting as a signalman. The injuries sustained by the crewman resulted in his death.

Before starting the loading operation, the first officer descended to the quay to read the drafts, observed the trapped mooring line and gave notice to the boatswain to loosen the headlines in order to open the bow off the quay and release the trapped line.

A representative audiovisual representation of the accident can be viewed in the following link:

Understanding the performance of operational personnel is a necessary but insufficient condition to ascertain the deeper factors linked to the occurrence of an event, claims the safety report produced by the National Department of Marine and Inland Waters Occurrences Investigation (DNISMFyL, in its Spanish acronym) of the JST.

> ***Understanding the performance of operational personnel is a necessary but insufficient condition to ascertain the deeper factors linked to the occurrence of an event".***

In fact, it is difficult to evaluate frontline operators' performance "in the void," that is, without fully appreciating the operational context in which it occurs, according to theories that explain how accidents and incidents start.

It is essential to describe elements like the processes, procedures, and policies implemented for risk control to identify the systemic factors involved in the occurrence and, as a result, to establish the most effective and appropriate safety recommendations, capable of preventing its repetition.

According to: International Maritime Organization (IMO):

> The causes of marine accidents and casualties can vary, and the underlying safety problems are frequently found far from the scene of the accident. A thorough examination that goes far beyond the available facts in search of factors that might contribute to future occurrences is necessary for the proper identification of such issues.
>
> So, it is important to think of marine casualty or incident safety investigations as a way to pinpoint not only the accident events but also safety flaws in the operation's whole management, from policy to implementation, as well as in regulation, survey, and inspection. Because of this, safety investigations ought to be thorough enough to satisfy these fundamental requirements.[1]

In that regard, the Strategic Equity research would have reached the same conclusion as those who simply attribute the accident's cause to "human error" if a linear technique had been employed.

However, the application of a systemic methodology allowed for the elaboration of certain aspects of the safety context. As a result, it was discovered through the voice recordings of the M/V Strategic Equity's VDR that there was a high probability that the waves created by the passage of another ship had an impact on the ship's movement and the sudden release of the trapped line.

As a result of the report's discovery of unknown risk factors in the ship's Safety Management System, safety suggestions were made to bolster the transport system's defenses.

The full report can be downloaded by scanning the QR code.

1. Resolution A.1075(28), Guidelines to assist investigators in the implementation of the Casualty Investigation Code [Resolution MSC.255(84)], Section 5.1.1, page 5.

RAILWAY

Gabriel Sosa
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STUDY OF SYSTEMIC ANALYSIS MODELS FOR SAFETY

Systemic-Matrix Reasoning in Socio-technical Systems Applied to Railway Transport

Methodological proposal for the analysis of transport systems based on the concepts of the systemic approach to accident investigation, developed through the creation of possible coupling matrices.

Introduction

To develop the central idea of this paper, let me start with Albert Einstein's phrase, published in The Saturday Evening Post in 1929: "Imagination is more important than knowledge. Knowledge is limited and imagination encircles the world."

So, what was the idea born from imagination and in what context did it become known? Its origin dates back to the introductory courses given by Alejandro Covello at the Transportation Safety Board (Junta de Seguridad en el Transporte, JST), with the support of the National Director Eng. Diego Di Siervi, and Eng. Germán Goñi, investigator of the National Department of Rail Occurrences of the JST (DNISF, Spanish acronym). On such occasion, the notions of systemic analysis and normal accidents in sociotechnical systems intersected with the concern that the country was going through in the context of the COVID-19 pandemic. So, in the process of searching for information on a systemic analysis of the Argentine economic and political crisis, we came across the investigation "Systemic analysis of the coronavirus pandemic. "A normal accident" by Covello and Muro (2020), in which the authors break down the sociotechnical systemwhere the pandemic develops into its different components and then analyze them in a new way.

Reading this material triggered a series of questions; how can we order the elements of a complex system in a simple, methodical, repetitive and general way? How can we visualize the interactions to determine the emergent properties? Is there only one way to search or handle those properties? These questions remained in the realm of ideas until confronted with the regulations, methods and risk-matrices of the DNISF Studies area, used to arrange information elements in intersections of rows and columns. Therefore, to try to answer the initial questions, and based on a wealth of knowledge in electronics and programming, we begin to reason in terms of systemic analysis through a matrix organization. And this is how we arrived to the system-matrix reasoning (SMR) that is described throughout this paper.

Possible coupling matrices

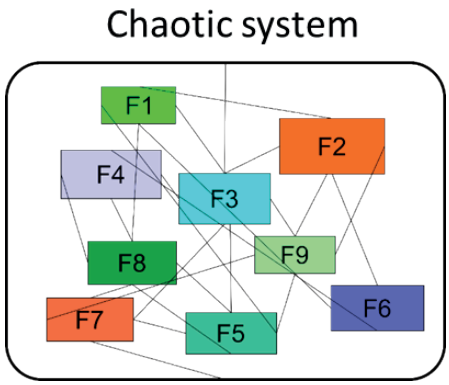
To develop the concept of the possible couplings matrices (PCM), we start from the idea of sociotechnical system (STS) coming from the general theory of systems (GTS).

Sociotechnical systems can be defined as a set of interacting elements. Interaction means that the "p" elements are in "R" relationships. The behavior of a p element in R is different from its behavior in another R' relation. If the behaviors in R and R' do not differ, there is no interaction, and the elements behave independently with respect to the R and R' relations (Ludwig von Bertalanffy, 1976).

The mutual interaction of the different elements that make up a system gives rise to emergent properties that may or may not be desired, and which are the result of the set of relationships between parties. These properties are based on simple behaviors. The properties generate a whole that is greater than the sum of the individual properties of the elements that make up the system.

For the system-matrix reasoing (SMR), the p elements are the component factors F1, F2, Fn-1 and Fn, and the R relations are the mutual couplings. If these do not have any order, restriction or barrier, we can say that the emergent property of the system would be chaos, as shown in Figure 1

Image 1. Chaotic system representation.



Source: own elaboration.

In order to develop the matrix of the system-matrix reasoning (SMR) it is intended, first, to visualize and analyze the different constituent factors of the system and their interactions. Following this logic, the system can be analyzed from a state of chaos of the interactions in order to achieve certain properties for a desired state of order, or else, the system can be analyzed from the current state of order, to visualize a state of chaos of the interactions, that allows to foresee properties that were previously undetermined.

To this purpose, a list of general constituent factors of the system (GF) is defined first. In the case of a transportation system, for example, vehicular, structural, organizational, regulatory factors, etc. are

stipulated, all of which provide information about the system itself. Table 1 develops a generic list of constituent factors.

Table 1. List 1 of constituent factors

Constituent Factors	Factor 1	Factor 2	Factor 3	Factor 4

Source: own elaboration.

Then, List 1 is transposed with List 2 of factors and they are mutually correlated, creating a Possible Couplings Matrix or PCM, as seen in Table 3.

Table 2. List 2 of factors, transposed with those from list 1

Constituent Factors
Factor 1
Factor 2
Factor 3
Factor 4

Source: own elaboration.

Table 3. Generic PCM of constituent factors

PCM	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	Element 11	Element 12	Element 13	Element 14
Factor 2	Element 21	Element 22	Element 23	Element 24
Factor 3	Element 31	Element 32	Element 33	Element 34
Factor 4	Element 41	Element 42	Element 43	Element 44

Source: own elaboration.

The numbers of the row and column they intersect identify the PCM information elements. For example, Element 12 intercepts Factors 1 and 2. Later on, they are defined as possible couplings and are identified with the letter "A". The cells in Table 3 that are shaded in gray are the values that make up a diagonal in the PCM, and that are later defined as "System identities".

The general factors of the system, in turn, are subdivided into the individual factors involved in the event. These factors are factually identified in the field survey.

Each element of the PCM can create a new matrix of correlations, with new possibilities, as if it were a fractal2 that repeats itself on different scales. This reasoning will reproduce the method for the different combinations, from the general to the particular. It should be clarified that the confluence of factors coupled with connections and interactions between them prevail over the search for cause-effect relationships.

In order to better visualize the application of PCM, we develop an example with a generic model, with general contributing factors, and then we will see how it is applied to a more specific example.

> ***"It should be clarified that the confluence of factors coupled with connections and interactions between them prevail over the search for cause-effect relationships"***

Factors defined for a first analysis

The defined constituent factors are determined abstractions in order to visualize the interactions within the transportation system, inspired by the RES170/2018 of the Ministry of Transport[2].

In order to carry out the analysis of an accident, the systemic model involves a series of steps (Hollnagel, 2009). The first refers to identifying the essential functions of the system. To do this, it must be determined what constitutes the system and its components. The second instance foresees determining the potential for variability of the context and of the main functions (human, technological and organizational). The third step refers to defining the dependencies between (correct and incorrect) functions and, finally, deciding the countermeasures (policies, defenses, monitoring, procedures, communication, etc.) (González, 2016).

Table 4 shows the general constituent factors with their functions, capacities and characteristics. Then, through the exemplification of an event, we will observe the particular variables.

1. A fractal is a geometric object in which the same pattern is repeated at different scales and with different orientation.
2. If the reader finds that a factor is part of a larger subsystem, he/she must consider that it is here used to apply the concepts in a more general way.

Table 4. General Factor for N9 Model

General constituent factors	Function	Initial Characteristics
Vehicular	Transportation	Design, specifications, damage, recommended maintenance, etc.
Structural	Bear transportation	Design, status, construction measures, time and intervals; pending, levels, damages, etc.
Human organizational	Operate	Techniques and psychophysics. Management, politics, researcher, etc.
Load	Load to transport	Characteristics of the transported load. Damage, human users, passenger. etc.
Visibility	To identify or be identified	Obstacles, position, measures and materials, etc.
Noise and variability	Disturb and modify	Unwanted random movements. Noise pollution, visual pollution, etc.
Surveillance and registration	Monitor and record the activities	Security cameras, videos taken by passers-by. Communication media Related legal events. Statistics.
Rules and customs and usage	Rule and regulate	Current standards, regulations, good practice manuals. Customs and usage.
Environment	Provide natural conditions for functioning	Climatic, topographical, physical. Energy, etc.

Source: own elaboration.

N9 Model

Table 5 shows the possible couplings matrix (PCM) of the factors defined in Table 4. The example is called the N9 Model (N9 refers to the number of constituent factors used). Variables are susceptible to simplification, and some could be included within others. In this example, however, all nine variables will be used separately.

The PCM is the result of the transposition and crossing of each element of the list of general constituent factors. An analysis of each relationship is carried out starting with the identity links, which are those that relate the factor to itself. Then, the other connections are analyzed. General couplings are identified as A[i][j] where i are the rows and j are the columns of the matrix

Table 5. PCMs of the general factors (GF) of the system defined as N9 Model

N9 PCM	Vehicular	Structural	Human organizational	Load	Visibility	Noise	Surveillance and registration	Rule	Environment
Vehicular	A11	A12	A13	A14	A15	A16	A17	A18	A19
Structural	A21	A22	A23	A24	A25	A26	A27	A28	A29
Human organizational	A31	A32	A33	A34	A35	A36	A37	A38	A39
Load	A41	A42	A43	A44	A45	A46	A47	A48	A49
Visibility	A51	A52	A53	A54	A55	A56	A57	A58	A59
Noise	A61	A62	A63	A64	A65	A66	A67	A68	A69
Surveillance and registration	A71	A72	A73	A74	A75	A76	A77	A78	A79
Rule	A81	A82	A83	A84	A85	A86	A87	A88	A89
Environment	A91	A92	A93	A94	A95	A96	A97	A98	A99

Source: own elaboration.

The general constituent factors (GF) can be subdivided, in turn, into individual factors (IF). They refer to the factual elements of the system under analysis and will have their corresponding PCM.

To visualize the PCM of the individual factors, we will now see an example of a level crossing collision (LCC) between a locomotive carrying a fuel coach and a passenger bus. These characteristics or elements will be part of the vehicle identity.

Table 6. PCM of the vehicle identity

A11 Vehicular	Locomotive	Coach	Bus
Locomotive	A'11	A'12	A'13
Coach	A'21	A'22	A'23
Bus	A'31	A'32	A'33

Source: own elaboration.

In table 6, the A11 Vehicular identity interaction generates a new PCM with A' couplings between the factual elements participating (FEP) in the event. That new matrix will also have possible combinational identities and elements. Gray shows identities and red, the collisional couplings between the locomotive and micro identities. Green shows the coupling between the locomotive and coach identities. And white shows the possible couplings not taken into account.

