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Interview

FROM AIR FORCE TO HYPERSONIC FUTURE: ÉLCIO GERÔNIMO DE OLIVEIRA'S JOURNEY IN BRAZILIAN AEROSPACE DEVELOPMENT (ENGLISH VERSION)

DA FORÇA AÉREA AO FUTURO HIPERSÔNICO: A TRAJETÓRIA DE ÉLCIO GERÔNIMO DE OLIVEIRA NO DESENVOLVIMENTO AEROESPACIAL BRASILEIRO (VERSÃO EM INGLÊS)

Dr. Élcio Gerônimo de Oliveira [1]

KVANTUM Technology & Innovation. Brazil.

Luis Alcides Brandini De Boni [2*]

Araucária Scientific Association. Brazil

The complete version of the interview is available at: https://youtu.be/FVvgNJ3ujlc?si=y4eSf-hXbZ08wfSF

*Corresponding author: *elcio@kvantum.com.br*

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ABSTRACT

Introduction: The interview with Élcio Gerônimo de Oliveira, conducted by reporter Luis, presents the professional trajectory of a Brazilian researcher with experience in the Brazilian Air Force and academia, focusing on space systems and hypersonic vehicles. **Objectives:** To document Élcio's career and contributions to Brazilian aerospace development, highlighting his transition from military to academic career and his participation in strategic projects, especially the 14X project. **Methods:** The interview was structured in thematic blocks, addressing the military career, academic experience, and, in greater detail, involvement in the 14X hypersonic vehicle project. Open-ended questions were asked, allowing the interviewee to share his experience and technical knowledge. **Results:** Élcio described his progression in the Brazilian Air Force, from researcher to vice-head of the Space Directorate, highlighting the development of launch vehicles, inertial navigation systems, and the SARA project. He reported his transition to an academic career, including his experience as a professor at Luleå University of Technology in Sweden. Élcio detailed his coordination in the 14X project, a hypersonic vehicle that reached Mach 7, with prospects of reaching Mach 10. **Discussion:** The interview reveals the importance of international cooperation and technology transfer, exemplified by the donation of Brazil's first hypersonic laboratory. It also highlights the technical challenges in building hypersonic vehicles and the potential of these technologies for military and civilian applications. **Conclusion:** Élcio Gerônimo de Oliveira's career exemplifies the Brazilian contribution to advanced aerospace research, demonstrating the national capacity to develop strategic technologies such as hypersonic vehicles, despite resource limitations, and pointing to future possibilities for transportation and space exploration.

Keywords: *Hypersonic, Aerospace, 14X, Propulsion, Rockets..*

RESUMO

Introdução: A entrevista com Élcio Gerônimo de Oliveira, conduzida pelo repórter Luis, apresenta a trajetória profissional de um pesquisador brasileiro com experiência na Força Aérea Brasileira e no meio acadêmico, com foco em sistemas espaciais e veículos hipersônicos. **Objetivos:** Documentar a carreira e contribuições de Élcio para o desenvolvimento aeroespacial brasileiro, destacando sua transição da carreira militar para a acadêmica e sua participação em projetos estratégicos, especialmente o projeto 14X. **Métodos:** A entrevista foi estruturada em blocos temáticos, abordando a carreira militar, a experiência acadêmica e, com maior detalhamento, o envolvimento no projeto do veículo hipersônico 14X. Foram realizadas perguntas abertas, permitindo ao entrevistado compartilhar sua experiência e conhecimento técnico. **Resultados:** Élcio descreveu sua progressão na Força Aérea Brasileira, desde pesquisador até vice-chefe da Diretoria de Espaço, destacando o desenvolvimento de veículos lançadores, sistemas de navegação inercial e o projeto SARA.

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Relatou sua transição para a carreira acadêmica, incluindo sua experiência como professor na Universidade de Luleå, na Suécia. Élcio detalhou sua coordenação no projeto 14X, um veículo hipersônico que alcançou Mach 7, com perspectivas de atingir Mach 10. **Discussão:** A entrevista revela a importância da cooperação internacional e da transferência de tecnologia, exemplificada pela doação do primeiro laboratório de hipersônica do Brasil. Evidencia também os desafios técnicos na construção de veículos hipersônicos e o potencial dessas tecnologias para aplicações militares e civis. **Conclusão:** A carreira de Élcio Gerônimo de Oliveira exemplifica a contribuição brasileira para pesquisa aeroespacial avançada, demonstrando a capacidade nacional de desenvolver tecnologias estratégicas como veículos hipersônicos, apesar das limitações de recursos, e apontando possibilidades futuras para o transporte e exploração espacial.

