

## APPLICATION OF INNOVATIVE NEUROSCIENCE TOOLS TO MITIGATE THE IMPACT OF HUMAN FACTORS IN AVIATION

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**Abstract:** *Innovative assessment tools based on neuroscience can be powerful tools for developing critical competencies among employees in the aviation industry. This new branch of science leads to a more vibrant understanding of the biological processes involved in learning, the relationship between the cerebral hemispheres and sensory dominance, the impact on cognitive control, the meta-concept of learning ability, personal motivation, and social and emotional learning. Some neuroscience tools can measure individual risk of human error, which directly affects all aspects of human factor, aviation safety levels and risk management.*

**Key words:** *Neuroscience, Competence assessment, Aviation industry*

According to a report by ICAO (International Civil Aviation Organization), the aviation industry's impact on society is very positive. It contributes to the transportation of health care and food supplies to remote communities and delivers humanitarian aid in emergencies. In remote or peripheral regions, air transport provides vital links that are not possible with any other modes of transport. Aviation offers educational opportunities for students around the world. It improves the quality of life by providing an opportunity for cultural exchange and increasing intercultural interaction and awareness.

The aviation industry is a source of significant economic activity, creating jobs based on passenger services at airlines, airports and air navigation service providers. Aviation directly creates jobs in the manufacturing sector (those companies that make aeroplanes, engines, and other vital technologies). Indirect impacts of the aviation industry include employment and economic activity generated by suppliers to the aviation industry: fuel suppliers, construction companies, suppliers of sub-components used in aircraft, manufacturers of goods sold in airport retail outlets, and a wide variety of activities in business services. According to ICAO, in 2016, nearly 11 million indirect jobs were supported globally by companies in the aviation industry purchasing goods and services.

Air cargo services are another essential part of the industry. They are the only way to deliver goods for perishable products and in remote regions. Today, aviation companies operate in a highly competitive and rapidly changing business environment that requires competitive and efficient business solutions. What made the business successful in the past is not efficient nowadays. The new reality urgently requires companies to find a way to become more agile, flexible, and ready for change to stay in the market and grow.

Today, we stand on the brink of the Fourth Industrial Revolution, which has fundamentally changed how we live, work, and connect. This technological revolution is



based on the rapid development of digital, physical, and biological technologies, which presents new challenges for businesses and consumers.

Two main factors drive the aviation industry's progress:

- Technologies
- Human factor

The interaction between these interrelated factors determines the future development of the industry. Technology is essential for the further development of the aviation business. Robots in terminals at Frankfurt Airport, Incheon Airport, Munich Airport, and Heathrow are becoming more common. Other airports, such as The Hague Airport and Hong Kong International Airport, are focusing on improving the efficiency of the baggage handling process by improving ergonomic working conditions for ground staff. Autonomous vehicles help customers make tight connections through an airport, deliver delayed luggage to customers, or transport aircraft parts to airports. Frankfurt Airport recently completed a test of a hybrid aircraft at Terminal 2.

Recently, the aviation industry has focused on the full potential of artificial intelligence (AI). Both airports and airlines are adopting chatbots to communicate with passengers and improve operations and services. The benefits to passengers include disruptions, real-time updates, reduced baggage delay time and pers, and information analysis. The development of 5G technology positively impacts the airport's customer experience.

Biometric technology is another trend whose full potential has yet to be realised. This topic was discussed at FTE Global, 1-2 September 2020, where case studies and lessons learned through its implementation were presented.

Expectations for 2020 were that more airlines would adopt facial recognition mobile apps to make the check-in process more accessible for passengers. Unfortunately, the Covid-19 crisis has limited the implementation process. This gives biometric technology proponents time to focus on standardization-based misconceptions, privacy issues, integration, security, legacy infrastructure, and building trust among all stakeholders.

Technological advances will completely change how airports and airlines support passengers with reduced mobility (PRM) and special categories of passengers by incorporating robotic elements into wheelchairs to enable them to move safely and independently through airport facilities. Technology is critical, but the most important thing is the employees who can ensure the safety of the passengers. The expansion of technology requires well-trained, experienced and competency-oriented personnel. Because of automation, 60-70% of low and middle-skilled employees will lose their jobs within the next ten years. This situation will require gaining new competencies and further development. In the competition between humans and artificial intelligence, people must perform cognitive processes such as making predictions and future forecasts. They must perform counterfactual thinking, evaluate alternative outcomes, recognise patterns, and solve problems sophisticatedly. Dr Vermeulen shares that nowadays, the average reader reads 200 words per minute with a comprehension of 60%, but future readers have to read 1000 words per minute with 85% comprehension.