Table 7. PCM of the Organizational Human identity

A33 Organizational human	Locomotive Driver	Driver Assistant	Bus Driver	Investigator
Locomotive Driver	A'11	A'12	A'13	A'16
Driver Assistant	A'21	A'22	A'23	A'26
Bus Driver	A'31	A'32	A'33	A'36
Investigator	A'61	A'62	A'63	A'66

Source: own elaboration.

In table 7, the A33 Human organizational identity interaction generates a new PCM with A' couplings between the factual elements participating in the event. In this case, the new matrix will have the identities of locomotive driver, driver assistant, bus driver and investigator. The identities could be more, but they were simplified due to a matter of length of the paper. In gray, the identities of the new PCM are observed, in green, the matches between driver and assistant and the matches between the investigator and all possible interviewees; and in white, the couplings not considered, such as the A'13 between driver and bus driver.

Identity Couplings

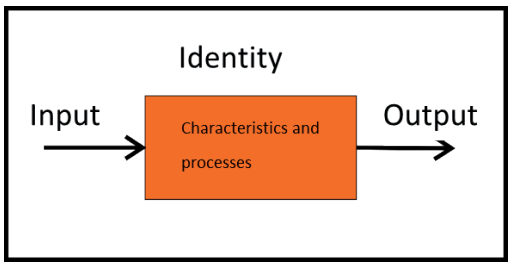
If we look at the PCM of tables 5, 6 and 7, we will see that the shaded elements mutually couple the factors. These are the elements where i is equal to j. In other words, when you look over the PCM, the row matches the column. These elements are defined as identities of the general factors (GF) PCM in Table 5 and as identities of individual factors (IF) in the PCM of Tables 6 and 7.

The characteristics of identities

To define identities, we rely on concepts from general systems theory. In this sense, the system itself is considered a "black box"; and its relationships with the environment and with other systems are represented in the block and flow diagrams.

Systems are described in terms of inputs and outputs. In our system-matrix reasoning (SMR), identities are defined based on their documentary characteristics and by the characteristics of the interactions that they may have at the input or output of the process. Documentary features can be photos, texts, and related files.

Image 2. Identity definition



Source: own elaboration.

The possible couplings

The possible couplings (PC) are those elements of the PCM that are not the general identities (GI) nor the individual identities (II). For example:

In Table 5:
1. Couplings A13 and A31 relate the Organizational Human and the Vehicular GI.
2. A71 and A17 relate the Vehicular and Monitor and registration GI.

In Table 6:
1. A'13 and A'31 relate Locomotive and Bus II.

2. Couplings A'12 and A'21 relate Locomotive and Coach II.

The PCs (possible couplings) arise from the combination of all the identities defined in the system model. In the N9 Model example, the nine general identities create [(NIG2)-NIG] or seventy-two possible combinations, and these in turn create individual identities with the same number of combinations, depending on the number of individual factors defined. Here, the need to develop a computerized tool to be able to go through all the combinations is observed.

MSR and PCM applications

This section introduces these applications. They are not analyzed exhaustively but are intended to show some principles and results obtained, since it is a large study still in developing process.

To put in practice the system-matrix reasoning (SMR) and the possible coupling matrix (PCM), a software in C# language4 was developed, where a local MySQL database (DB) is used to store the possible coupling matrices created as information is collected and the system under analysis is loaded, so they can then be processed and analyzed from different approaches.

First, the method was defined. Then, the lines of computer code were written to store the collected information and the tables of identity characteristics in a local database in the form of PCM. Images, texts, related files, etc. can also be stored in the database.

Application according to the desired emergent property

According to different interpretations of the possible links and interactions between the different identities of the PCMs, we could place ourselves in different systemic approaches.

The systemic model considers accidents as an emergent phenomenon. They are also "normal" or "natural" in that they are something to be expected. This is related to Perrow's (1984) concept of normal accidents, applicable to simple and complex systems (Hollnagel, 2009).

Then, we will focus on the failure prevention approach (Marchitto, 2011), where the desired emergent property will be "reliability."

We can detect some emerging defined in RES170/2018 of the Ministry of Transport through the MSR in the PCM couplings. For example, the "active failure" can be identified and recorded in the possible coupling of the example given in table 6 A11-A'13 between locomotive and bus, or A11 - A'31 between bus and locomotive which are marked in yellow in table 8.

Table 8. Emerging identified in PCM A11 Vehicular as active failure

Active failure	Locomotive	Bus
Locomotive	Identity	A'13: Crash
Bus	A'13: Crash	Identity

Source: own elaboration.

We can assign the "barriers or defenses" to the couplings identified as active failures. Table 9 shows an example with the assignment of an automatic barrier and the whistle signal.

Table 9. Example of defense assigned to the emerging A11-A'13 and A11-A'31

Defense	Locomotive	Bus
Locomotive	Identity	A'13: Whistle signal
Bus	A'31: Install automatic barrier	Identity

Source: own elaboration.

Up to here, we present two synthetic and simple examples of how the MSR and PCM can contain the prevention approach. This idea will be expanded and refined as the investigation progresses. The incorporation of the barrier will modify the A22 structural identity of table 4 previously defined, which in the example did not take into account an automatic barrier. The whistle use will modify the previously defined A88 Rule identity, which did not take the whistle use into account. These modifications at the level of general factors (GF) and individual factors (IF) will modify the possible couplings (PC) and will create new identities and, therefore, will modify the properties of the system.

When the desired emergent property is "control," rather than "reliability," we move into the control theory approach. We will give a simple example to identify a control structure through the MSR and relate

3. C# is a modern, object-based, type-safe programming language. C# enables developers to build many types of secure and robust applications that run on .NET.

it to a control structure based on STAMP5 from the Massachusetts Institute of Technology (MIT).

Tables 10 and 11. Simplified matrix of A13 and A31 couplings

A13 Vehicular - Organizational Human	Locomotive Driver
Locomotive	A'11

A31 Organizational human - Vehicularr	Locomotive
Locomotive Driver	A'11

Source: own elaboration.

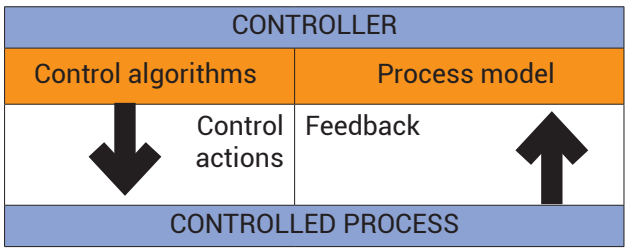
Table 12. Control structure contained in the simplified PCM

Driver		
A13 - A'11		A31 - A'11
Locomotive		

Source: own elaboration.

Table 12 shows a control structure between driver and locomotive comparable to that of Image 3.

Image 3. STAMP-based control structure



Source: own elaboration.

As demonstrated so far, the MSR can also be used from the control theory approach, identifying structures in PCMs, which will be developed in future investigations, along with other emerging properties that are identified with the system-matrix reasoning (SMR).

4. The Systems Theoretic Accident Model and Process (STAMP) is a theoretical accident and process model that draws on control systems theory to try to find out as much as possible about the factors involved in a hazard, and to provide clear guidance as to to the control structure that leads to danger.

CONCLUSIONS

It is partially concluded that the MSR methodology allows the identification of several approaches in a single general possible coupling matrix (PCM) and in their individual PCMs, from which different emergent properties can be obtained. With the correct definition of the identities, accidents due to component failures can be analyzed, and with the analysis of possible couplings, accidents due to component interaction can be analyzed. To advance in its development, it is necessary to continue with the partial writing of the software presented in this article, which will allow, in turn, to automate the database and different parts of the procedure to make it more intelligible.

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When Information Makes a Difference

After an accident, families are immersed in uncertainty. Informing them about the progress of the investigation contributes to the grief elaboration and recovery process.

IVAF

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A new trend in the transportation industry started to emerge a little more than 20 years ago: prioritizing individuals who have been injured in accidents and helping them through the various procedures they must go through after the worst has occurred.

Initial steps were seen in the aviation industry, where a string of disasters made it increasingly clear how damaging it was for the relatives of accident victims to get inadequate care due to a lack of planning and foresight. The creation of appropriate regulations that would compel all parties involved in an accident—from operators to investigating agencies—to reconsider how victims were helped, not just right away but also in the days and weeks that followed, became essential.

The 1996 Act, which set duties for the victims and the care they ought to receive, came into existence in the United States at that time. The International Civil Aviation Organization (ICAO) then created two documents, the Policy on Assistance to Victims of Aviation Accidents and Their Families, and an ad hoc Manual, urging its member countries —including Argentina— to adopt the necessary measures in this regard. The Protocol on Assistance to Civil Aviation Victims and Their Families was then put into effect by the Argentine Civil Aviation Accident Investigation Board (JIAAC, Spanish acronym).

In addition to adopting the multimodal nature of the agency, the Información a Víctimas de Accidentes y Familiares (IVAF), which is a Section specialized on Information for accident victims and their families was established right upon the creation of the Transportation Safety Board (Junta de Seguridad en el Transporte, JST), replicating what was accomplished and applied in aviation, in the other transport modes. Nevertheless, from the perspective of the investigation agency; how might family members be supported? What can the JST provide to those who have lost a loved one in order to help them heal and move on? Firstly, using truthful facts obtained directly.

> ***"It is then where the intervention of the IVAF area makes sense, intending to serve as a communication channel between the JST and the relatives of accident victims.***

The Royal Spanish Academy defines an accident as ["an unforeseen event that changes the normal course of things."] It is also often said that those who lose a family member in an accident, whether on the road, the air, at sea, or on a train, have their routines forever changed, and everything they have ever known stops making sense. For this reason, the search for answers is one of the most frequent attitudes among family members, who need to know what happened and how the events occurred in order to be able to move forward.

It is then where the intervention of the IVAF area makes sense, intending to serve as a communication channel between the JST and the relatives of accident victims —provided the occurrence is under investigation by the agency.

Family members will be informed of the most important findings of the investigation through the task performance of the area and JST's reports, and will be able to direct all of their questions that come up throughout the investigation. They are also the first to get material specifically created with the intention of being exposed, ensuring that there are no middlemen and that they can accurately comprehend the nature of the investigation. This prevents confusion and misunderstandings, which frequently result in family members becoming entangled in perplexing circumstances that hinder their recovery.

It is for all of these reasons, that the JST, an institution engaged in technical investigation, values these kinds of best practices, which are supported by our internal policies and are available for review on the agency website.

AVIATION

IMPROVING SAFETY IN AIR TRANSPORT

How are Aviation Occurrences Investigated Today?

The 5th edition of the MAPRIAAC - Procedures Manual for the Investigation of Civil Aviation Accidents and Incidents was created in June 2022, by the National Department of Aviation Occurrences Investigation (DNISAE, Spanish acronym). The investigation techniques outlined there suggest a strategy that looks beyond technological failure or human error and instead focuses on the environment, reconstructing the occurrence's context and searching for triggers.

The investigation process

The Transportation Safety Board (Junta de Seguridad en el Transporte, JST) is the Argentine agency responsible for investigating any aviation event that is deemed to be an accident or incident, including those involving experimental aircraft that have been awarded a Certificate of Airworthiness, by the National Civil Aviation Administration (ANAC, Spanish acronym).

The reactive element of safety management that stands above all others is the examination of aviation accidents and incidents. Active failures and latent circumstances are the two main pillars on which the systemic model put into practice by the JST is founded. In this way, the National Department of Aviation Occurrences Investigation - DNISAE takes into account the analysis of the organizational (OFs) and human factors (HFs) involved in occurrences.

This is why the JST's investigations into air accidents and incidents go beyond simply identifying technical failure or operational error to examine any latent deficiencies in the aviation system that might serve as systemic precursors to further occurrences. To accomplish this, information on HFs and OFs must be gathered and analyzed with the same care and thoroughness as any other conventional area of investigation.

> ***"Any errors or omissions were caused by underlying system issues that ultimately manifested in such ways. So, it is crucial to contextualize the error and comprehend it as a result rather than as a cause."***

"The human element is the most flexible, adaptable, and valuable component of the aviation system, but it is also the most subject to factors that might have a negative impact on its performance", according to the International Civil Aviation Organization's (ICAO) paper 9683.

In aviation, human factors (HFs) are concerned with using what we know about people—their traits, capabilities, and limitations—to design the equipment they use, the settings in which they operate, and the tasks they perform. Operational performance, on the other hand, refers to how people carry out their work and reflects the level of human involvement to a system's performance. People are both a source of risk and a crucial component of identifying and managing all the risks inherent in the aviation system.

In general, the following categories can be used to group the operational performance data that will be gathered as part of an investigation into an air accident or incident:

a. Allowing investigators to create a thorough timeline of all important events leading up to and, if necessary, following the occurrence (this chronology should highlight the actions or omissions of the aviation personnel involved and their potential consequences for the occurrence).

b. Background information on the operation's context enables investigators to analyze in depth the cause of the behavior of the engaged aviation employees.

