HUMAN PERFORMANCE OPTIMIZATION CONCEPT DEVELOPMENT AND APPLICATIONS IN THE MILITARY FIELD

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In these times, dominated by accelerated cognitisation and sophisticated automation, rapid development of computers and multiplication of forms of communication, the human factor seems to have a secondary role. From our point of view, this is just an appearance, because the new cognitive instruments do not replace, but mirror and simulate aspects of people's higher psychic functions, acting as a multiplier for talented, educated and original minds. The concept of Human Performance Optimization (HPO) represents a systematic effort to use the latest technologies and knowledge to achieve the maximum performance of individuals, teams and/or organisations. At the same time, HPO is an ethical way to optimize technological synapse between the forms of artificial and human intelligence.

Keywords: Human Performance Optimization; resilience; risk factors; countermeasures; technological environment;

INTRODUCTION

Currently, there is intense pressure on human resources due to technological and social progress, as well as the prospect of accelerated development of artificial intelligence, robots and drones with increasingly autonomous functions, along with other emerging technologies. In the military field, an integrative vision of the role of the human factor, taking into account the constant need for improvement, the impact of the technological environment and new forms of conflict, has developed since the first decade of the 21st century.

Technical-scientific progress in the field of national security has forced the reconceptualization of human performance, considered to be "the ability of the person, as a unit and biological entity, to cope, to adapt to special conditions, conditions that exceed the 'functional parameters' for which man is ontologically and genetically conditioned.

Technical-scientific progress in the field of national security has forced the reconceptualisation of human performance, considered to be "*the ability of the person, as a unit and biological entity, to cope, to adapt to special conditions, conditions that exceed the 'functional parameters' for which man is ontologically and genetically conditioned. Exceeding the parameters can be adverse (extreme environmental conditions, high stress, etc.) or intentional (performance sports, physiologically or mentally demanding activities, etc.)"* (Marin, de Hillerin, Marin, Vizitiu, Nistorescu & Vizitiu, 2015, pp. 107-113). By definition, the *concept of optimising or increasing human performance (Human Performance Optimization/HPO)* emphasises the fact that it is addressed to healthy people, an essential particularity that differentiates it from a preventive, diagnostic, therapeutic, regenerative or aesthetic approach: "*...is an emerging field that aims to explore medical or rehabilitation therapeutic methodologies, such as strategies, drugs and external artificial prostheses whose main purpose is to compensate for the diminution or lack of a function, in order to increase/augment the physical and cognitive abilities of healthy individuals, beyond the characteristic level of physiological performance in healthy conditions"* (Di Pino, Maravita, Zollo, Guglielmelli & Di Lazzaro, 2014, 8: 109).

The HPO concept focuses on physical, cognitive and social performance and has three main interconnected objectives of interest and action:

- professional excellence (zero errors) and the culture of safety at work (zero accidents);
- resilience and endurance (in the case of demanding professions – maintaining the quality of the prolonged professional act and/or in adverse conditions by increasing the functional reserve and the capacity to manage stressors);
- preventive, protective strategies and countermeasures to professional risk and aggression factors (prevention, rapid recovery, active longevity, quality of life).

The concept of human performance optimization was operationalized in 2005, being highlighted in the report "Human Performance Optimization and Military Missions".

This vision is both a new chapter in which the human factor is adapted to national security requirements, and a forward-looking approach that takes into account estimates of the role and technology of the military in the 2050s.

ETHICAL APPROACHES AND APPLICATIONS OF THE *HUMAN PERFORMANCE OPTIMIZATION* CONCEPT

United States of America

The concept of *human performance optimization* was operationalized in 2005, being highlighted in the report *"Human Performance Optimization and Military Missions"* (Russell, Julkley, Grafton, 2005). The merit of this document is the realization of a unitary selection of similar concepts presented in the past years, but adapted to a new post-bipolar security environment, marked by the terrorist attacks of September 11, 2001. In this report, the human performance optimization was defined as "*application and the administration, in a relatively precise, controlled and combined manner, in the short or long term, of substances or devices in order to optimize the performance of a person or military group (units)"* (Ib.).

The consequence of this report was the request to organize in 2006 the conference "*Human Performance Optimization in the Department*

of Defense: Charting a Course for the Future", whose aim was to develop a strategic plan for the implementation of the concept of "*Human Performance Optimization (HPO)"* at US Department of Defense (DoD) level. There were five working panels – food supplements and other methods of self-improvement, leadership and teamwork, physical training, devices, innovative approaches – whose presentations were used to to develop a general framework, used in the next day, during a simulated conflict scenario (Muza, Roussel, 2018).