The human factor is often associated with mistakes, incidents, costs and errors, but it also affects all humankind's positive aspects.

Bastian, Delta's leader, shares: „*Our leading source of innovation is our people. Our people can spend some of their time collecting tickets and scanning boarding passes, but they are too talented for that.*”

Any innovative technology can be effectively implemented, and corporate strategy can be achieved only through a competent and motivated workforce. Organisations can have a successful and sustainable future if they recognise the critical role of people. The management must invest much time, effort, and finances in people's development. Increasing the workforce's value leads to better results, higher satisfaction, higher motivation and engagement, and higher confidence. All these things lead to tangible and intangible benefits for business, build a solid competitive advantage, and contribute to society.

In the wake of COVID, safety concerns in the aviation industry have grown significantly. Many employees who were released or did not fulfil their functions and duties for an extended period had to recover their skills and competencies quickly. This happened with somewhat limited access to active practice. A significant reduction in work activities negatively impacts individual and collective skills and competencies, decision-making, task accuracy, situational awareness, and information exchange processing. As a result, the expected risk of human error has increased significantly.

Human resource professionals are looking for alternative, innovative and effective ways to improve employees' competencies and make them more flexible and adaptable to the continuous changes in a demanding environment.

In his book: „Exponential Organizations: Why New Organizations Are Ten Times Better, Faster, and Cheaper Than Yours (And What to Do About It),“ Salim Ismail states that in 10-20 years, many of the -big corporations will not be in a global market. He asserts, „Today, the only constant is change, and the rate of change is increasing. Your competition is no longer the multinational corporation overseas, and it's now the guy or gal in Silicon Valley or Bandra (Mumbai) garage using the latest online design and cloud printing tools, their latest innovation.“

This requires the development of new key technologies supporting information, such as data science, 3D printing, nanotechnology, and even aspects of energy. The changes in the perspective of the workforce are also crucial, such as:

1. Shared resources
2. Staff on demand
3. Community and crowd

Aviation is an industry that depends on technology and innovation as much as it does on the human factor. The case of the Boeing 737 MAX technology defines the significant importance of the human factor in safety through the lens of decision-making.

The importance of people in the aviation industry is growing, and the time is near for them to be recognised as the most critical asset for organisations. Changes in management structures (flat organisations) and work organisation (more autonomy and flexibility of employees, but also more responsibilities), process reorganisation, digitalisation and technology development, and last but not most minor, building new skills and competencies, implementing new leadership styles, and continuous learning will be the main factors for survival and success.

As Dr. Pepina Miteva (2020) defined in her dissertation, „an innovative and successful business strategy can only be effectively implemented through a competent workforce“. Organisations in the aviation business that understand the critical role of people and their development will achieve success in the future.

The rapid development of technology is constantly changing the design of workplaces. The future will require different competencies, and humans must compete with artificial intelligence. To be adequate in the labour market, people must unlock and develop their brain potential.



In the Internet era and information overload, accessing, selecting, and analysing information quickly and smartly is critical. Neuroscience is focused on mechanisms that influence brain functions and the learning implications of different brain regions.

The exponential development of Neuroscience over the last two centuries, especially in the fields of behaviour and cognitive Neuroscience, has allowed the development of individuals and organisational human capital.

Adaptability, Agility and flexibility are becoming increasingly important due to the continuous changes in the aviation business environment. However, organisations can only be flexible if the people who work there are flexible. The term „agility“ refers to „the power to move quickly and easily“ and „the ability to think and draw conclusions quickly“. As organisations become more complex and dynamic, people's ability to learn from experience becomes paramount. The traditional concept of learning does not consider factors such as the driving forces that enhance the performance of people's brains or the neurophysiological components of a person's neurological design and the interaction between these factors. Some leading companies have already used the concept of learning agility – learning from experience and applying that learning to new and stressful circumstances with a focus on further improvement. This can be the main criterion for talent development initiatives or the definition of high potential in the company.