The JST's method for investigating air accidents and incidents always assumes that any errors or omissions were caused by underlying system issues that ultimately manifested in such ways. So, it is crucial to contextualize the error and comprehend it as a result rather than as a cause.

Furthermore, it is impossible to foresee how certain human behaviors and circumstances will interact with particular elements and features of a working environment. Individual-based mitigation techniques are therefore not thought to be efficient.

The study must go further to explain elements that are remote in time and place from the event in issue, such as unsafe behaviors by frontline personnel or mechanical problems. Despite this, the factors that explain human performance and the occurrence of mechanical failures are typically linked to the workplace environment of frontline operators, the organization in charge of that environment, and even to external factors that have an impact on the organization, such as rules or oversight from the aviation authority, among other things.

An evaluation of the system's defenses at the time the occurrence in study occurred must be included in the analysis of active faults and latent conditions. Each defense must be identified, and its success or failure must be determined. Like this, it is important to evaluate any viable defenses and advocate their use to the relevant agency, natural person, or legal entity in each instance.

Safety Recommendations (RSO)

The most significant outcome of an investigation is the Safety Recommendations, which aim to ensure that the identified safety flaws are brought to the attention of the relevant agencies and entities to implement the necessary changes and prevent the repetition of similar events. Safety Recommendations offer suggestions to prevent the recurrence of accidents and incidents, which helps to strengthen the national and regional transportation system's defenses.

When the investigation is still in progress or when it is over, as part of the Final Safety Report, the JST may issue Safety Recommendations. When it is determined that there are one or more factors that could jeopardize safety and against which the current defenses are not fully effective, the formulation of a Safety Recommendation during the investigation process will be justified. It is then imperative to communicate this officially and immediately to whoever oversees taking the necessary action.

A Safety Recommendation must persuade the reader to take safety precautions in order to reduce the hazards discovered during the investigation. The accomplishment of this objective can be facilitated through communication that is concise, clear, and well-organized. The following qualities must be included in a properly constructed Safety Recommendation:

- Clearly state who the recipient is
- Addressed to the most qualified organization to implement change
- Be justified and pertinent
- Be timely and attainable
- Display verified and accurate information
- Avoid the use of abstract language
- Make a direct and explicit connection to a fact that affects safety
- Be founded on the development or strengthening of safety defenses
- Be free of presumptions and value judgments
- Be cautious not to overprescribe
- Do not limit the margin of action of the recipient
- Focus on the expected result
- Be measurable and traceable for its follow-up

Safety recommendations developed by the DNISAE are composed of two sections:

a. A summary of the safety issue that was found, along with conditions that could endanger safety, any defenses flaws, and lingering risk (or negative effects) of inaction.

b. The suggested safety measures (risk management alternatives), along with the anticipated outcomes.

The recipient responsible for carrying out most safety recommendations will be an Argentine public or private organization, such as the civil aviation authority, the air service operator, the aircraft manufacturer, the supplier of air traffic services, or the airport operator.

However, the JST may communicate safety recommendations to recipients in other sovereign states, always through the appropriate Accident Investigation Authorities. For its part, ICAO will be the recipient responsible for implementing recommendations that relate only to standards and recommended practices.

The DNISAE issued 352 Safety Recommendation between 2015 and 2021. Data analysis reveals that with 64 % of the targets, ANAC was the primary target of air mode safety recommendations. 8.5 % of this mode's safety recommendations went to aircraft owners, while 7.5 % went to operators (commercial carriers). As opposed to this, 4.5 % of businesses offer services (ramp, air navigation, meteorology, etc.). The final 4 % went to federations, (groups that unite general and commercial aviation operations).

The DNISAE and the Safety Recommendations Monitoring Area work together to evaluate the closure of an aeronautical safety recommendation. The JST determines whether the recommendation's goal has been achieved fully, partially, or otherwise based on the responses received. Both the safety recommendations that were closed as having been completed and those that had an alternate risk mitigation action applied are regarded as satisfactory.

The JST received 80 % of successfully submitted responses in 2021. The more the agency's recommendations that receive a satisfactory response, the greater the contribution been made to increase safety. To make increasingly specific and practical recommendations that will effectively help to strengthen the defenses of our transportation system is the enormous task that lies ahead for the investigation of aeronautical incidents.

INVESTIGATION PROCESS

OCCURRENCE

1 NOTIFICATION

2 FIELD TRIP

JST

3 ON-SITE SURVEY

4 BASIC REPORT

5 REQUEST FOR INFORMATION AND CONDUCTION OF INTERVIEWS

6 PRELIMINARY REPORT

7 ANALYSIS

8 SAFETY REPORT WITH SAFETY RECOMMENDATIONS (RSO)

9 RSO TRACKING

IMPROVEMENT IN THE TRANSPORT SYSTEM

JST | SEGURIDAD EN EL TRANSPORTE

Ministerio de Transporte Argentina

primero la gente

PRESENT AND FUTURE OF AVIATION TRAINING

The Current State and New Challenges of Professional Training in Aviation Transport

We interviewed Carlos Alejandro Di Bernardi, professor of Aeronautics/Aerospace Engineering at the University of La Plata (UNLP) and director of the Research, Development, Extension and Transfer Unit (UIDET). Di Bernardi is one of the experts who are part of the Technical Cooperation Program of the International Civil Aviation Organization (ICAO) and has a professional background in more than 130 airports in 19 countries in the Americas, Europe, Africa and Asia.

Considering your professional career, what is your opinion on the trainings and qualifications that are given for aviation transport in Argentina in relation to other countries of the world?

There are some very good ones and others not so much. We find areas of knowledge that are repeated with different levels of success and others that are not mentioned, are not updated or are not perfected. Air transport is characterized by its technological and regulatory dynamism, its permanent transformation and evolution: those who do not update are almost sure to fail.

Argentina is, in general, relatively good in certain respects. For example, the Air Transport Group of the UIDET, which is part of the Faculty of Engineering of the UNLP, prepares and teaches more than 80 courses in different areas of knowledge, aimed at different aviation authorities abroad. In addition, it actively participates as a speaker in the international seminars organized annually by the Spanish Agency for International Development Cooperation (AECID), ICAO and Spanish Airports and Air Navigation (AENA). Similarly, we should mention graduates of the Aeronautics/Aerospace Engineering Career of the UNLP, since the professionals who enter the labor market are highly required by the national and international industry.

In any case, naturally, it is necessary to undergo continuous processes of review, diagnosis and action through internal and external audits that allow assessing and evaluating quality indicators. With a clear diagnosis, action plans conducive to maintaining and enhancing assets can be generated, while neutralizing or mitigating the negative aspects.

What are the strengths and points of improvement in the training currently provided in aviation transport in Argentina?

The main strength lies in having different stages of differentiated but complementary training pro-

cesses. An example of this can be seen in the various schools of aviation technical education, in the flight technical institutes, in the training centers for mechanics, in the technicians, in the university degrees of aviation trajectory and, of course, in the various centers of instruction in civil aviation found throughout the national territory. This situation allows us to have a wide offer with multiple and diverse approaches.

Within the points to be improved we could mention the curricular contents themselves, the methodological processes of instruction and evaluation, the facilities and the conformation of the teaching staff. It is necessary to focus on strengthening the processes of each institution, within a framework of national strategic development that is in accordance with State policies. By the way, the latter, at the national level, are yet to be established.

> ***"It is necessary to undergo continuous processes of review, diagnosis and action through internal and external audits that allow assessing and evaluating quality indicators."***

Taking that in account, we must try to generate multifocal teams with convergent systemic approaches, but differentiated according to training and professional skills specific to each activity. This will allow us to have complementary and enriching views when implementing the pedagogical actions that are necessary to carry out specific and robust training programs.

On the other hand, I believe that we should think about education locally, but without losing sight of the fact that we are part of a globalized, highly competitive world in permanent demand for innovative knowledge. In this context, our training systems should be the result of bottom-up evolutionary processes based on strategic training planning and the generation of skilled resources.

Another aspect to work on is related to the development of instruction manuals, whether they are from service providers, airline or airport operators or from the state aviation action bodies themselves. Each institution should make known its organizational chart, as well as the missions and functions of each job. With this in mind, we would have a map of training requirements according to the specificity required by each area of action.

How could different institutions and organizations partner to generate training content according to the needs of the current aviation market?

Training processes are long-term and the programs we generate today will have an impact not only in the short term, but also in a future full of innovation and transformation. Visions must be strategic, with clear goals in the short, medium and long term. Specific action plans and programs are required to allow the periodic review and updating of curricular content. It is important to establish dynamic, flexible and innovative training profiles. We live in a world where everything changes, and curricular content should not be the exception. We are facing a very challenging scenario, so we could ask ourselves: are we really aware of it?

In this historical moment, where change is permanent and the only certainty is uncertainty, we must work hard on actions that allow, in some cases, to deepen and, in others, to generate mechanisms conducive to the construction of robust institutional ties, long-term, seeking at all times the rapprochement, without pettiness, of the entire national aeronautical sector. It is necessary that industry, the State and academia find points of convergence in a permanent dialogue table.

What pedagogical or practical tools do you consider essential for the delivery of training in the aviation field? Which ones could be implemented to improve quality and reach more stakeholders and students?

It is necessary to consider pedagogical tools as instruments of information and training. We must continue to work on the skills of the teaching staff and on the attitudes of the student body (whatever it may be). It is not only about knowing, but also about knowning how to do it. Attitude and aptitude are two different qualities, but twinned in intention when we talk about training. The meeting point is the classroom, whatever it may be. Likewise, we must try to generate spaces for doubt, interrogation, and debate, encouraging discussion and assertive exchange of ideas through knowledge-based argumentation. To do this, we must be clear about what, how, when, where, who and why, among other basic questions.

Finally, the pandemic has shown us that we are able to reach many through the internet. Virtuality is convenient, but there is nothing like entering a classroom, looking and observing the students, listening to their concerns and, also, reading their various languages: gestures, attitudinal, corporeal.

The Transportation Safety Board (Junta de Seguridad en el Transporte, JST) and the UNLP conducted a certification in "Safety in the Investigation of Ac-

cidents and Incidents in Civil Aviation". Do you think that this type of training contributes to the improvement in safety?

Anything that involves the generation of content through multiple systemic approaches— provided that it has the multifocal views of the professionals involved—will be a surpassing product. We do not understand a training process in safety without knowledge of the context, full discussion of the applicable regulations, systematic vision, critical look, lateral thinking, questioning the status quo and reflection on paradigms, among others.

Given that participants occupy different positions in different areas of the aviation system, would it be convenient to segment the formations according to making learning more specific?

It is clear that training must be staggered and segmented. An example of this could be seen in airport emergency plans. Faced with the question of who must know the emergency plan of an airport, the answer should always be: "all actors in the airport system, without exception." But this response brings us different levels, some will have to know it to be aware of the response mechanisms that exist and how to act in those cases, while those who are not part of the process will have to know it and understand that they should NOT do anything, that they are not part of the response and that their presence on the scene will only affect the capabilities of the emergency systems.

> ***"The main strength lies in having different stages of differentiated but complementary training processes."***

Is multimodal safety training necessary and feasible?

Yes, of course. When you look at the aviation of the future, it's easy to see that new trends will have a direct impact on the way we move today. The way we move in urban and suburban plots will be modified, we will go from 2D to 3D and automation will be the order of the day. The concepts of urban air mobility and advanced air mobility will become more important, which will require piloted vehicles (on board or remote) and others controlled and guided by automatic systems.

All this will demand big data processing procedures, where the Internet of Things (IOT) and 5G technology will be the order of the day. Airports 4.0 and smart cities will be a reality. At this juncture, the scenarios for 2050 establish the need for control and management systems for multimodal transport of the integral type. But let's not think about those futuristic scenarios, let's go to the reality of nowadays. We live in a context of multimodality, complementarity and interconnectivity, and that is why safety must be analyzed from the multimodal perspective, beyond the particularities that each means of transport deserves and requires.

Finally, what book would you recommend to a person interested in getting started in the field of aviation transport?

Rather than recommending a particular book, I would advise each reader to read the Chicago Convention of 1944, since this document and its 19 annexes make up the reference framework on which the work of international civil aviation is based and substantiated. There are more than 5000 pages of specific technical content, where you can see aspects that make licenses, accident investigation, aerodrome design, safety, airworthiness, among many others.

In addition to this, you can also find the catalogue of documents that ICAO publishes and updates every year. The simple reading of the titles will help the construction of knowledge, it will give you an idea of the diversity of topics in which the air transport system is working. In turn, you could advise to read-across the strategic objectives of ICAO and the strategic objectives of sustainable development (SDG) of the United Nations (UN).