Significant progress was made in 2008 with the establishment of the 711th Human Performance Wing (711 HPW), located at Wright-Patterson Air Force Base. The mission of this unit is to promote and develop solutions designed to improve human performance for military personnel operating in the air, space and cyberspace, through research, education and counseling. The main areas of interest are the advanced health assessment (physical, psychological, cognitive, behavioral) and the performance of seafarers, human-machine collaboration, protective and resilience strategies, education and training (AFRL).

The unit responsible for HPO concept implementation in the US Navy is the Naval Medical Research Unit (NAMRU-D), a world leader in aeromedical training and toxicology.

Moreover, an important US institution involved in assessing the evolutionary trends of the security environment, anticipating combat needs for the next 15-30 years, in developing advanced combat programs and which has an HPO dimension is the United States Marine Corps Warfighting Laboratory/Futures Directorate (MCWL). In this body, we highlight the project *The Marine Corps Science Fiction Futures*, which aims to combine the predictions of the evolution of conflicts with creative sci-fi thinking.

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Other institutions involved in promoting HPO in the US military are: The 18th Aerospace Medicine Squadron, through human performance training teams (HTPP), the Directorate for Biosystems and Human Performance Training (HPTBD), Human Performance Resource Center-HPRC, an educational component of the Military Health and Performance Consortium (CHAMP), the Brain Fitness Center (Walter

Reed Military Hospital), the Center for Augmented Performance (West Point Military Academy), the Collaborative Technology Alliance for Cognition and Neuroergonomics.

Along with these permanent bodies, multiple military-civilian research partnerships have been developed, especially with universities or corporations.

A new vision of human factor optimization was articulated in 2014, through the implementation of the *"Human Dimension"* program, a component of the Force 2025 vision. The widespread implementation of the HPO is considered to be part of the response to the flexibilization of military forces in a rapidly changing world with complex dynamic and a high degree of uncertainty.

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The aim of this initiative was to establish a general framework for the evaluation, integration and synchronization of training and educational, scientific and technological resources, holistic medical approaches and human resources policies, programs, etc. in order to support the military professions. In this document, the HPO was defined as "*a process in which emerging knowledge, skills and technologies are used to enhance and maintain the individual capabilities of the military and military organizations to perform essential tasks"* (Army.mil).

The medical initiatives promoted by President Barack Obama were another opportunity for the integration of HPO into the military, for example the *BRAIN* (2013) and Precision Medicine (2015) initiatives. Although not directly aimed at optimizing performance, a number of military research topics have been able to be advanced and received funding under these initiatives.

In retrospect, we can distinguish three complementary approaches – maximising functional optimization in the case of a biological system, cyborgisation (use of human-machine interfaces, exoskeletons, military robots) or maximising psychological (individual) or sociological processes (teams, larger groups). As will be seen, a separate segment will be represented by programs designed to improve sensory functions, cognitive and emotional balance, initiatives that we will detail below.

The first approach was based on the premise that the physiological thresholds of the cell and the biological tissue are finite and that attempts

to maximize performance can produce irreversible destructive changes, so the emphasis has been on identifying innovative approaches. For example, the *ElectRx* program aimed to improve physical and mental performance by accurately stimulating the peripheral nervous system. This program sought to develop neuromodulation and neurofeedback strategies that would allow for a faster recovery and optimization of performance (DARPA-1).

The "*In vivo Nanoplatforms"* program studied the development of new classes of adaptive biocompatible nanoparticles that allow for distributed, persistent, and risk-free monitorization both inside the human body (biological, in extension) and in the environment (DARPA-2). Another project, "*Safe Genes"*, explored the possibility of creating a set of modular and adaptable solutions to implement genomic editing technologies, including the correction of genetic defects or the insertion of genes that generate better phenotypes. (eg by using CRISPR – Cas9 technology) (DARPA-3).

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Probably the most visible and scientifically interesting are the programs designed to optimize performance by cyborgization. The *HAPTIX* program envisaged the development of neural interfaces used for bionic prostheses to provide feedback via a peripheral nerve implant (DARPA-4). This program complements the "*Revolutionizing Prosthetics"* initiative, in which two types of anthropomorphic bionic modular prostheses (DARPA-5) have been developed.

Another program is "*Restoring Active Memory" – RAM*, which aims to create a wireless implantable brain-computer interface, which can be used for both restorative purposes (medical, in the case of veterans with neurological injuries), as well as augmentative. Although some remarkable progress has been made, especially in the field of high-accuracy encephalographic analysis and microelectrodes, hippocampal implantable neuroprostheses are not yet used in medical practice (DARPA-6).