Palavras-chave: *Hipersônica, Aeroespacial, 14X, Propulsão, Foguetes.*

1. INTRODUCTION

In an era of rapid technological advancement and space exploration, Brazil has stood out with significant contributions in the aerospace field. In this exclusive interview, we speak with Élcio Gerônimo de Oliveira, a central figure in the development of Brazilian strategic technologies. With a career that spans from the Brazilian Air Force to international academia, Élcio shares his experience in developing space systems and, particularly, his contribution to the 14X project, a Brazilian hypersonic vehicle that represents a milestone in national aerospace engineering. His trajectory not only illustrates Brazilian scientific potential but also reveals the challenges and achievements of someone who dedicates their professional life to technological innovation in a sector vital to the country's sovereignty and development.

Luis: Good afternoon, Élcio Gerônimo de Oliveira. How are you, sir?

Élcio: Good afternoon, Mr. Luis de Boni. How are you? Everything well?

Luis: Thank you very much for receiving us today. Our interview will be published in Portuguese by Periódico Tchê Química, in English by the Southern Journal of Sciences, and we will share this interview with a local television station, Conecta Mais TV. The interview content will be shared under a Creative Commons license. Is this acceptable to you, sir?

Élcio: No problem.

Luis: By the way, would you prefer that I address you as professor or doctor?

Image 1: Dr. Élcio Gerônimo de Oliveira.

Élcio: No, no formality is needed, but Élcio is sufficient.

Luis: Thank you very much, Élcio. I'll start by asking questions about your career. Are you agreeing?

Élcio: Agreed.

Luis: First question. You held several positions in the Brazilian Air Force, such as research officer, head of the space systems division, and deputy director of the space subdirectorate. Could you describe your most significant achievements and challenges in these roles?

Élcio: It was indeed a very dynamic career. I started in 2007 as a researcher in this area and remained until 2018, when I left the Air Force. During this period, I initially worked as a

researcher in the area of flight dynamics. Later, I worked as a researcher in the space vehicle control area, specifically rocket control. Then, I worked in the flight dynamics area, where I was already serving as deputy head of the sector, and in my career progression I became head of the space systems division, which included within the division the aerodynamics sector, structure, control, flight dynamics, and the project itself, all the rocket design part.

That was the composition, and later I assumed the role of deputy chief of the Space Directorate of the General Space Institute, where we had ten subordinate divisions. So, I went from heading one division to being deputy chief of the directorate, which encompassed ten divisions, including my former space systems division, plus the chemistry division, mechanics division, electronics division, and testing division. These ten divisions comprised what we could call the industrial and research park for the Air Force's rocket area. It was where we developed and manufactured the components used in building our rockets, from the propulsion part, the electronics part, metal structures, carbon fiber structures, and, in short, all the necessary elements that were available in our directorate.

Luis: This is located in São Paulo?

Élcio: Yes, it's in São Paulo, more precisely in São José dos Campos.

It's difficult to enumerate what the most important points were within the career because we dealt with various elements throughout this period, but the development of launch vehicles was particularly noteworthy. I was involved in the old VLS project, later in the VLM project, in developing the engine for this rocket, the microsatellite launch vehicle. I also participated as project manager for the atmospheric reentry satellite, SARA, intended for research, and the navigation and control system for rockets that we developed internally. This last one represents a strategic base product, the inertial navigation system, which is a restricted item that is not easily available on the market, as it involves sensitive or embargoed technology that is difficult to access. We developed and produced it, and my doctorate and a significant part of my time at the Institute were dedicated to developing this inertial navigation system. I consider these three points to be the most important in my career, in terms of work, although we had the opportunity to deal with all imaginable types of activities, including meteorological studies, making this period very interesting and dynamic.

It was an excellent career in the Air Force. It was quite intensive, requiring many hours of planning and study, reviewing literature and theory, because it's necessary to constantly adapt, as there are always new challenges. You need to continuously update and prepare yourself to answer questions and solve problems that occur during project development. Since no project is perfect and problems always arise, it's necessary to find solutions, frequently turning to books, research, travel, getting to know other institutions, talking with specialists in the area, and taking courses, which made this period quite intense in this aspect.