With this suggested material, they will have background information to build their general frame of reference. With this in mind, it'll be a question of choosing a topic and delve into it. Finally, it only remains to continue on the path, fulfilling what Lao-Tzu once said: "a journey of a thousand miles begins with the first step."

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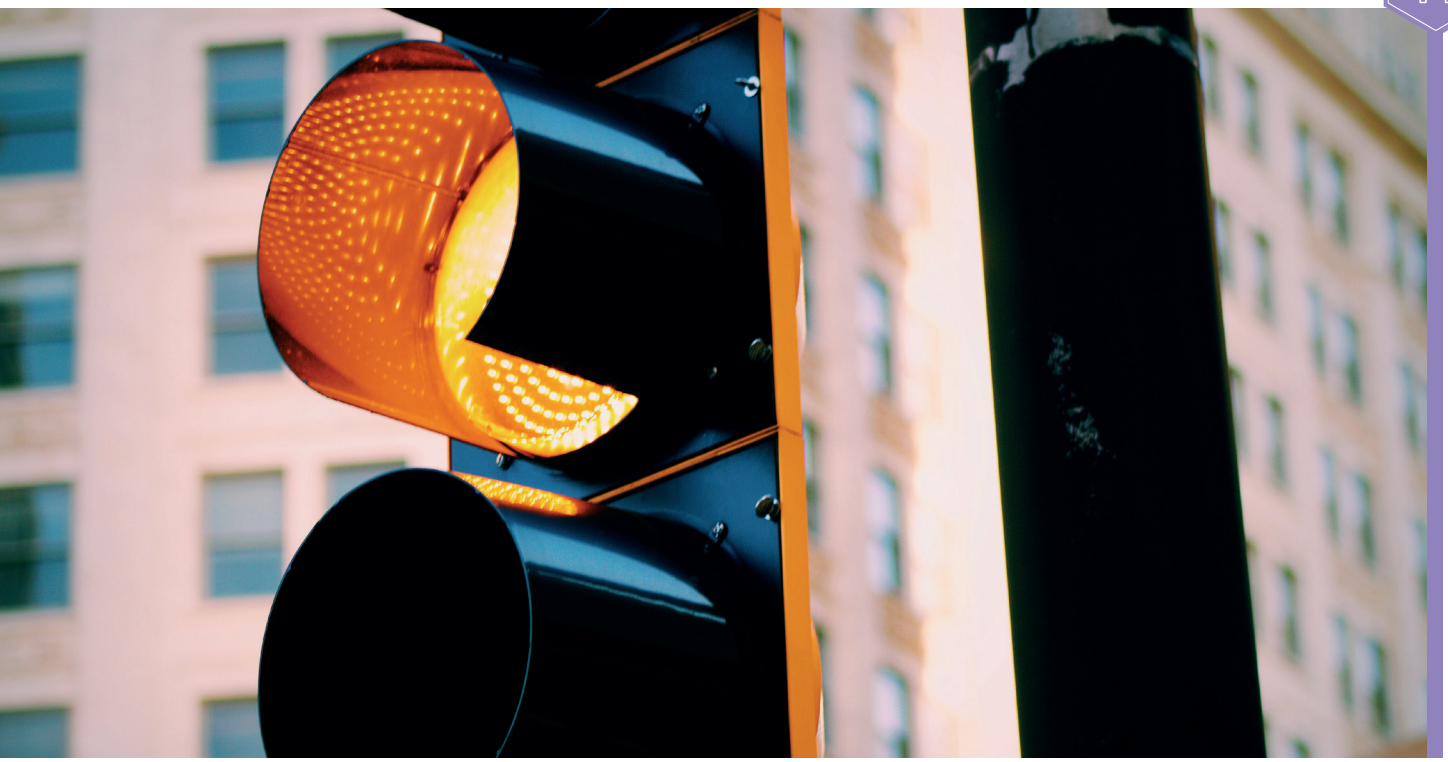

Carla del Cueto
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PUBLIC POLICIES AND RISK MANAGEMENT THAT FOCUS ON A SAFE TRANSPORTATION SYSTEM

Road Safety, Risk and Traffic Regulations in Argentina

In the debates on road safety that are currently taking place, we warn about the error of thinking about risk prevention based on individual behaviors. Instead, we propose to address the issue of traffic safety from a more comprehensive and systemic perspective in which the human factor is linked to other factors of equal or greater weight, such as vehicle safety and road infrastructure.

In this article, I'll present you with a few considerations on traffic risk management. In Argentina, the rapid adherence to automobile was very early accompanied by sustained concern about the damage caused by motor vehicle traffic. Hence, steps were taken to increase road safety beginning with the National Traffic Administration's early years of operation in the 1930s. Road safety has been reduced as a topic of investigation in the social sciences generally, despite the fact that it has created extensive debate and concern in state agencies to the point of becoming a public problem (Gusfield, 1981; Kessler 2008; 2009).

The perception of dangers and formal regulatory mechanisms to manage vehicular and pedestrian mobility zones within a society, are an intrinsic part of the concept of road safety.

According to this definition, road safety focuses first on lowering risks and the subsequent deaths and injuries brought on by traffic accidents (Bess and del Cueto, 2018). However, more recent approaches propose to expand the concept and take into account the greater comfort in human mobility, since it is considered that this approach qualitatively expands the possibilities of analysis and intervention (Rojas, 2015).

According to Tabasso (2012), four road safety paradigms can be found in the concept's evolution that have predominated at various points at the international level. The first of these (1900–1925/35) intended to regulate the usage of automobiles, and safety initiatives concentrated on mechanical parts, long-term restrictions, and adjustments between vehicle and driver. The second paradigm, which spanned the years 1925/1935–1965/1970, concentrated on traffic situation control. In this approach, the emphasis switched from the cars to the drivers, emphasizing on human error. The administration of the traffic system, which comprised the circulation of pedestrians and vehicles on the ground, was the issue facing the third paradigm (1965/70-1980/85). Eliminating system hazards was given top attention in order to achieve this. The fourth paradigm focuses on managing the transportation system for the achievement of a sustainable road safety; regarded as a complex, and global system which comprehends all mobility modes. Prevention aims not only to reduce the risk of injury, but, and above all, to proactively minimize its exposure. In a similar vein, it is asserted that infrastructures are crucial to road safety and that road design may both prevent human error and lessen the damage when it occurs (Sánchez Ferreira, 2012).

"Prevention aims not only to reduce the risk of injury, but, and above all, to proactively minimize its exposure."

We can think about traffic control and road safety policies using the perspective of governmentality. This phrase refers to the set of procedures for executing government business. Firstly, it lays more emphasis on "ideal" understanding of governmental objectives rather than specifics of the implementation of measures and their empirical results. These problems have something to do with "government technology" or approaches to solving these "imagined" problems. Second, it is assumed that government is a widespread and dispersed practice from the perspective of governmentality. This means that several forms of government can always be identified in relation to any given situation (O'Malley 2007, p. 155). Documents, government initiatives, political comments, pamphlets and manuals, all serve as sources used in the governmentality method.

Simon (1998) contends, in his study on the introduction of liability insurance in the United States, that the automobile—and practically every facet of its ownership and use—became a catalyst for the development of new political strategies. Politics discussions have shifted to a discussion of the fundamental rationality of government or governmentality. The essential role that behaviors play in enhancing road safety is a recurring theme across the various governmental initiatives around traffic. In this way, the many forms of government action aim to produce a person who is aware of the law and accountable for his deeds.

The popularity of the automobile represented a problem for governments everywhere, including Argentina. The country's streets and roadways were filled with this object, which sparked several legal efforts and the beginning of the management of new facets of social life. These regulations covered things like the permitted speeds and rights of way, parking locations, car identification laws, technical specifications, and the installation of mandatory civil liability insurance, among other things. Due to the varied historical periods at which traffic rules were developed, the challenge took on various shapes at the legal level. The infrastructure evolved, there were new needs, and the vehicles themselves underwent technical improvements.

The earliest attempts to control traffic on a national scale were made in the middle of the 1930s. As a result, the National Traffic Administration (Dirección de Vialidad Nacional, DNV) was established under Act 11.658 in 1932, and once it was put into operation the following year, it became clear that national roads required traffic legislation. It also became clear that regulations were needed to regulate traffic on the new roads since connecting the various parts of the country was a key component of the physical and symbolic creation of the territory.

Figure 1. Road education campaign poster of the National Traffic Administration, 1934

Source: DNV Report, 1934.

Figure 2. Hand-Changeover campaign poster, 1945

Source: AGN.

The General Traffic Rules on National Highways were implemented in 1936. The rules related to a general order that included a variety of topics, including technical specifications, driving guidelines, speed restrictions, parking, races organization, passenger transportation regulations, required civil liability insurance, and infractions. This law is the first to create national traffic laws, which are essential for any upcoming construction of new highways.

A presidential decree that was authorized with the force of law in 1949 replaced the prior regulation in 1945, under the administration of Edelmiro Farrell. This time, the nationalization of the railways and a complete break with England are the contexts. The fundamental justification for the adjustments focused on the requirement for legislation to keep pace with technical advancements and the upgrading of transportation infrastructure. A productive structure centered on industrial activities was consolidated over those years. These strategic considerations in transportation include the nationalization of the railroads, the decision of manufacturing materials for transportation, and the promotion of the

automotive industry. Transportation requirements for both people and products increased since the mid-1940s because of the developing industrialization. All these components work together to create a foundation for the creation of new traffic laws.

The Executive Branch enacted a traffic law in September 1983, the final month of the previous civic-military dictatorship, but it was overturned by Parliament two years later. It is notable how the law's structure differs from other laws in a significant way. Even with the justification of ensuring freedoms, the oppressive nature of its conceptualization is obvious in its fundamental structure. It prioritizes penalties over the declaration of regulations. The need of road safety instruction is emphasized, and the need for national examples of articulation is urged. The phrase “road safety" makes its first appearance in this law.

The Traffic Law 24449 was enacted in 1994 as part of the State's reform and “modernization" process, and it is currently in effect. Carlos Menem was the president at the time. The key road corridors were given to concessionaires as part of the “modernization" project. Most of the legislative debates were devoted to the subject of law enforcement authority on national roads. They also indicated worries about how to deal with the rising number of fatalities from traffic accidents and emphasized the significance of raising awareness and improving controls through road safety education. New standards for driving safety were established, and the criterion for determining speed limits grew increasingly complicated.

“Most of the policies supported by the National Administration center on social control, including speed limits, alcohol restrictions, and point licensing.”

The rules became more exact throughout time, narrowed their scope of application, and began to regulate a wider range of subtler issues. Concern over minimizing hazards grew stronger. The limits governing the idea of safety likewise grew increasingly intricate. Examples of this include the modification of speed limits or the mandated use of new safety equipment. There was an increase in interest in the governance of individual behavior. On the one hand, strict enforcement of adherence to technical, legal, and vehicle safety criteria. But ultimately, individual traffic behaviors assume centrality: for instance, rights of way, overtaking, and speeds.These actions were identified and made the focal point of an intervention program for improving road safety. In short, the effort to regulate traffic using tools

that can serve as models for more responsible and risk-averse conduct became more important.

Regarding government initiatives to improve road safety, numerous studies that looked at experiences in other nations have demonstrated how individual responsibility is at the core of our nation's policy in this area.

Several control and prevention methods, in which the burden of the problem of road safety rests with drivers, are included in the regulatory package that establishes road safety measures at the national level. The analysis of these projects reveals that the State's engagement in this field was given priority, as evidenced by the National Road Safety Agency's establishment in 2008. The national rules of Traffic and Road Safety set the framework for state measures to address the issue of road safety.

Most of the policies supported by the National Administration center on social control, including speed limits, alcohol restrictions, and point licensing (which this year was implemented in the Autonomous City of Buenos Aires or Ciudad Autónoma de Buenos Aires, CABA). Since this new law was approved in 2008, road safety became "State policy". The problem is described in several texts as an urgent one that requires action and whose solution places the State at the center. This emphasis on the State's centrality takes place in the context of a reevaluation of its capabilities under the administrations of Néstor Kirchner and Cristina Fernández. The actions of the various traffic users remain the focal point of the intervention, nevertheless.

"The emphasis on breaching the law goes against the core of the concept of "accident" (as a confluence of common circumstances).

A two-pronged approach is used to address the issue of road safety. One, through means of restrictions and penalties. On the other hand, education and awareness-building campaigns support these approaches. Governance technology such as driver's manuals and preventative campaigns are aimed at enhancing stakeholder self-governance. It is suggested that citizen training include a focus on traffic safety.