We also emphasize the *Preservation of the Force and Family Task Force (POTFF-TF) (USSOCOM)* program for the US Special Forces (SOF) military, dedicated to SOF fighters in their dual capacity as members of their own families but also of the military "*family"*. This program

aims to achieve a holistic integration of all the factors that contribute to achieving and maintaining performance over a period of two or three decades (considered to be the operational life of an SOF fighter). This program involves psychologists, marital consultants, coaches and trainers, doctors, priests, etc., in order to achieve a "*preventive maintenance"*, in other words, early identification, awareness, prevention, building resilience and strategies, coping, social and family reintegration, so as to prevent the occurrence of chronic problems.

The most important civilian US agency involved in HPO research is the National Aeronautics and Space Administration (NASA), especially through The Human Research Program (HRP). Particular interest is given to the factors that influence the health and performance of cosmic crews in conditions of prolonged isolation, exposure to cosmic radiation, biological effects generated by microgravity, etc.

Particular emphasis is placed on the psychological dimension, in particular the development of stress resilience and the improvement of collective cognitive and behavioural performance. Given that the profile of SOF missions involves long periods of family separation in sometimes very different geographical areas, involves clandestine and high-risk missions, the aim is also to optimize *"social performance"* in the form of establishing and maintaining open and fruitful relationships. especially within families. The HPO component mainly refers to performance nutrition, sports medicine, elements of sports psychology. The existence of a component that addresses spiritual performance, designed to "*improve essential spiritual beliefs/identity, values, awareness, relationships and experiences"* (Ib.) inside and beyond the religious experience, is remarkable.

Of particular interest is the possibility for other states or hostile entities to use various techniques to increase the performance of fighters, able to offer superiority over conventional military. In this regard, we note the statement of Undersecretary of State Bob Work (USA) in 2015 on the development by other countries of "*Enhanced Human Operations"* (Work, 2015).

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Other civilian US institutions involved in various human performance optimisation niches are Sandia National Laboratories,

Lawrence Livermore National Laboratory, Center for Applied Brain and Cognitive Sciences (a consortium between Tufts University and the U.S. Army DEVCOM Soldier Center).

Early exposure to this culture of improved performance since college education has a facilitating effect on the adoption and enrollment in HPO programs during military service. We mention some of the HPO centers in the American academic environment: the Fighter Human Performance Research Center (University of Pittsburg), the Human Performance Laboratory (Conneticut University), the Department of Health and Human Performance (Hudson University), the UCSF Center for Human Performance from California), Center for Advanced Bioengineering for Survival (GeorgiaTech), Brain and Cognition Research Laboratory (University of Illinois), etc.

Canada. In 2017, the report *"Identifying Ethical Issues of Human Enhancement Technologies in the Military"* (Girling, Thorpe, Auger, 2017) was published by officials from the Defense Research and Development Canada (DRDC). The main message of this document is that HPO applications in the military environment require a review of the policies, legislative environment, sets of values and codes of ethics currently in use, without which they will not be fully evaluated and operationalised by the armed forces. Defining the ethical framework from the conception of these technologies will allow a faster and risk-free implementation, so that the armed forces can maintain their competitiveness in front of their opponents. The report mentions 34 emerging HPO technologies, categorised by authors into three broad categories: physiology, computational/cognitive, automation/ robotics.

Launched in 2018, *The Innovation for Defense Excellence and Security* (IDEaS) (DND) program consists of several sections dedicated to human performance optimization, such as: increasing cognitive performance, predicting and optimizing military personnel performance, performance optimization in extreme weather environments.

In 2021, Defense Research and Development Canada (DRDC) released the report "*Soldier Information Presentation and Cognitive*

Load" (Hollands, 2021), which mentions various ways to improve the efficiency of military personnel by reducing the degree of physical and cognitive load and increase resilience, protection and mobility.

In the civil field, there is interest in the epidemiology of cognitive augmentation among students and the consequences on health, academic performance and ethics (Kudlow, Treurnicht Naylor, Xie, McIntyre, 2013, pp. 360-365). In this regard, we also highlight the establishment, in 2007, of an important center of neuroethics – The National Core for Neuroethics at the University of British Columbia (UBC).

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The United Kingdom has adopted the *OPSMART/Optimizing Human Performance Through Stress Management and Resilience Training* (Army.mod) program in 2018, with the aim of early detection of psychological abnormalities, increasing mental resilience, optimizing quality of life. The importance of developing mental resilience is emphasized, which has the role of helping to regulate psychological stressors and emerging emotions generated in conditions of operational stress, such as information and sensory overload, complexity, fear, anxiety, sleep deprivation, fatigue, time pressure. and extreme weather conditions.