Luis: Thank you very much. Let's move to our second question, just noting that I'm not a professional reporter, but considering the circumstances, I appreciate your patience.

Élcio: No problem, we can proceed.

Luis: Élcio, you made the transition from the military environment to academia, working as a professor and researcher at universities, such as Luleå University of Technology in Sweden - sorry for the possible incorrect pronunciation. What motivated this career change, and how did you adapt to the academic environment?

Élcio: There's no need to apologize, because it really is a difficult name to pronounce. Normally in Portuguese, it would be pronounced "Luleia," but since the A has a circle above it, the pronunciation ends with U, so it's "Luliu" - that's the correct pronunciation of the name.

Actually, it was a very smooth transition because during the period I was working at IAE, at the Institute, I had completed my doctorate at ITA and was invited by ITA to be a professor in one of the disciplines that was part of my training, related to Kalman filters, dynamic systems optimization, and Kalman filtering.

This period provided me with a lot of experience because master's and doctoral courses are offered at ITA. I had students under my guidance as well, and this invitation, this work at ITA, was something that motivated me a lot and made me comfortable with the academic environment. I also wanted to do this for an internal feeling of giving back. I taught at ITA without remuneration, as a guest professor,

offering my participation for free, without receiving payment for it, and I considered this a counterpart for the years I studied there during my doctorate. I did four years of doctorate at ITA and then worked for approximately four to five years as a guest professor, which constituted this counterpart and gave me a lot of experience. I taught from 2012 to 2017 at ITA, totaling five years, which gave me a very solid foundation from the point of view of academic coexistence, scientific development, guidance, and other activities.

When I ended my period in the Air Force, which is a normal process upon completing the time of service, I requested my reserve status, already having a good relationship with some institutions and international researchers. At a certain point, I received an invitation to spend a year at Luleå University as a visiting researcher and professor in the rocket area, as they were interested in developing this area. I accepted the invitation to spend a year, later participated in a competition for a permanent professor position at the university, was approved, took the position, and remained three years in Sweden, living and working as a permanent professor.

During this period, the pandemic occurred, and some difficulties began, such as the impossibility of traveling and accompanying my family in Brazil. I had a mother of a certain age, who began to create situations that made my return to Brazil difficult. So, at the end of the third year, I decided to leave the university and return definitively to Brazil to be with my family and offer support.

The transition was very smooth; the academic structure there is excellent, and the university is very well organized. They significantly value pedagogical and didactic issues, which was very beneficial. In my training as a physicist, I also completed all the academic parts related to didactics, teaching psychology, and teacher certification, and one of my goals was, at a certain point in life, to assume the role of teacher, which would be quite useful in the activity.

It was very easy; the didactic part was very smooth, the classes were very similar to what I already taught here in Brazil, and I began to guide students following the same profile and the same line we adopted here, without major problems. I believe the biggest difficulty was dealing with the students' accents. I had a class with 40 students, approximately 10 to 15 Swedes, about 15 Indians, and various Europeans from different parts of Europe. When they all gathered in a room, it was interesting because each one spoke differently, with distinct accents, and with mutual comprehension difficulties. It took about a month to adapt and understand what each one was saying.

Luis: Supposedly, they all spoke English.

Élcio: Everyone spoke English, however, I had a British student in the room, a student from Latvia, a Spaniard, an Italian, an Indian, a Mexican, and you can imagine the diversity of accents. In the first days, it was quite challenging until I could understand. I consider this to be the most challenging and interesting part because there were moments when communication was really difficult due to very pronounced accents. In certain situations, I needed to interrupt and ask them to repeat, because although we all spoke English, we are not native speakers - I am not native - so getting used to this multicultural environment was a challenge, as well as dealing with cultural issues, considering that each individual has a different culture, from personal mentality influenced by their country's culture to religious issues. I believe this was the biggest difficulty: dealing with this cultural and origin diversity at the university. The rest was smooth; the technical part didn't present major problems.

Luis: Very interesting. Professor Élcio, we'll now move to a second block of questions related to your professional activities. As flight test coordinator of the 14X project at the Institute for Advanced Studies, IAV, what were your main responsibilities, and what was the most challenging aspect of this role?

Élcio: This is an interesting question. Remember I mentioned that I had left the Air Force and later went to Luleå University? Actually, there was a significant 8-month interval. When I left the Air Force, in the last year as deputy chief of the Space Directorate, my function was to be the point of contact between the group that manufactured the rocket and the group that was developing the 14X project, which is a hypersonic vehicle.