The various measures to increase road safety and consequently decrease the number of fatalities and injuries in traffic accidents are shown in various sociological evaluations of European experiences, particularly in France. Pérez-Diaz (2004) notes that various variables, including the development of automobiles, infrastructure, and the control of conduct using criminal law and prevention, are responsible for the decline in traffic fatalities observed in France since the early 1970s. However, currently, expectations are focused on drivers' behaviors. Despite the multiple factors recognized in traffic accidents, drivers are generally held responsible for "accidents." The means of action in this area are then education, in the long term; prevention and repression, in the short term. In other words, government initiatives are mainly aimed at generating prudent behavior and minimizing risks.

Nevertheless, human error is not always the only cause of an accident, even when the driver is at fault for losing control of the car. On the other hand, these measures give criminal law the authority to alter conduct due to both the prohibition and the preventative role that calls for the detection and punishment of offenses. The risk models specify that the rules must be applied effectively and frequently to achieve this. Pérez-Diaz draws the conclusion that technical advancements in control, rather than legal considerations, are more important to the effectiveness of some measures. The likelihood of catching the offender is increased by these control and penalty methods. Automatic speed controls fall under this category.

For his part, Brenac (2004) criticizes the morality of many of the assumptions of prevention policies in his critical review of the many road safety prevention measures in multiple European countries, particularly the notion that accidents only happen to drivers who break

the rules (in Argentina this reading has a lot of resonance). The emphasis on breaching the law goes against the core of the concept of "accident" (as a confluence of common circumstances). Investigation reveal that "mistakes" rather than infractions are the primary cause of accidents. Speeding issues that put people's safety on the road at jeopardy, prompted new public efforts to try and limit car traffic.

It should be mentioned that from the point of view of governmentality, this emphasis on behavior control and awareness to address road safety is consistent with what has been stated because it attempts to reduce hazards not only through control and repression but also through awareness. In this approach, new aspects of traffic behavior that are open to government interference are set up. It regulates conduct and aspires to be an example of caution and risk-aversion. Road safety education campaigns and manuals serve to raise awareness, but policies also clearly have a repressive element in their controls and fines.

Figure 3. National Road Safety Agency campaign poster, 2012

Source: ANSV, 2012

"A two-pronged approach is used to address the issue of road safety. One, through means of restrictions and penalties. On the other hand, education and awareness-building campaigns support these approaches."

Regarding the education campaigns in our nation, a common characteristic is that drivers' carelessness and lack of accountability are what cause most traffic accidents, with a focus on the behavior of the actors themselves. In recent years, the National Road Safety Agency (Agencia Nacional de Seguridad Vial, ANSV) has incorporated statistical data that would aid in forming ethical behavior.

The mistake of thinking about risk prevention from individual behaviors is warned against in current debates on road safety. Instead, a more thorough and systemic approach to addressing the problem of traffic safety is suggested, one in which the importance of the human aspect is linked to that of other factors, such as the safety of the vehicles and the road system, that are at least as important if not more so.

According to the sustainable road safety concept, accidents happen when hidden flaws in the traffic system and risky acts while involved in traffic happen to

"According to the sustainable road safety concept, accidents happen when hidden flaws in the traffic system and risky acts while involved in traffic happen to occur in a particular sequence of time and place."

occur in a particular sequence of time and place. While risky behaviors cannot always be avoided, the sustainable safety vision, which has been put into practice in some European nations like the Netherlands, strives to eradicate latent flaws from transit.

This sort of action seeks to lessen the user's instantaneous and individual decisions that direct the actions in transit, as these decisions may not be the best and may increase the risks (Wegman, and Letty, 2006). The Safe System approach's initial implementation is the Netherlands' sustainable security strategy (OECD, 2008). Australia then created its own Safe System method after Sweden launched Vision Zero. Although the three countries developed similar techniques, each one made adaptations for its own geographical conditions.

Road safety policy is a process that is directly related to governmentality and modernization. It was developed in reaction to the deployment of new transportation technology that altered daily mobility. Is it feasible to find a solution to an issue that has confounded governments since the early years of the proliferation of motor vehicles in light of these fresh perspectives on road safety?

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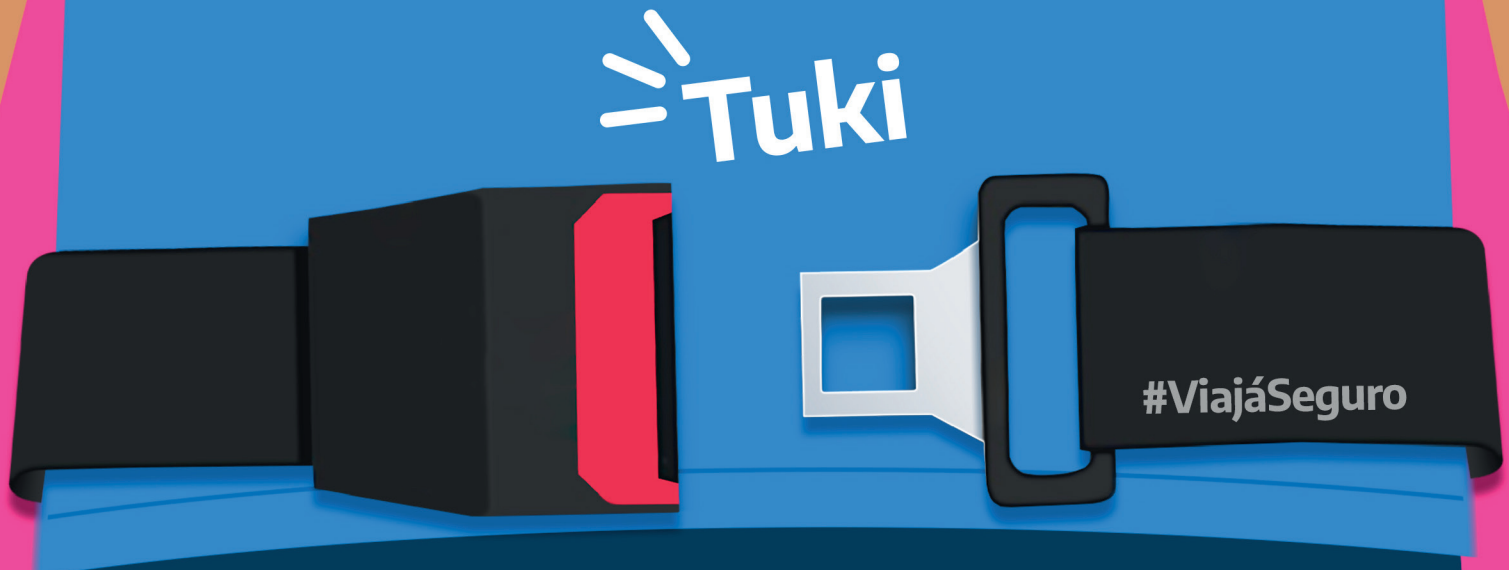

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SEGURIDAD VIAL

Ministerio de Transporte
Argentina

Rogelio R Marzialetti
Test Pilot (EPNER-France), Airline Pilot, and Accident Investigator.

OPERATIONAL AIRCRAFT EVALUATION

Certification and Operations/ Maintenance Activities: A Virtuous Relationship

The improvement of safety in transport aviation over the last decades requires an ongoing evaluation of existing processes to identify areas for enhancement in accident prevention, understanding of causes, and corrective measures.

Interfaces

Recent aeronautical events emphasize the complex nature of accident prevention and the importance of understanding and improving processes related to the interfaces between certification and operational and maintenance activities.

Two cases are briefly presented as examples:

1. Alaska Airlines Flight 261 Accident[1]

The McDonnell Douglas MD-83 aircraft experienced an in-flight loss of control, followed by a nosedive, with documented failures in the maintenance of the control of the trim or longitudinal control compensation system.

The United States National Transportation Safety Board (NTSB) considered several potential causes, including maintenance practices. The analysis of the stabilizer nut revealed that the components were not lubricated, leading to excessive thread wear.

The investigation also identified systemic supervision issues in maintenance programs, the approval process for maintenance interval extensions, and compliance with certification requirements by the aviation authority.

2. Lion Air Flight 610[2] *and Ethiopian Airlines Flight 302*[3] *Accidents*

A typical example of the interfaces between aircraft certification and operational and maintenance activities is the case of the Boeing 737 MAX.

These aircraft accidents occurred within a span of five months. The investigative committee identified, among other events, failures in the certification process and the operational evaluation of the aircraft.

The flight crews had not been informed or trained on Boeing's new system, the Maneuvering Characteristics Augmentation System, known by its acronym MCAS. It is an automatic system that receives information from Angle of Attack (AOA) sensors located on the aircraft's nose and acts on the horizontal stabilizer.

The installed software was designed to prevent uncommanded increases in angles of attack caused by engine thrust effects. A system failure erroneously activated MCAS, leading to a series of cascading effects that created extreme situations for longitudinal control of the aircraft.

Boeing did not consider it necessary to modify the aircraft's Flight and Operations Manuals, nor did it inform pilots about the existence of this system, as they believed it should not significantly alter operational handling. There was also no formal training program to familiarize pilots with the differences between the old and new Boeing models.

As a result of these accidents, the operation of the Boeing 737 MAX was suspended, and a recertification process began with the involvement of experts from the United States Federal Aviation Administration (FAA), the Canadian Civil Aviation Authority (TCCA), the European Union Aviation Safety Agency (EASA), and the Brazilian National Civil Aviation Agency (ANAC).

The items analyzed in the validation process were:

- Aircraft software.
- Flight crew procedures.
- Flight and maintenance instructions.
- Required maintenance.
- Flight simulator.
- Master Minimum Equipment List (MMEL).
- Certification regulations.

Operational Aircraft Evaluation

It is an integrated process that should be carried out by aviation authorities for a new aircraft model that requires a type rating for its operation or for an already certified model when modifications are introduced. This task should be performed by groups of specialists in certification in the areas of engineering, flight crew, cabin crew, and maintenance.

The objectives of this process are as follows:

- Evaluate all elements related to compliance with operational standards, including operational suitability with a special emphasis on normal, abnormal, and emergency procedures, as well as all operational documentation.
- Establish the prerequisites for flight crews, including their prior experience.
- Define the type rating requirements needed for the operation of the aircraft.
- Determining operational similarity with the

1. Accident occurred in January 2000 with 89 fatal victims.
2. Accident occurred in October 2018 with 189 fatal victims.
3. Accident occurred in March 2019 with 157 fatal victims.

previously certified aircraft model, when applicable.

- Providing difference requirements for the crews when necessary.
- Recommend Standard Operational Procedures (SOPs) for the new or modified aircraft model.
- Recommending minimum standards in emphasized areas (e.g., Flight Management System - FMS, Electronic Checklist, all-weather/low-visibility operations - LVO, etc.).
- Determining applicable requirements for pilot training, proficiency exams, and suitability maintenance.
- Analyzing aircraft compliance with operating standards according to current regulations, such as the Argentine Civil Aviation Regulations (RAAC) Parts 91[4], 121[5], and 135[6], in the case of Argentina.
- Defining the characteristics of devices used in pilot training, whether it is Flight Simulation Training Devices (FSTD), Full Flight Simulators (FFS), Flight Training Devices (FTD), or devices used for theoretical knowledge enhancement.
- Use of equipment or functions such as Electronic Flight Bag (EFB), Head-Up Display (HUD), Enhanced Vision System (EVS), etc.
- Recommending training for the certification staff in the maintenance area.
- Approving the Master Minimum Equipment List (MMEL).
- Evaluating technical and flight characteristic improvements that manufacturers incorporate into production aircraft (e.g., increased operational ceiling, equipment integration, Reduced Vertical Separation Minimum - RVSM, integration of autothrottle[7] into the autopilot system, etc.).

Additionally, if applicable:

- Recommend minimum training standards and the respective area of emphasis, verification of competences, and validity of cabin crew members (including difference training requirements).

The results of the aircraft's operational evaluation processes should be published on the aeronautical authority's website as an Operational Evaluation Report. This report serves as a reference for the certification processes of air service operators, approved training organizations, and aeronautical personnel certification, among others.

Flight evaluations to validate the aircraft type certificate:

These are tests conducted for the purpose of demonstrating or verifying compliance with applicable airworthiness standards to ensure that each aircraft conforms to its type design and is in a condition of safe operation.

The process begins with the participation of a team of specialists based on the technical complexity of the aeronautical product to be certified. It may cover areas such as structures, propulsion, systems and equipment, avionics, performance, in-service difficulties, continued airworthiness, and flight tests. The first step is to prepare a program of activities that includes flight evaluations.