In 2020, the UK Ministry of Defense, together with the Bundeswehr's Office of Defense Planning, released the report *"Human Augmentation - The Dawn of a New Paradigm"* (MoD, 2020), which looks at issues related to human performance optimization, necessary technologies, ethical and legal issues, implications for society and for defense. The main emerging technologies that can be used for augmentative purposes and relevant to military institutions are mentioned.

In 2021, the British Army published the report *"Future Soldier"* (British Army, 2021, p. 9), which outlines the directions for modernisation for the coming decades. One proposal envisages a plan *for "Health, performance and well-being"*, with the aim of gaining dominance in the physical, cognitive and social planes. The implementation will be carried out using specialised multidisciplinary teams (Force Mental Health Team), able to promote the mental health, well-being and performance of the military.

France, a member of the select club of nuclear nations, has the full spectrum of military specialties capable of operating in any physical environment and anywhere in the world. We mention, in particular, as an institution of excellence in the field of HPO, the Institute of Space Medicine and Physiology (MEDES), involved in the selection, training and post-mission recovery of French or the European Space Agency/ ESA astronauts.

In 2014, in the report "*The impacts of technological convergence on disarmament and arms control agreements"* (FRS, 2014), prepared by the Fondation pour la Recherche Stratégique in Paris, we find a section in which are discussed the methods to improve physical and cognitive performance and also the potential applications in the military field. Mention is made of research conducted by DARPA (USA), but also by France, such as exoskeletons, new pharmacological options with applicability in increasing stress resilience and neuro augmentation, brain-computer interfaces, new developments in neuroimaging and real-time performance monitoring, etc.

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In 2016, the journal *Études de l'IRSEM* of the renowned Institute for Strategic Research of the Military School of Paris (Institut de Recherche Stratégique de l'Ecole Militaire) dedicated issue 42 (Colin, 2016) to debating the sociological impact of the increase use in military of the HPO (originally, "*L'Homme augmenté, réflexions sociologiques pour le militaire"*). A number of areas related to performance improvement are also specified, such as synthetic biology, advanced biotechnology, regenerative medicine, bioinformatics or artificial intelligence.

In 2019, officials of the French Ministry of the Armed Forces (Ministère des Armées) stated that they intend to carry out research programs for *"augmented soldiers"* in order to achieve *"operational superiority of the armed forces in a challenging strategic context"*, while respecting the rules governing military, humanitarian law and *"the fundamental values of our society"* (E&T, 2020).

Germany attaches great importance to the social and academic impact generated by the use of nootropics, the approach being from the perspective of public health and academic ethics.

Germany is home to one of the most advanced HUP centers in Europe - The European Astronaut Center (EAC), located near Cologne. This ESA Center of Excellence is involved in the selection, training, medical support, supervision of astronauts, but also their families during training and in flight.

In the military field, we note the report "*Human Performance Optimization and Enhancement"* (MCDC), published in March 2021. It was carried out in a multinational program under the coordination of CDR. Dr. Christian Haggenmiller of the German Institute for Defense and Strategic Studies. The report seeks to provide a reasoned view and a stratification of potentially augmentative technologies from the perspective of interoperability and utility for modern armies in the context of possible conflict scenarios. Particular attention is paid to the standardization of terminology and ethical and legal issues from the perspective of the implementation of augmentative technologies.

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Israel is another state that has made significant investments in military performance improvement programs, supported by the import of state-of-the-art military equipment from the United States, the domestic defense industry and the exceptional research and technological base. A particular note is the psychological training techniques based on traditional cultural elements and the use of emerging technologies (artificial intelligence, military robotics, drones).

In academia, we note the interest in establishing an ethical and regulatory framework for neuro-augmentation, brain-computer interfaces, artificial intelligence, cybercrime (CSRCL), etc. The ethical dimension of neuroaugmentation is specifically analysed by a neuroethics subcommittee of the Israeli Academy of Sciences. Notable are neuropsychological research aimed at understanding the emotional underpinnings of the Israeli-Palestinian conflict, as well as the conditions that would facilitate a stable peace.

Australia has established, since 2017, through The Defense Science and Technology Group (DSTG), together with several local universities, corporations and other government agencies and stakeholders,

a consortium dedicated to applied research in the field of human performance for various specialties called the *Human Performance Research Network* (HPRnet). This network of experts is a pool for interdisciplinary teams participating in research projects focused on the application of HPO in the military and international cooperation. The areas of interest are vast, including optimising physical and cognitive performance, increasing resilience, fighting in extreme climatic environments and conditions, optimising nutrition and sleep, performance genetics, etc.