Imagem 2: Visualização do projeto 14-X.
Image source: provided by the author (Dr. Oliveira)

They were developing an engine and wanted to test it in flight. Since I had worked in the control area, flight dynamics, and had been head of various sectors, I had a comprehensive view of the vehicle, the rockets, and how to use them to conduct this test. So, my last year in the Air Force was dedicated to helping my colleagues at IAV, at the Institute, in project decision-making and studies, in developing studies, mainly those related to the trajectory to position the engine in the ideal condition for its operation.

The hypersonic engine has certain particularities. It only operates from the moment it reaches a certain speed, a certain Mach number, which already represents hyperspeed, and at a certain altitude, defined by the project, where it encounters a certain air density. Therefore, it combines hyperspeed with a certain air density, entering the favorable regime for operation, at which point the engine starts to function and accelerates the vehicle to an even higher speed, continuing to advance.

Luis: Allow me to ask some additional questions on your topic.

Élcio: Certainly, feel free.

Luis: First, I followed the 14-X through news reports, I didn't know you were involved in this project. My first question is: Who assigned the name to the project, if you know?

Élcio: I believe, if I'm not mistaken, it was the researcher considered the father of the project in Brazil's propulsion area, Colonel Salamoni. He assigned the name 14-X in honor of Santos Dumont, who created the 14-Bis. It was his choice, along with his team at the time. If I'm not wrong, that's the story, although some details may be lost over time. In an informal conversation I had, I curiously asked about the origin of the name, and they explained the reference to 14. Therefore, the 14 refers to the 14-Bis, and the X designates the hypersonic project, adding an element that alludes to a secret project.

Imagem 3: Caça A1
Image source: Chris Lofting.
https://pt.wikipedia.org/wiki/AMX_A-1#/media/Ficheiro:FAB_AMX_International_A-1A_-_Lofting.jpg.

Normally, we see this nomenclature in other projects, like the A1 Fighter project, originally called AMX, which was developed in partnership between Brazil and Italy. The 14X follows this logic: when it's a test or prototype, the X is used. In fact, the flight test institute has the X as its symbol. This is already part of the institutional culture. And the 14 originated from the 14-Bis.

Luis: Returning to the main question, I appreciate the information, which was very interesting and allowed the audience to learn a bit of these stories. It's also important to recognize these people who were true pioneers, often unknown to the general public.

Élcio: To illustrate the importance of this colonel, he received the first hypersonics study laboratory in Brazil from the Air Force as a donation from his hypersonics advisor in the United States. He completed his doctorate there, and his advisor was the owner of the laboratory. When the advisor retired, he donated the laboratory to him. The laboratory was then transferred to the Air Force and installed there, becoming the country's first hypersonics laboratory. This demonstrates the importance of international relations and research. Imagine the difficulty of setting up a hypersonics laboratory from scratch at that time.

Luis: It would be practically impossible.

Élcio: Considering the necessary resources. This is a historical fact. The laboratory

even received the name of this professor, Professor Nagamatsu, in honor of this American academic who made the donation. The story behind this project is truly remarkable and significant.

When I left the Air Force, I was thinking of dedicating myself to the academic area. However, the team felt my absence, commenting that they had lost the person who made the connection between the projects. So they invited me to work temporarily on the project. It was an external arrangement, since I was outside the Air Force, being hired as a kind of consultant to set up this project, the flight test project. There's the rocket project, the hypersonic engine project, and to unite these elements, a specific project is needed: the flight test project, which is the flight test project.

So, I defined the requirements. I had an excellent team. I talked with the hypersonics area specialists, who informed me of their needs, and with my team, who informed me of what was possible to accomplish. Occasionally, conflicts arose, which I mediated, aligning everything so we could reach viable solutions.

When I left the Institute, the flight test project was already completed. I left the Institute to go to Sweden, to Luleå. In 2019, I published a scientific article about this 14X test. I left at the beginning of 2019, more precisely at the end of 2018. At the beginning of 2019, I went to Sweden, and in that same year, I published the article about the 14X test, which is available online. The flight was scheduled for 2020, if I'm not mistaken.

Luis: This is my next question. Understand that I follow from afar, not in person, but through the internet. Did the launch occur successfully?