Execution of flight tests

The flight test program generally consists of verifications of the most critical performance and flight characteristics. In addition, verifications of specific systems may be included in the program.

Analysis of the certification documentation or known aircraft background can raise suspicions about marginal compliance with certain requirements. This is why areas of doubt must be explored, and determinations must be made regarding the acceptability or non-acceptability of the matter or raise objections and discrepancies.

In some cases, significant modifications may be required, while in others, they may be of lesser magnitude, such as including information in operational publications. As an example, two cases are presented below.

1. The case of the validation of Boeing 707 in the United Kingdom (UK)

After conducting the analyses and certification flights, the Civil Aviation Authority of the United

4. Flight Rules and General Operation.
5. Requirements for Internal and International Regular Operations: Supplementary Operations.ts for Internal and International Non-Regular Operations.
7. Automatic Thrust Control System.

Kingdom (CAA) demanded the incorporation of a device that restores stability to acceptable levels in the flight control system to enhance low-speed stability with flaps extended. This aircraft does not exhibit any stability issues except in the fully extended flaps configuration during decelerations to certify the stall speed. During these deceleration maneuvers, uncommanded pitch-ups occur, which must be aggressively counteracted by the pilot to prevent reaching values that could compromise flight safety.

2. The case of the validation of McDonnell Douglas MD-88 in the Argentine Republic

During the validation process of the aircraft that would become part of Aerolíneas Argentinas' fleet, a formal request had to be made to the Federal Aviation Administration (FAA) to include a warning in the Flight Manuals about a significant instability phenomenon due to compressibility effects within the flight domain.

This phenomenon occurs at Mach 0.83 (maximum operational Mach 0.84), and at this speed, applying rudder input to one side (left or right) results in reverse induced rolls, contrary to what happens in the rest of the flight envelope.

The Manufacturer's Flight Manual did not provide any warning about this issue, which meant that flight crews were unaware of this anomalous behavior. After lengthy discussions, the FAA acknowledged that pilots should not be unaware of this phenomenon, and if they ever entered the range of these speeds, they should know how to apply the controls to exit such a situation. Eventually, the Flight Manual for Argentina was modified, and a warning about this phenomenon, known as "rudder reversal"[8] was added

CONCLUSIONS

Certification processes and their interfaces with aircraft operation and maintenance are specific responsibilities of aeronautical authorities and the industry. It is essential to broaden the perspective and strongly consider the lessons learned from past accidents.

The aviation industry is advancing rapidly, and aeronautical authorities have a duty to keep pace with this increasingly complex technological environment.

Moreover, to achieve significant improvements in reducing the accident rate, a better understanding of the issues affecting human performance is required. Manufacturers face the challenge of developing systems that are less prone to errors, and procedures must be more explicit and robust concerning the range of skills and techniques of operational personnel (including cabin crew) and maintenance staff.

8. This phenomenon is a high-speed characteristic inherent to the entire MD 80 family.

INTERVIEW WITH ENGINEER MIGUEL LABORDE

“A Wise Government Policy to Produce Hydrogen from Natural Gas”

In order to analyze hydrogen transportation systems, look into strategic countries, and the need for human resources in the development of research, among other things, the Transportation Environmental Safety Area technical team spoke with Engineer Laborde about the current hydrogen scenario in Argentina.

"Argentina has plenty of natural gas", says Miguel Ángel Laborde; emeritus professor at the School of Engineering of Buenos Aires University (UBA), a Ph.D. in Chemical Sciences of La Plata National University, a member of the Board of Directors and former chair of the National Scientific and Technical Research Council (CONICET). This is the conversation that we had with one of the main leaders on hydrogen issues in Argentina, who was invited in 2013 to be one of the contributors and authors of the "National Hydrogen Plan".

What is green hydrogen?

Before I respond, I should state that hydrogen is colorless.

Depending on how it is made, or what kind of energy source must be present for a reaction to happen, different colors are ascribed to it.

Hence, the idea of "green hydrogen" was widely accepted. It happens when water is the starting material, and the energy is generated through electrolysis using the wind, sun, or another renewable energy source, such as hydraulic or nuclear energy. That is, a significant amount of energy is provided to two electrodes in a water tank. The water molecule is broken by electric power, releasing oxygen and hydrogen without any carbon.

Green hydrogen is typically defined as hydrogen that was produced without the release of carbon dioxide, such as when using natural gas to produce hydrogen. The latter is referred to as "grey hydrogen," and hydrogen turns blue when carbon dioxide is trapped to prevent emissions into the atmosphere.

It is also called green hydrogen when it is obtained from biomass. Although it releases carbon dioxide into the atmosphere, when it grows and absorbs carbon dioxide, the cradle-to-grave effect would be zero carbon dioxide emissions.

After reading this introduction, we realize that since hydrogen must always be produced using energy, green hydrogen is that which is produced by water electrolysis utilizing renewable energies. Therefore, production energy is always higher than energy obtained from hydrogen.

How is it produced in Argentina?

Anywhere in the world, if the necessary resources are available, hydrogen production is simple. Water, an electrolyzer, and a power supply are required. When you have natural gas, it can be created by a procedure known as "steam reforming," which, together with electrolysis, is a fairly established technological method.

In Argentina, hydrogen is industrially used, and it is obtained through steam reforming using natural gas, with or without carbon dioxide capture.

How can green hydrogen be implemented in transportation activities? Which are the implementation stages?

Hydrogen, regardless of its color, requires an infrastructure to be implemented in transportation activities.

It may be used as a direct fuel —through combustion of hydrogen with air— instead of gasoline combustion.

There are two issues with this use. where energy is released and primarily lost through an exhaust pipe. The second issue is that at the temperature at which hydrogen and oxygen burn, nitrogen in the air reacts to produce nitrogen oxide, an orange-colored steam that eventually results in acid rain.

This type of use implies two problems. The "Carnot Cycle" is the first, where energy is released and largely lost through an exhaust pipe. The second issue is that at the temperature at which hydrogen and oxygen burn, nitrogen in the air reacts to produce nitrogen oxide, an orange-colored steam that eventually results in acid rain.

Hence, a fuel cell, a type of battery that is continuously fed with hydrogen and oxygen, may be utilized in conjunction with hydrogen to use it most effectively in transportation activities. Hydrogen reacts with oxygen forming water without combustion, and such chemical energy is converted to electrical power. The result is an electric vehicle that can be charged with hydrogen at a filling station rather than requiring it to be charged at 220V.

This is where the infrastructure problem arises. Hydrogen refueling stations will be needed, at a cost of approximately one or two million dollars each. In addition, Argentina is so vast that a major network of refueling stations will be required.

In which transportation mode would the implementation be more feasible and why?

Hydrogen would be used in heavy vehicles that need great driving range. This includes trains, trucks1 short-distance buses, long-distance buses, and so on. One hydrogen filling station at the terminals of the various

modes of transportation would be advantageous. However, this basically applies to heavy vehicles.

The use of biomass or hydrogen-derived biofuels for ocean liners, airplanes, and ships in general is being studied. Jet fuels based on full oil and kerosene are not an option.

What obstacles face the development and use of hydrogen?

In addition to the infrastructure of filling stations, the key obstacles to a hydrogen-based economy are hydrogen storage and transportation. Since it is a very light and not so dense gas, it may be leaked from all sides. It has a huge gas diffusion and it may even weaken the steel in the pipes. Although storage in solid materials is intended and is being intensively researched for transportation storage, there is still a long way to go.

The only options left are to store hydrogen as liquid or at a high pressure of about 700 bars.

The issue with liquid hydrogen is that it must be kept at such pressure and temperature —which is highly expensive— in order to liquefy at 20 Kelvin. It looks like this are the only two alternatives for hydrogen transportation.

Using a carrier molecule is a third option. For instance, ammonia is composed of one nitrogen atom, three hydrogen atoms, and zero carbon atoms. Thus, the plan is to create ammonia from green hydrogen, which will then be further broken down in the place where it will be used.

Which are the hydrogen transportation mechanisms now available? And the most feasible ones in Argentina

Pipelines may be used for short or relatively short distances. Pipelines used to carry natural gas, or trucks, may be used to carry hydrogen. The question is to consider the condition of those pipelines.

Another option for transportation is to combine hydrogen and natural gas. Compressed natural gas (CNG) and hydrogen may be used to power CNG-powered vehicles. These would be combustion vehicles similar to current vehicles, not electric vehicles, with a little less pollution.

What is the current regulatory framework in Argentina?

A hydrogen legislation was released in 2006. The Energy Department, which had the power to enforce regulations, never did so. To facilitate the introduction of hydrogen into the market, a "National Hydrogen Plan" was devised in 2013 in conjunction with the establishment of the "National Hydrogen Fund." It was abandoned after Mauricio Macri was elected president of Argentina. But it is currently being recovered.

The 2006 law expired, and went unregulated for 15 years. Congress is currently looking at a new regulatory statute.

Moreover, the "Hydrogen Roadmap" is being created by the National Department of Strategic Affairs. To this purpose, a selection process was put in place involving various consulting firms to obtain the roadmap for production, demand and the regulatory framework.

The CONICET research teams and a consulting firm teamed up, and we were chosen to produce hydrogen. Along with the Department of Strategic Affairs, we are currently addressing this issue.

Obtaining green hydrogen through electrolysis would prevent the emission of 830 million tons of CO2 yearly.

When gas is created using fossil fuels, CO2 is produced. In addition, substituting grey hydrogen globally would produce an extra 3000 TWh of renewable energy each year (similar to the current electricity demand across Europe). Although there are some concerns regarding production feasibility, these concerns will be answered as global efforts to reduce carbon emissions advance and renewable energy generation becomes more affordable.

Advantages of green hydrogen production

Argentina has chances for investment and growth due to the production of hydrogen, mostly because of its potential applications. Hence, in addition to the strategic discussion held between associated industries and scientific/technological institutions, the National Low Emission Hydrogen Strategy 2030, a public-private effort, has already been presented.

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

The interview was conducted by the National Department of Rail Occurrence Investigations of the JST, Eng. Diego Di Siervi.

TECHNOLOGY DEVELOPMENT FOR PROACTIVE PURPOSES

Portable Microscope to Analyze Wear on Rail Surfaces

We interviewed Engineer Maximiliano Zanin, Secretary of Investigation, Innovation and Graduate Studies at the Haedo Regional School of the National Technological University (UTN), to discuss the significance of the wheel-rail contact phenomenon in the railway field and on the development of an experimental portable microscope to examine rail profiles and wear surfaces.

How did you become involved with trains?

I became interested in trains when I was very young. In Villa Regina, my hometown in Río Negro Province, where trains were the long-distance means of transportation. In the 80s, when I was a boy, I eagerly awaited family members who were coming from Buenos Aires. Although 1000 km is not that far today, at that moment it meant waiting for our cousins "coming from far away", and who we got to see once a year. It was wonderful. Just like travelling by train to visit them, of course.

Later, I was always curious about seeing the routes, studying about train history, and the Argentine railway technology. Bit by bit, I was introduced to this world without being a railroader in the strict sense. Let's say that I see myself as a railroader by choice.

Which is your field of work in Mechanical Engineering?

I work both investigating and teaching. I analyze materials, mechanical damage, surface tear caused by wear, and evaluate solid lubricants or self-lubricants. All these lines of work target the industry in general, with a special focus on the transportation industry, but also on other applications.

What is your investigation focus in the railway field?

Railway transportation in Argentina has been slowly resurfacing in the last few decades. It is known that the proposed goal of our various country-wide projects is to increase the railway vehicles' speed and load capacity. Therefore, we need to study the various mechanical systems adapted to already existing technologies, including the study of wheel-rail contact.

What does the wheel-rail contact phenomenon mean?

This is probably the most characteristic phenomenon in railway research, since it crucially impacts on the dynamics of this means of transportation. It is a type of contact between metallic pair sets where the rail surface is harder than the wheel to increase its service life, since its maintenance and replacement involves more work than replacing the wheels.

Which are that the factors involved?

The nature of this contact is influenced by actuating forces, vehicle kinematics and contact geometry. The latter refers to a cross section of the rail and a radial section of the wheel. In addition, stresses may vary due to differences in curvatures in the contact profile.

Friction and wear in railway systems are caused by the relative movement between the wheel and the rail. These are associated with the type of material, the characteristics of the contact, the surface shape and topography. A freight train running in dry areas with sandy and windy environments is not the same as one running in wet or coastal areas.

It should be considered that surface unevenness can cause a random local contact with variations in the friction force, thus boosting an increase in the wear rate at the wheel-rail interface.

> ***"This is probably the most characteristic phenomenon in railway research, since it crucially impacts on the dynamics of this means of transportation"***

Why is the wheel and rail wear study important from a safety viewpoint?