The Australian Navy has its own program dedicated to maintaining health and quality of life, called the *Navy People Wellbeing Program* (Navy.gov). This program has many of the features encountered in HPO – concern for mental health, quality of life, psychological resilience, optimization of physical performance, leisure, etc.

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Within the **North Atlantic Alliance**, in 2009 the symposium "*Human Performance Enhancement for NATO Military Operations*" was organized in Sofia. The purpose of the meeting was to explore the theoretical possibilities and ethical limitations associated with the HPO concept that can be applied in NATO operations.

The conclusions of this meeting highlighted the fact that performance-enhancing technology is not yet operational, no concrete research proposals are made, no ethical framework is established and no synergies are developed at the level of NATO Member States in this direction. The recommendations sought to clarify some theoretical issues and reduce the operational gap: establishing separate performance scales for fitness and health, developing a minimum ethical framework, implementation of HPO medical research programs between NATO member states, establishing a foundation from the implementation of HPO programs in the military environment (Sofia, 2009).

In 2017, the workshop *"Human Performance Programs in Special Operations Forces"* was held, hosted by NATO Special Operations Headquarters (NSHQ) (WHOOP, 2017). Decision-makers and scientists from 25 countries participated, with discussions evolving around

the establishment of common organizational platforms, terminology and indicators to be used in order to improve or start new human performance optimization programs for SOF operators.

In October 2021, the symposium "*Applying Neuroscience to Performance: From Rehabilitation to Human Cognitive Augmentation"* (events.sto.-1) was held in Rome. The scientific activities of this symposium focused on applications of the neuroscience in the military, the identification of emerging neurotechnologies, collaboration between researchers from NATO Member States in the field of applied neuroscience and neurotechnology for military personnel, other demanding professions or extreme environments.

In the autumn of 2022, in collaboration with the NATO Center of Excellence for Cold Weather Operations, the symposium "Human Performance and Medical Treatment and Support During Cold Weather Operations" (events.sto.-2) will be held, which aims to develop activities biomedical research for operations in the Arctic and in adverse weather conditions.

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Several elements of interest included or associated with the HPO concept were also discussed at other NATO symposia: Human-Autonomy Teaming: Supporting Dynamically Adjustable Collaboration (NATO STO, 2014), Improving Human Effectiveness Through Embedded Virtual Simulation (sto.nato-1, 2014), Assessment of Augmentation Technologies for Improving Human Performance (sto.nato-2, 2017).

It is also relevant that at the beginning of 2022, on the website of the Science and Technology Organization (sto.nato-3) we can identify no less than 14 ongoing projects related to or with an HPO component. The topics addressed by these projects are diverse and have a pronounced multidisciplinary character, such as: monitoring pilots' stress through brain-computer interfaces, countermeasures to prolonged cognitive load and/or sleep deprivation in operational conditions, *"operational ethics"*, use of technology blockchain in the case of portable / mobile medical sensors, identification and prevention of organic damage caused by the use of high speed marine vessels, etc.

At **European Union** level, the concept has been debated mainly from the perspective of the ethical and legal framework. A first report, published in 2008, entitled *"Converging Technologies and their Impact on the Social Sciences and Humanities (CONTECS)"* (Andler et al., 2008), funded by the European Commission, mentions techniques for improving human performance as having an i ncreased scientific, economic and political potential. In addition to a state-of-the-art presentation of HPO techniques and methods, a number of observations are made on the ethical and legislative framework of the Community, the differences in scientific approach, public attitude and legislation encountered in the United States and the European Union, potential applications in the fields of education, medicine and public health or in the military.

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In 2009, the *Human Enhancement* report, prepared by the Science and Technology Options Assessment, a body in the European Parliament, deepened the community's interest in HPO. Human improvement is defined in this report *as "modification in order to improve individual human performance through methods based on science and technology in the human body"*, emphasising the distinction between non-augmentative restorative and preventive interventions, therapeutic and non-therapeutic augmentations (aesthetic or functional) (STOA, 2016).

The interest in optimizing performance also materialized in the form of projects that explored various elements of interest for the future of European society. Thus, the *ENHANCE* (FP6) project (Cordis-1) examined the ethics of performance improvement in four areas of application interest – neuro-augmentation, life extension, emotional enhancement, and physical performance. The aim was to understand the ethical and philosophical framework associated with the use of dual-use technologies, beyond a therapeutic approach.