Brain power is the primary human competitive advantage in the era of the Fourth technology revolution. The brain's primary purpose is to let people survive in any circumstances. It reflects on two levels:

- A physical level – it regulates bodily functions and is directly involved in a human's overall health condition;
- A mental level is related to a person's ability to adapt, survive and thrive in a continuously changing world. Staying competitive in today's business world requires a fierce ability to learn, improve, and adjust. „The ability to learn is a meta-concept reflecting a constellation of individual characteristics and attributes that enable people to develop or refine their job-related knowledge and skills in response to changing job demands and to improve their performance.“

Prof. Dr Nick Van Dam (2017) states that learning and development have become more strategic in many organisations as shareholders increasingly consider the role of intangible assets when they value organisations. Based on her experience in the field, she has noticed that most of the widespread best HR practices in training and development are effective on a short-term scale.

According to Bear, Connors, and Paradiso (1996), a revolution in understanding how the brain works comes when scientists realise they must take an interdisciplinary approach, combining traditional techniques with new syntheses and perspectives. Neuroscience is a multidisciplinary branch of biology that deals with the structure, development, function, chemistry, pharmacology, learning effects, and pathology of neurons, as well as physiology, neurophysiology, chemistry, psychoneuroimmunology, and anatomy. This new branch of science has led to a more substantial understanding of the biological processes involved in learning, the relationship between the cerebral hemispheres and sensory dominance, the impact on cognitive control, the metaconcept of learning ability, personal motivation, and social and emotional learning. Nobel laureate Roger Sperry's discovery of the differences between the functions of the left and right hemispheres of the brain proves that people differ in their perceptions and learn in different patterns. According to Andre Vermeulen (2018), the founder of the NeuroAgilityProfile assessment tool, the science of learning is

fundamentally rooted in education and psychology. Scientific research focusing specifically on the brain provides a methodology that supports more direct observations of relevant variables, which serves to validate findings from the behavioural sciences. This is important not only for medical purposes (the pathology perspective) but also for behavioural and individual development purposes (the developmental perspective).

According to Andre Vermeulen (2018), brain flexibility and neuro-flexibility are central to human development. They are a framework for optimising performance, learning abilities, and information processing. Neuroflexibility is the ability to use the full range of a specific neurophysiological attribute of thinking or learning, depending on what function is required in a particular situation. The level of neuro-flexibility is determined by the interplay between the driver dimensions that optimise brain performance and the neuro-design components that cause neuro-flexibility. Both components affect the speed, ease, and flexibility with which people learn and perform.

Humans are constantly seeking a better understanding of their neurodesign. Bear, Connors, and Paradiso (1996) share that „it is natural to be curious about how we see and hear; why some things feel good, and others hurt; how we move; how we reason, learn, remember and forget; the nature of anger and madness”. In their book *Neuroscience, Brain Research*, they share comprehensive knowledge on existential topics. An exponential journey into the brain and its activities provide insight into the relationship between the brain and behaviour, the cellular and molecular basis of brain development, learning and memory as part of the most exciting frontiers of modern neuroscience.

The main disadvantage of neuroscience is the need for more awareness among non-neuroscientists of its application possibilities. This interdisciplinary science has great theoretical complexity, which limits its practical application within HR practices.

Dr. Vermeulen shares, „Much research has been done on neuroplasticity with positive and negative visual stimuli in animal models and humans. Neuroplasticity can be defined as the ability of the brain to reorganise, reform or form new pathways or synapses in different areas of the brain when exposed to various stimuli. Visualisation helps strengthen these pathways, whether positive or negative. Visualisation triggers a cascade of chemical events, releasing neurotransmitters such as dopamine, which bind to dendritic receptors on the cell body, causing a depolarising effect and producing an electrical signal. When this happens repeatedly, the release of dopamine concentration can increase slightly over time, strengthening pathways or creating new connections with more vital electrical impulses to and from different areas of the brain, such as the hippocampus, a structure associated with memory and emotion, thereby helping the individual to make associations between emotions, executive functions of memory (frontal lobe areas). This physiological response influences the outcome of the behavioural response, depending on the stimulus's positive and negative emotional gradient.

Cognitive neuroscience is a significant part of modern neuroscience, which includes cognitive science, psychology, education, and the science of learning. Recent neuroscience research has significantly enhanced our understanding of brain processes and functions. It answers questions like how the brain stores and processes information and how neural plasticity impacts learning and observable behaviour.