Well, it's clear that from a safety viewpoint, the wear in wheels and rails could cause head checks, surface deformations, rippling, etc., causing an eventual cracking which may lead to unwanted outcomes.

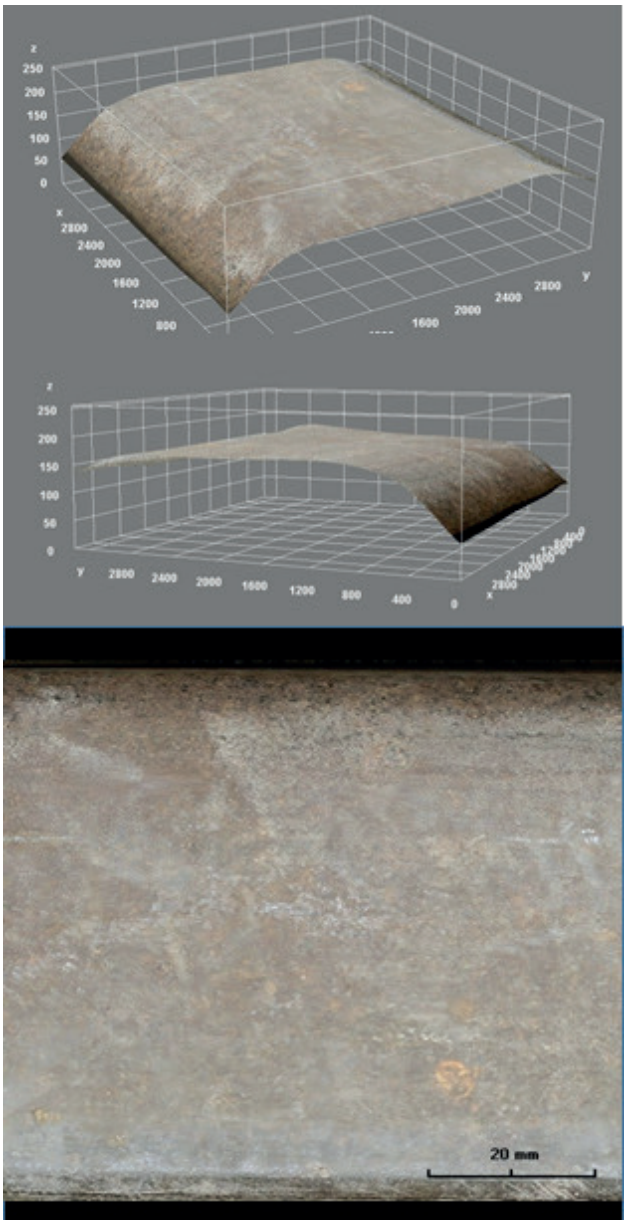
The rail wear study may provide valuable information at the time of examining contact conditions. It is estimated that rail wear is stronger in curves, railway switches, and rail connections. Additionally, predicting the wheel and rail wear is increasingly more relevant for the system performance based on design parameters, such as profile shapes for a specific track type, among other variables.

The study of wear surfaces in rails using high resolution imaging would clearly facilitate a determination of the different wear mechanisms and their causes.

About the latter, what is the purpose of the microscopic observation device developed by your team?

The development of an "experimental portable microscope to examine rail profiles and wear surfaces" is intended to examine rail profiles using digitally processed images which may be overlapped on the model of a new primitive rail. These images, when focused, have a capturing position, which allows for 3D modelling using actual images. Through this development, the surface and global geometry of the analysis area may be examined.

Figura 1. Imágenes de un perfil tridimensional y de la superficie de un riel elaboradas con técnicas de stitching y stacking



How did the idea come up and when did it start being materialized?

The idea came up by observing and studying critical wear areas in curves and rail connections. In 2016, with the recently created Wear and Solid Friction Group of the Railway Rolling Stock Associate's Degree course of the UTN, together with Engineer Nicolás Urbano Pintos[1], we completed a tridimensional lineal movement platform to capture images, which allowed us to compile and digitally process such images.

1. D. student in engineering with a specialization in signal and image processing at the Universidad Tecnológica Nacional (UTN), Facultad Regional Buenos Aires. From 2016 to 2021 he served as secretary of the Railway Rolling Stock Technicature at the UTN, Haedo Regional Faculty.

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> ***"Friction and wear in railway systems are caused by the relative movement between the wheel and the rail. These are associated with the type of material, the contact characteristics of the contact, the surface shape and topography."***

Cristian Donato, from the Instituto de Investigaciones Científicas y Técnicas para la Defensa, participated in the design and printing of 3D parts and was in charge of the mechanical assembly of the device

How does the portable microscope work?

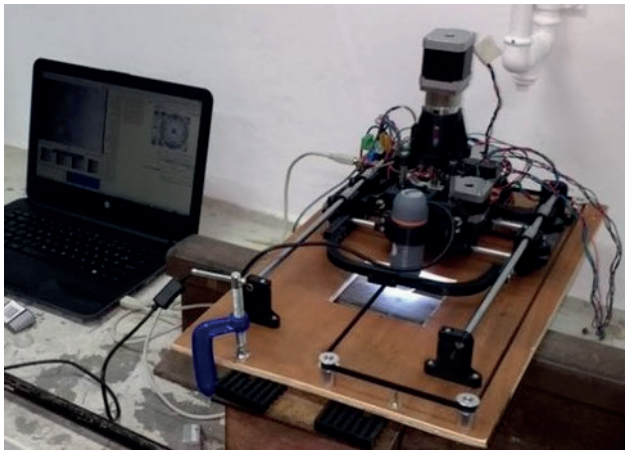
Engr. Urbano Pintos took the conceptual idea of the first ad-hoc microscope as basis to assemble a low-cost device, to examine rail profiles using digitally processed images which can be overlapped on the model of a new primitive rail.

At first, the idea was to create a good-resolution image using the stitching technique, through which multiple images are combined to create a high-resolution image by fitting together or overlapping individual images. Then, under a continuous improvement process, images started being processed using the stacking technique, though which an image is created based on a series of images of the same position, captured from different focus angles. This allowed creating a high-resolution image eliminating out-of-focus areas.

How is this device composed?

It is mostly made by parts that have been modelled using a 3D printer, with commercial stepper engines and a commercial USB connection camera. The idea was to create a low-cost device with a basic design.

Figure 2. General view of the device in a laboratory rail profile analysis.



Is the software used to examine images friendly for daily use?

It is still an experimental development. Various free trial softwares have been used, each having their own pros and cons. The faster processing software require more powerful processors, while the user friendlier software does not provide much information or based on the number of images captured, they do not properly "stitch" images resulting in a somewhat blurred panoramic image.

Could the device be used by any infrastructure staff member?

Of course. Any careful person with a basic knowledge of the computer programs applied may capture and process images on site. Although the analysis could be more feasible using higher-resolution displays.

Have tests or trial runs been already conducted?

Currently tests are only experimental. Although the equipment is conceived to be portable, some lighting adjustments are required. The capture of images with natural light needs to be improved to make the most of out the images that are taken, so that it is not difficult to create a global image

What were the results?

Test results were successful, although certain detail adjustment is necessary, such as adjusting light when capturing images on curved or shiny metal surfaces

What is the scope of this item?

The microscope, with a minor redesign and adjustment of its parts, may be a broad-scope device. In the railway field, it could also be used to determine the wear in the axles of assembled pair sets, tire profiles, roll bearings, etc. It may be used in the railway industry as well as in metal-mechanic or other industries, where knowing the wear of parts that are in contact with each other, or in constant friction, is required.

> ***"From a safety viewpoint, the wear in wheels and rails could cause head checks, surface deformations, rippling, etc., causing an eventual cracking which may lead to unwanted outcomes."***

Considering that safety is based on minimizing risks in ordinary work operations, what would be the benefit of implementing the use of this microscope?

Through this development, an inspection plan could be put in place, considering variables of train circulation on railway connections, curves, and track switch gear, etc., or give indications of wear on inner rail flanks which could be associated with lubrication issues.

Could the use of this device be implemented in a maintenance plan?

Sure. It can be implemented in all potentially critical areas, considering all associated variables, such as heavy load, and speed, among others. There could also be a compilation of data to assess the evolution of surfaces and contact profiles.

Do you think that, upon implementing the use of this microscope, we are going into a proactive system?

Yes, because an item like this, used, for example, for track inspection works would help obtain much more accurate information on the wear condition in curves, straight lines, rail connections, track switch gear, etc., from high-resolution images, which could be used to develop future maintenance plans, thus avoiding cracking or tearing that could trigger accidents.

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AN ESSENTIAL COMPONENT FOR SAFETY IN PUBLIC TRANSPORT

Estimate of the Minimum Demand for Tires in Public Passenger Transport

The study prepared by the National Department of Road Occurrences Investigation (DNISAU, Spanish acronym) of the JST carried out an exercise to estimate the minimum demand for tires calculated for public urban, interurban and tourism passenger transport.

Given the mission of the JST to promote actions that guarantee safety in operations, the relationship with the different actors in the sector is one of the fundamental resources to set the guidelines for the organization's activities.

In light of this, the DNISAU started a line of work that led to the creation of a safety study that examines the tire market for all public passenger transport services under National Jurisdiction. The provincial and municipal levels are included in the analysis when it comes to urban areas.

The study carries out an exercise of estimation of the minimum demand calculated for the case of public urban, interurban and tourist passenger transport, according to the characteristics identified as prevalent in the mobile fleet, both in terms of the technical category of the vehicles and the configuration of axles for a two-year cycle. The selection of these services specifically reflect the objectives and focus of the JST.

This article addresses the main aspects of the study published on the JST's official website. Among them, the conclusions regarding the functionality of the tires for the operation of the vehicles; the main characteristics of the activity segments; the method of estimating the minimum demand; the assumptions used for the estimation; and the results obtained for urban public passenger transport of municipal, provincial, and national jurisdiction, as well as interurban and for tourism under the national administration will be presented.

Segments Under Analysis

Urban public passenger transport

The data extracted from the Single Electronic Ticket System (SUBE, Spanish acronym) for the year 2019, when observing the set of administrative levels adhered to this system, show that urban public passenger transport is concentrated in the Metropolitan Region of Buenos Aires (RMBA, Spanish acronym).

Figure 1. Axle configuration, low-floor urban bus (national jurisdiction), 2021

Source: illustration extracted from the internet, 2021

Within the RMBA, those services operating in the national jurisdiction represent 44 % of the vehicle population in this area in relation to the other administrative levels (provincial and municipal). This level also includes services that operate outside this urban area, which are 2 % of the vehicle population. Regarding the services of provincial jurisdiction in the districts of the RMBA, these represent 32 % of the vehicles, while the municipal reaches 24 %.

The data provided by SUBE allows obtaining information corresponding to the vehicle fleets of businesses operating under provincial and municipal jurisdiction, at the federal level of those jurisdictions adhered to this system for the analyzed period, outside of the RMBA and the national jurisdiction. Together, these make up a population of 5.503 units.

Data from the National Commission for Transport Regulation (CNRT, Spanish acronyms) (2021) allow us to establish the characteristics of the vehicles that correspond to urban transport of national jurisdiction, a section on which this document deepens, given its importance in the service provision. In roadworthy vehicles, the prevalent coachwork type is the urban low floor, of reduced mobility with air-conditioning (AC), which reaches 44 % of the units. In the actual distribution, it is followed by the common urban and urban with AC that, as a whole, reach 50 % of the total units.

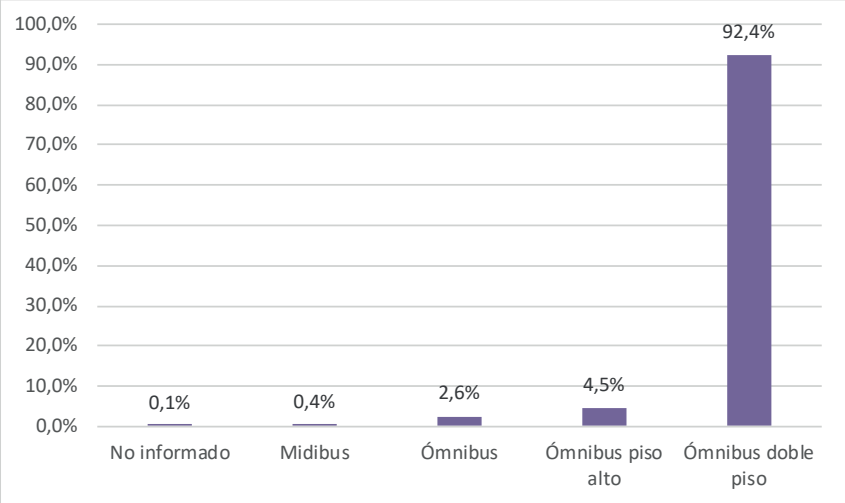
According to the studied information, demand estimation is made on the type of vehicles indicated as dominating. In these, the majority axle-configuration is the 1S-1D, which reaches practically the entire population. The 1S-2D and 1S-1D-1D-1D configurations are sporadic in the distribution (CNRT, 2021).