The *EDC* (Cordis-2) project investigated ethical and socio-political issues encountered in neuroscience, including performance optimization as non-therapeutic, non-restorative and non-preventive methods.

The ETHICBOTS (Cordis-3) project addressed cybernetic issues related to cyborgization in an interdisciplinary manner, with research

including experts in artificial intelligence, ethics, philosophy of science, psychology and cognitive science.

The *EURON* project (Cordis-4) assessed various aspects of the use of robotics for human augmentation, including those related to invasive cyborgization through implantable brain-computer interfaces. Of particular concern was the unwanted scenario in which HPO technologies would allow for higher-than-human performance, which would be the privilege of only a small group.

The FABRICED (Cordis-6) project focused on the extent to which a number of emerging biotechnologies and technologies used for therapeutic purposes can be adjusted and reconverted as methods of augmentation (emotional control, cognitive improvement, improved physical performance). The ethical impact was studied from the perspective of individual autonomy, the nature of humanity and social justice and from the perspective of the health system.

The *ENHANCEMENT ETHICS* (Cordis-5) project discussed ethical issues from the perspective of the ethics of virtue and sought to identify and explore the philosophical dimension of the ownership of biological material relative to the idea of increasing human performance.

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Another major European project developed under the H2020 FET Flagship Project is the *Human Brain Project*, designed to stimulate and accelerate neuroscience, artificial intelligence and brain-machine interfaces (Human Brain Project). Two niche projects have been associated with this ambitious megaproject.

BrainScaleS (Brain-inspired multiscale computing in neuromorphic hybrid systems) (BrainScaleS today, 2020-2023), conducted between 2011 and 2015, involved 19 groups of researchers from 10 EU countries. The project aimed to understand and emulate the function and interaction between multiple temporal and spatial scales involved in information processing in the brain.

ROMANIAN ENDEAVOURS IN THE FIELD OF HUMAN PERFORMANCE OPTIMIZATION (HPO)

ROMANIAN MILITARY THINKING

The terms *"nootropic"* and "*nootropic substance"* were introduced into the medical vocabulary by the Belgian doctor of Romanian origin Corneliu Giurgea, who synthesised piracetam, the first pharmaceutical substance with nootropic properties, in 1964, for the Belgian Union Chimique.

Professor Corneliu Giurgea was a visionary who foresaw the development of the idea of neuroaugmentation from an empirical practice, almost clandestine, to an accepted medical niche. Professor Giurgea might be considered one of the forerunners of the neuroaugmentation field: *"man will not passively wait millions of years until the evolution it will give him a better brain".*

Currently, in the non-military field, we can mention the role of the National Academy of Physical Education and Sports (NAPES) in sports training and research on the factors that conditions human performance. Faculties of Physical Education and Sports, from all over Romania, in addition to their main tasks, teaching and training, have developed specialized centers for the study of human performance. As an example we can mention the Research Center for Human Performance (University of Oradea, University of Pitești), Research Center for Human Performance (University of Bacău), Center for Consulting and Assistance for Human Performance (Brăila).

In the field of psychology and neuroscience, we emphasize the impact of the Institute of Philosophy and Psychology "*Constantin Rădulescu-Motru"* of the Romanian Academy, as well as the Center for Personal Development, Counseling and Experiential Psychotherapy. We can mention also the Program of in-depth studies of Applied Psychology in the field of National Security from the Faculty of Psychology and Educational Sciences/University of Bucharest and the International Institute for the Advanced Studies of Psychotherapy and Applied Mental Health within the *"Babeș-Bolyai"* University, Cluj-Napoca.

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A special moment in the evolution of this field was represented by the selection process of the two Romanian cosmonauts, Dumitru Prunariu and Dumitru Dediu, the first performing the flight into the space (Intercosmos 40), in May 1980. Also, during this period, together with the Institute of Normal and Pathological Physiology, the biomedical and psychological experiments *"MIOCARD", "RHEO", "INFORMATION"* and *"IMMUNITY"* were elaborated (Prunariu, 1982).

After Romania's acceptance in the Euro-Atlantic structures, the National Institute of Aeronautical and Space Medicine "*Gl. Dr. Av. Victor Anastasiu"* from Bucharest, was modernized and brought to international standards, being able to carry out the medical evaluations of Romanian and allied pilots. Research in the field of aerospace and human performance in special conditions are shared with international comunity at national and international congresses, as well as in the Journal of Aeronautical Medicine and Psychology, established in 1997 (www.inmas.ro).