Despite recent discoveries about the brain, neuroscientists believe that humans still use up to 5 % of their brain capacity. Research on the structure and components of the brain shows that different areas and centres in the brain are responsible for various activities.

People use predominantly one of the brain hemispheres – the right or the left. The dominant hemisphere impacts how they access and interpret information, learn, and think.



People with the dominant right hemisphere are more creative, impulsive and practical, focused on the big picture. People with left hemisphere dominance are logical, theoretical and systematic, focused on details and facts. At a time, people use either the left or right hemisphere.

This aspect of our brain activity is called homolaterality. All people are born homolateral as they use one brain hemisphere at a time alternatingly. The whole brain has to work as one entity, not a single hemisphere at a time. There is a multiplication effect when humans use both hemispheres simultaneously. If people succeed in becoming bilateral (to use both hemispheres simultaneously), all neural systems and brain regions will synergise and create optimised brain performance. Laterally-integrated people have learned how to use the two brain hemispheres together as a whole system. According to Neuroscience and Dr Vermuelen, any disabilities, difficulties and diseases that people experience are symptoms of failure to achieve the integrated, whole-brain state. Homolateral people are confused by bilateral activities such as walking, swimming, running, or jogging; all require increased conscious effort and control, which causes them to switch off the right brain. Instead of relaxing and energising them, these activities cause further frustration and may lead to injury. Homolateral learners use mostly the back brain and usually experience difficulty fully internalising information.

Integrated people express themselves fluently through language area. „The laterally integrated person can process information simultaneously, with both hemispheres' switched on' simultaneously. They can move and think simultaneously, read with the writer's hand, speak with the listener's ear, and commit to any task while bringing the whole person to it. The integrated person thrives on the new, the spontaneous and the creative. Even the most straightforward undertaking becomes a joyful opportunity for full self-expression.“ – Dr. Paul Dennison.

Accessing both brain hemispheres simultaneously is vital, as the non-dominant hemisphere switches off during stress and new situations. In that case, the most important is whether people can access their dominant brain hemisphere through their dominant senses. This means that people have a dominant eye, ear and hand. Suppose their dominant senses are on the same side as their dominant brain hemisphere during stress, fatigue, or lack of brain fitness. In that case, they may experience a neurological hindrance that inhibits electrical transmission between the senses and the hemispheres. This is the main reason for experiencing human error. When the dominant senses are opposite the dominant brain hemisphere, there will be no neurological hindrance during stress, reducing the individual risk for error.

It was mentioned that people learn and think in different ways, and it can be expected that the combined learning activities do not provide the expected result for each participant. The aviation industry is highly regulated, reflecting a large amount of professional and on-the-job training for each position. Many experts in the field design special training courses called „Train the Trainer“, where trainers and instructors learn how to develop training concepts, design training, and use visualisation and tools. What must be noticed is that people are different and process information differently. Any learning activity should include knowledge of the three modes of learning: reading, listening and practice (visual, audio and kinesthetic learning).

In the long term, the results of the training activities could be more sustainable, competency-based and practice-oriented. This is a severe concern for an industry like aviation. Based on research by Krassimira Karadzova for her Master's thesis at the London School of Business and Finance (2020-2021), the percentage of experts who still believe

that current HR practices in training activities produce the expected results is meagre (between 32 and 35%). The remaining HR experts believe that the established training activities do not achieve the expected results (between 10 and 22%) or partially cover the expected results (between 45 and 55%). This is a strong message from the aviation HR community that current practices are outdated and should focus on finding new, innovative alternative practices to meet the demands and expectations of today's challenging environment.

As an expected result, the group of HR experts who have already sought further development of HR practices is very high (65%). 25% of HR professionals are willing to try something new but have yet to start the process, and only 10% of the survey participants believe that current practices can be applied to the challenges ahead.

Innovative assessment tools based on neuroscience can be a vital instrument for better outcomes and enhancement of HR practices by building new competencies among employees to meet future skills demands and be in compliance with corporate strategy. The neuroscience-based tool ensures higher efficiency of investments in human resources by supporting competency-focused and based recruitment, performance appraisal, training, career development, succession planning, and supporting corporate strategy for better business results.

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