Interurban passenger road transport

Public services and tourism transportation make up the universe of mass passenger transportation services at the national jurisdiction level (Parodi and Sánchez, 2021). According to the analyzed statistics from the CNRT 2021, each of the units can exclusively conduct public services (21 %), exclusively provide tourism services (45 %), or provide a service-mix impacted by both activity groups (34 %).

In accordance with the regulatory framework that affects this subsector of activity, the pub-

Figure 2. Distribution of the type of coachwork corresponding to the mobile fleet of interurban public services of national jurisdiction, 2021



Source: own elaboration based on CNRT data, 2021.

lic transport service is one that attempts to satisfy the service provision with continuity, regularity, generality, binding force, and uniformity under equal conditions for users. Tourism service include all those who according to their programs are involved in this commercial activity (art. 13, art. 15, Decree 958/92).

In accordance with the observed data, the estimation of demand is made on double-decker vehicles (figure 3). The reason for this specific scope is determined by the weight of this type of coachwork, whose dominating axle-configuration is the 1S-1D-1S (CNRT, 2021), which obligatorily requires super wide directional tires on the front axle (SSTA Provision 294/11, art. 3).

The tourism service presents a more dissimilar distribution of fleet characteristics, locating vehicles with varying coachwork types in the technical categories M1, M2, and M3. Buses falling under the technical category M3 double-decker were chosen for the investigation. They feature a predominate 1S-1D-1S axle arrangement, are widely distributed (76.5 %), and demand super wide directional tires for the front axle (Documento Universal de Transporte, 2019).

As previously mentioned, this structural configuration requires a specific type of tire with unique properties and functions for each of the axles that make it up.

Directional tires

These are utilized in the tractive unit's front axle. They are specifically designed to provide the traction or grip needed to take the curves and counter-curves that arise along the way. In the case of urban transport, conventional-tire sizes are used, such as 295 mm. In the case of interurban, 385 mm (super wide).

Figure 3. Directional tires

Source: image extracted from the internet, 2021.

Traction tires

They are used only for the front axle by which the power and torque of the engine is applied to the road. They are recognized by the characteristic pattern of deep grooves, interspersed across the width of the tread that reduce the possibility of the vehicle skidding on slippery surfaces. In the case of urban and interurban vehicles, conventional-tire measures are used, such as 295 mm and 315 mm, respectively. Although equal in size to the directional ones for the first case, for both types of service the structural characteristics of the tire vary according to the required function in the vehicle.

Figure 4. Traction tires

Source: image extracted from the internet, 2021.

Free-axle tires

Both lateral braking forces and fluctuating loads must be withstood by them. They are designed to roll without torsional effort while withstanding centrifugal and compressive stresses. Sidewalls that have been reinforced aid in preventing housing damage when braking. These axles also use 385 mm (extra wide) tires for interurban transit.

Figure 5. Free-axle tires

Source: image extracted from the internet, 2021.

Minimum Demand Estimation Method

Standard model description

This estimate takes into account the entire two-year tire demand cycle in the examined industry sectors. The logic of this model recognizes that in all circumstances, after the directional axle's corresponding tires have served their purpose, they must be replaced by a new pair of tires for this axle. Note that the directional tires that reach their maximum mileage can be recapped twice and continue to be utilized on the traction- and/or free-axles according to the observed type of bodywork and service. Two one-year cycles of tire consumption are produced by this movement, which, depending on the circumstance, may result in a stock that lessens the requirement for new tires. Because it is assumed that there are no retread failures and that it is possible to achieve a total of two tread changes for each cover, we consider this estimating model determines the minimal number of new tires needed. According to the appropriate parameters for each activity segment, this standard description obtains particular content.

Urban Public Passenger Transport

Mobile fleet and kilometers traveled

Data for the number of vehicles and the number of kilometers traveled by urban lines operating at the national, provincial, and municipal levels and providing service inside and outside the RMBA for the year 2019 were taken from SUBE. The selection criteria for that year were thought to be the most reflective of typical operating conditions since they addressed the changes that the COVID-19 pandemic caused in transport's many sectors of business. All the industries included in this article are evaluated using the same criterion.

Axle configuration

According to information provided by the CNRT, the types of tires utilized correspond to the prevalent axle arrangement (1S-1D) (2019). There are six tires in total per vehicle.

Tire durability

A vehicle can travel 60.000 km before the first tire needs to be replaced, and it can run up to two retreads with an additional durability of 30.000 km each, according to the spare value of tires indicated in the cost structure calculated for a model company for the payment of subsidies (Resolution 422/2012).

Public Transport and Tourism with Interurban Passenger Vehicles

Population of public and tourism service vehicles

Data for the vehicle population of the nation's public and tourism services, broken down by domain and company for the year 2019, were submitted to the DNISAU by the CNRT. In accordance with the criteria established in the previous section, the population corresponding to the technical category M3 and double-decker configuration was selected.

Kilometers traveled, public services

The travel distance of each service corresponding to the various companies is taken into consideration as a reference, along with the weekly frequencies of summer and winter, which are discernible from the seasonality with which they are provided, according to the characteristics of the data provided by CNRT. In accordance with the frequencies set up for this time period, based on this information, the annual mileage of each service is projected (12 summer weeks for the period from December 15 to March 15 and the rest of the year, for a total of 40 weeks). The average number of kilometers traveled for each unit is then calculated.

Kilometers traveled, tourism services

Data on the origin and destination of tourism firms was submitted by the CNRT to DNISAU from the Documento Universal de Transporte (DUT). To determine the routes taken by each of the units in this calculation, the destinations of the places concerned must be homogenized. The services routes were identified in order to calculate the miles traveled by each vehicle after the geographic points were determined. The total mileage made per unit was added in the case of businesses that offer tourism-related services and public services.

Axle configuration

The predominant axle-configuration of technical category M3 (1S-1D-1S) is used as the reference to determine the types of tires utilized. The number of tires per vehicle is eight.

Tire durability

A unit's tires can be recapped twice and must go 110.000 kilometers before needing to be replaced, according to an estimate done by Casari and Baldini (2015). A maximum of 55.000 kilometers can be driven on each set of recapped tires. As stated in the estimate's assumptions, a strategy resembling that of urban services was used to determine that the retread has a 50% lower durability than its initial use.

Estimate Assumptions

Applied description of the model (Urban public transport)

To accommodate demand for this axle, the directional tires are replaced when they have traveled 60-000 km in total (Resolution 422/2012). Recaps of the set that reached its maximum mileage on the directional axle are now used for traction. The service life of these last treads is 30.000 km, with a maximum of two retreads.

Applied description of the model (Public and interurban tourism transport)

To meet the demand for this axle, the directional tires are replaced when they have gone 110.000 km overall (Casari and Baldini, 2015). The set is recapped to be utilized in the free for a total of 110.000 km after it has reached its maximum mileage on the directional axle (2 retreads). The drive axle has an initial performance of 110.000 km and is recapped twice. The service life of these last tire sheathings is 55.000 km per recap in all cases.

The outcome of the model used during the two years covered by this estimate may change according to a variety of factors. Depending on the level of stock availability and tire usage for the drive axle or free axle, according to the relevant activity sub-segment (urban or interurban). There are three possible scenarios based on their combination:

- The number of directional-recapped tires is insufficient to fulfill the drive- or free-axle replacement requirements. To account for the discrepancy, new tires are required.
- The quantity of directional-recapped tires covers the demand of the traction- or free-axle and are consumed in full. It is not required to purchase new tires in this instance to make up the difference.
- Although there is a surplus in its consumption that serves as stock for the second year of the estimate, the amount of supply of directional-recapped-tires is equal to the demand of the traction- or free-axle.

The tires can be entirely recapped twice and travel the maximum distance predicted for them in every situation. Because of the variability in this condition based on the type of use, tire quality, and carcass characteristics, an estimate must be made in this manner. As a result, this estimate establishes the absolute minimum values of tires that must be used without considering any potential reduction in performance or kind of wear.

Results

The Provincial fleet totals 10.918 vehicles, the Municipal fleet 10.791, and the National Jurisdiction's urban service 12.115.

The following table illustrates the total number of tires required on the market annually for the steering- and traction-axles in both years. The total number of directional tires that are readily available for use in a full cycle estimation on the drive-axle is also displayed in the stock column. In this case, availability is not discriminated by company.

"The directional tires that reach their maximum mileage can be recapped twice and continue to be utilized on the traction -and/or free-axles according to the observed type of bodywork and service."

Table 1. Absolute estimate of the tire demand for urban passenger public transport by jurisdiction and prevalent axle-configuration for the first estimation cycle, 2019

YEAR 1			
MUNICIPAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Within RMBA districts	9.942	195	9.548
Outside RMBA districts	3.494	101	3.264
MUNICIPAL TOTAL	**13.436**	**296**	**12.812**
PROVINCIAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Between RMBA districts	12.592	511	11.486
Outside RMBA districts	2.132	191	1.746
PROVINCIAL TOTAL	**14.724**	**702**	**13.232**
NATIONAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Inside the RMBA	13.316	551	12.090
Outside RMBA	504	154	180
NATIONAL TOTAL	**13.820**	**705**	**12.270**
COUNTRY YEAR 1 TOTAL	**41.980**	**1703**	**38.314**

Source: DNISAU-JST, own elaboration, 2021.

Table 2. Absolute estimate of the tire demand for urban passenger public transport by jurisdiction and prevalent axle-configuration for the second estimation cycle, 2019

YEAR 2			
MUNICIPAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Within RMBA matches	15.162	9.192	4.110
Outside RMBA matches	5.932	3.151	1.954
MUNICIPAL TOTAL	**21.094**	**12.343**	**6.064**
PROVINCIAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Between RMBA districts	18.592	11.186	4.210
Outside RMBA districts	3.254	1.682	604
PROVINCIAL TOTAL	**21.846**	**12.868**	**4.814**
NATIONAL JURISDICTION			
	TOTAL 1S	**TOTAL 1D**	**STOCK**
Inside the RMBA	24.478	11.862	9.356
Outside RMBA	710	277	60
NATIONAL TOTAL	**25.188**	**12.139**	**9.416**
COUNTRY YEAR 2 TOTAL	**68.128**	**37.350**	**20.294**

Source: DNISAU-JST, own elaboration, 2021.

The results of the estimate for interurban services under national control are shown in Table 3 and are broken down by the type of service they offer, the year of the estimating cycle, and the most common axle configuration. The entire number of directional, free, and traction-axle tires that the market is expected to buy in the year of estimation is shown in this Table, as in the situations before. The number of directionals recaps that will be employed on the free axle as a whole is represented by the stock. Once more, stock availability is not company specific.

According to the most common axle design, operational sub-segment, and estimation cycle, Table 3 shows the absolute estimate of the tire demand for interurban passenger transport in the relevant national jurisdiction in 2019.

The importance of tires as an essential component of vehicles has been shown throughout this text. The concessionaire businesses carry out maintenance during the useful life and renewal at the end of it, which raises the operating safety margins for road transport services. The DNISAU-JST tire demand estimation model establishes the bare minimum requirement for public and private urban and interurban road transport businesses so that the tire demand cycle can function in accordance with the intensity of their consumption under optimal performance parameters. For this to occur, it is required to provide the conditions that enable operators to buy a sufficient number of various tire types to ensure the continuity of services, particularly those of a public nature that play a strategic and essential role in the transportation of people.

Table 3. Absolute estimate of the tire demand for interurban passenger transport of national jurisdiction according to prevalent axle-configuration, operating sub-segment, and estimation cycle, 2019

	1S (385)	1D (295-315)	1S (385) Free axle	STOCK
PUBLIC SERVICE				
Year 1	1.876	1.096	0	390
Year 2	3.084	2.656	264	604
TOURISM				
Year 1	80	0	0	40
Year 2	582	160	28	251
MIXED				
Year 1	2.348	1.276	0	536
Year 2	4.306	3.420	429	979
TOTAL				
Year 1	4.304	2.372	0	966
Year 2	7.972	6.236	721	1.834

Source: DNISAU-JST, own elaboration, 2021.

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2022

The Permanent Observation Topics are a list developed by the Transportation Safety Board (JST) that identifies and lists the key issues for proactive action in the management of safety whose resolution will contribute to the most effective and efficient operation of the State's safety management system (SMS).

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