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Continuing in the same field of evaluation of human performance in special conditions, we can mention the Center for Hyperbaric Medicine and Diving in Constanța, this being an institution that can perform evaluations of diving and hyperbaric medicine, including hyperbaric therapies (medicinahiperbara.ro).

Within the institutions in the field of national security, an institution with a role in psychological assistance is the National Military Center for Psychology and Behavioral Health within the General Directorate of Human Resources Management of the Ministry of National Defense. Reorganized in 2014 and 2018, this institution carries out activities meant to prevent and combat operational stress specific to military missions, by psychological training of personnel and early identification of sensitive cases that can cause psycho-behavioural disorders.

Another institution with responsibilities in the field of behavioural optimization is the Psychosociology Center of the Ministry of Internal Affairs, which has the *"tasks to exercise the psychological act" and it is "vested with regulatory authority, guidance, coordination and control in the field of psychology"* (www.mai.gov.ro).

Other Romanian organisations involved in sports performance research are the National Institute of Sports Medicine (psychodiagnosis and care), the Research Center for Sports Problems and other departments and faculties of physical education. The activity of these organizations is supported by the Romanian Commission for Sport Psychology, a member of the Romanian Sports Science Council and of the European Federation of Sport Psychology and Body Activities.

ASPECTS RELATED TO THE APPLICATION OF HPO CONCEPT IN ROMANIA: STARWALKER CENTRE OF COMPETENCE WITHIN THE INSTITUTE OF SPACE SCIENCE (ISS), MĂGURELE, ROMANIA

The STARWALKER Centre of Competence is a collaborative scientific-technological platform aimed at stimulating and consolidating at the national level the field of Countermeasures associated with human spaceflight with human crew in adverse conditions, by developing appropriate solutions to counteract the physiological and psychological adverse effects caused by prolonged exposure to MICE (Micro-gravity, Isolated and Confined Environment). According to the constitutive document, the purpose of the STARWALKER Centre of Competence, which is based on national/international interdisciplinary collaborations both in the scientific and industrial sectors, addresses a particular niche as stated: *"assisting, training and recovering the human crew (astronauts) before/during/after prolonged space flight through assisted informational feedback, neuromuscular and mental control training".*

The STARWALKER Centre of Competence was set up as a result of a project funded by the Romanian Space Agency (ROSA) within the National Research Development and Innovation Programme STAR – Space Technology and Advanced Research.

The STARWALKER Centre of Competence was set up as a result of a project funded by the Romanian Space Agency (ROSA) within the National Research Development and Innovation Programme *STAR – Space Technology and Advanced Research. The legal host of the STARWALKER* Centre of Competence in Space Technologies in Support of Space Flight with Human Crew is represented by the Institute of Space Science (ISS) through the Space Applications for Human Health and Safety Department located in Măgurele, Romania.

The projects developed within the STARWALKER Centre of Competence integrate the interdisciplinary expertise of experts in engineering sciences, human medicine, natural sciences, social sciences, while carrying out the entire engineering effort according to the Systems Engineering (SE) methodology, as a standard approach of the European Space Agency (ESA) in balancing the stakeholders' needs with technological progress and complexity.

The main objectives of the STARWALKER Centre of Competence are the following: to develop the national scientific and technological capacity to participate in manned space flight activities; to engage the Romanian research and industry community, and assist the latter in participating in ESA Programmes; to promote interdisciplinary public education and awareness activities in the targeted research field; to disseminate the results in scientific publications, conferences, thematic workshops and seminars; to establish contacts and cooperation with entities in Europe and in the world.

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The human performance applications developed in STARWALKER have strong potential for technology transfer for the realization of commercial products and services in the field of countermeasures to the space sector and, at the same time, to society in the form of terrestrial *spin-offs*. Among the communities that may benefit from STARWALKER results in society, we can mention the following target groups with an interest in increasing human performance: entities with demanding professions (army, firefighters, special forces, divers etc.); sport community; medical community on disease prevention and the health recovery of the workforce etc. Examples of *spin-offs* are applications designed to improve human performance in extreme conditions, especially resilience to physiological stress and maximal cognitive load for a long time in adverse conditions, rehabilitation and post-traumatic motor recovery, optimization in sports performance, deepening information management at the level of biological organisms etc.

Particular attention was drawn to the methods of neuromuscular assessment, training, recovery before/during/after space flight, being applied a specific training methodology based on various

types of real-time feedback (visual, auditory, haptic etc.) provided to the movement of the human subject to improve muscle strength, movement accuracy and quality. This type of methodology has been studied for a long time and is being evaluated in order to be tested in simulated space flight conditions.