Élcio: Yes, it occurred successfully. We adapted the hypersonic engine, which actually has two engines. It was quite interesting because the hypersonic engine has a particular configuration. Imagine a plane with a bevel, which is the intake. Similar to American fighter aircraft that have square turbines, with square air intakes. The design is similar: a plane with a square intake, containing internally all the processing necessary to generate thrust, hypersonic propulsion.

Two of these engines were used positioned frontally, creating a quite peculiar configuration. These engines were coupled to the end of a rocket. The intakes, these bevels, were positioned at the tip, giving it a shape resembling a screwdriver. The complete rocket, observing its end, resembled a screwdriver. The interesting thing is that, instead of the traditional conical tip, it ended with a straight line.

It was an interesting challenge to reach the final configuration and conduct the necessary aerodynamic studies to make the flight viable. The test was carried out, the vehicle reached the necessary flight conditions, and the engine was activated and functioned adequately. Currently, they're already in the preparation phase for a second test, which will involve more rigorous conditions, aiming to reach another level in the project requirements.

The launch occurred in 2021, when I was no longer in Brazil, or perhaps in 2020; I don't remember precisely, it would be necessary to verify. It was very gratifying because it was a project that I had outlined and that was delivered ready to function. I didn't conduct the study alone, I just coordinated, but we had an exceptional team that conducted all this work, both from IAE and IAV, very competent teams that provided support for this to be realized. These are distinct phases of development.

Luis: Do you believe it would be possible to manufacture the 14-X at scale and find other applications?

Élcio: The 14X is...

Luis: Or what products could derive from it.

Élcio: We conducted the engine test, and the next test will be of the complete vehicle. The vehicle resembles a board with these two engines coupled to the lower part, configuring a small aircraft. It presents a Delta-type format, an interesting aerodynamic configuration, containing all the requirements necessary for this design, to meet the flight requirements. It uses the same engines that have already been tested. However, this aircraft needs to be accelerated by a rocket or some other means to reach the conditions necessary for its autonomous operation.

For understanding, the 14-X flight, more specifically the 14-XS, which refers to the engine, needed a rocket to accelerate to approximately Mach 7. At this speed, the engine starts to function.

Luis: To make a comparison, in the movie Top Gun 2, the aircraft reached Mach 10.

Élcio: Exactly. The next step, with the complete aircraft, has the nominal requirement to reach Mach 10. Our company, which provides consulting in this area, has already conducted a study and we managed to develop a rocket configuration capable of reaching Mach 10, positioning any hypersonic vehicle in this condition. Once the vehicle is placed in this condition, it proceeds autonomously.

Luis: Allow me to ask one more question, this being the last one.

Élcio: Certainly.

Luis: When the launch is carried out, does it occur from the ground or does it need to be done from another aircraft?

Élcio: It's possible to carry out both from the ground and from another aircraft. We carried out from the ground, especially for higher Mach speeds. For higher Mach speeds, a heavier and larger rocket is necessary, which represents a significant load. Adapting this to an aircraft is more complex and more challenging, requiring many studies. It's more practical to position it on a rocket and launch from the ground, allowing it to fulfill its mission autonomously.

Within this context, the most challenging aspect for me in the 14-X project was, first, developing the mission project, the test project, and coordinating the two teams, identifying the balance points to position the engine in adequate conditions, respecting the capacities and limitations of the rocket used. It was a very interesting process, involving many studies to reach the final configuration of the project, making it successful.

There are other applications for the hypersonic area that are relevant for space research and transportation. As mentioned, the movie presents an aircraft that reaches Mach 10. Historically, we had the Concorde, an extremely high-speed aircraft, which was deactivated due to operational costs and other issues. However, nothing prevents us from developing a means of transportation based on these engines in the future to carry out some type of mission different from current ones.

Luis: Different from military applications, for civilian purposes.

Élcio: Yes, civilian applications also exist.

Luis: I hope to be able to use this technology someday.

Élcio: Who knows in the future. We'll see.

Luis: I'm an optimist by nature.

Élcio: We share this characteristic.

This interview was part of the interinstitutional scientific dissemination partnership project of the SSCON – 2024 conference, continuing for the future 2026 edition in RJ.

Image: SSCON 2024 Logo.

DECLARATIONS

1. Limitations: The interview is limited to its content.

2. Funding source: The host funded this interview.

3. Conflicts of interest: The host has worked for the journal for many years, and this may have influenced the interview.

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