Other activities aimed at developing an innovative myotonometer (i.e., *Mustone*) that characterises the mechanical properties of striated surface muscles by measuring mechanical impulse propagation along the muscle fiber (proximal and/or distal monitoring), as well as participating in international experiments in analogues of microgravity as Dry Immersion.

The *Embedded Emotion Assessment Application* aimed to create a video analysis solution with low energy consumption, designed to assess facial expressions in order to estimate the extent of adaptation to the daily schedule and to determine the psychological status of astronauts involved prolonged human space flights.

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The interest in evaluating the performance of astronauts was also reflected in other activities of identification and classification of non-invasive and non-contact indicators that allow the detection of language disorders. These indicators have been proved useful in assessing the degree of emotional impaired performance in real space flight conditions. The research involved specific investigations on the discussions of American astronauts in the *Mercury, Gemini and Apollo Programmes*.

Other activities focused on the connection between motor activity or mental exercises and brain functioning under different conditions depending on the quality and quantity of information provided to subjects (with/without feedback).

It were undertaken also initiatives to implement parallel computing methods using methods specific to artificial intelligence with low resources and time benefits designing technologies appropriate to the conditions and requirements imposed by their use in space flight.

A recent direction of research is the possibility of using non-invasive transcranial stimulation methods (magnetic, electrical, ultrasound or laser) for the therapy of pain during space flight and in accelerating post-flight neuromuscular recovery.

In the near future, together with universities and medical partners, it is desired to create a Centre for Occupational Health and Human Performance which will incorporate in its structure a department for health, countermeasures and performance in space flight and extreme environments (ESCAPADE). The centre considers in particular interdisciplinary research projects and applications in the field of medicine, psychology, engineering, sports, ethics. Particular attention will be paid to the development of strategies for the prevention and ethical monitoring of professional performance in order to raise awareness, identify and prevent neuro-psychological burnout at work, and to define organizational culture and institutional health strategies intended for the prevention of non-communicable diseases and individualized optimization of professional performance in the case of active persons (usual, demanding, special professions).

CONCLUSIONS

Based on the analysis performed, we believe that it is necessary to develop a particular national vision, to be substantiated on research that responds to intrinsic needs, as far as that goes the development and implementation of programs to optimize human performance for demanding professions. The existence of a Romanian civil tradition in the field of sports performance, corroborated with the capitalization of the original techniques of training and psychological protection represents a significant basis for the application of the concept of *Human Performance Optimization (HPO)* in one national HPO program. All this can be complemented by specific training methods and, possibly, the integration of some methods of traditional Romanian medicine, together with the experience of specialists, civilian and/or military doctors accumulated in international missions.

Given our approach, we advance the proposal to establish civilian and military institutions (departments, research laboratories, centers, institutes) dedicated to implementing the concept of *Human Performance Optimization* for demanding professions of particular importance.

The concept of *Human Performance Optimization* is an interdisciplinary field that can serve as a *"technological crucible"*

for cutting-edge research in medicine and psychology, technologies applied in emerging fields of artificial intelligence and related industries. Accelerated technological development has increased the likelihood of materialization of "*technological surprises"* based on niche breakthroughs, generating asymmetries in the information market. The ramifications of the mentioned fields are vast and present a special commercial and military potential.

The development of *countermeasures to the specific aggression factors* aroused by the demanding civilian and military professions, is another direction of capitalizing on the concept of *Human Performance Optimization*. This pragmatic approach, encountered in the case of special professions (astronauts, deep-sea divers, climbers, extreme sportsmen, Arctic explorers, etc.) can generate innovative solutions capable of "revolutions" in the field of weapons systems or can contribute to reaching a maximum threshold of human performance (*used in enhanced human operations*).

The concept of Human Performance Optimization is an interdisciplinary field that can serve as a "technological crucible" for cutting-edge research in medicine and psychology, technologies applied in emerging fields of artificial intelligence and related industries.

A more general approach allows the development of *countermeasures* in case of common situations frequently encountered in the professional environment (chronic or longer sleep deprivation, prolonged cognitive load, neurovisual fatigue, decreased operative performance during prolonged activities, decreased ability to struggle due to physical fatigue, etc.).

In particular, we emphasise the importance of epidemiological research and the identification of legislative and organisational measures, as well as countermeasures in the case of burnout syndrome. Although frequently invoked and studied in relation to the medical profession, it can be encountered (and, to the same extent, underdiagnosed) in the case of other professions, civil or military, of responsibility, precision and with major socio-economic impact.

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