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Aerospace exploration in Central America. A hub for the world and outer space. Costa Rica as a pioneer in the region.

Alex Sáenz Rojas*

* Student of Computer engineering, Tecnológico de Costa Rica.
200 meters' south and 25 meters west of Super Divi, Tejar, Cartago, Costa Rica. 30801
sr.alexe@gmail.com

Abstract

The democratization of science and technology (S&T); moreover, the creation of knowledge-based societies are big challenges that should be addressed in a way that could bring development to humankind and push the boundaries of what is believed possible. Central America because of its geographical and political positioning, has a great opportunity to lead the efforts to make this a reality. Costa Rica could use this opportunity to thrust itself into the use of space technology as a tool to create a platform for a more sustainable planet, and by doing that, it can show the world a path to follow. With the vast experience and high-quality standards in medical and computational industries, Costa Rica can take the role as an orchestrator of the efforts generated in Central America. By maximizing and optimizing the use of the great human resource present in the region, space exploration becomes a plausible reality.

1. Introduction

The development of aerospace technologies is seen as an opportunity for Costa Rica to assume a role as a pioneer country and to establish itself as a role model in the Central American region, taking advantage of the vast resources of human capital.

Creating a historical context of scientific and technological advances seeks to lay the groundwork for the development of a more in-depth investigation that allows detailing the capabilities and resources available in the region, as well as evaluating the state of aerospace exploration and its advances in the last years.

With limited and scattered information on the state of the matter, the use of research carried out in other countries, has been resorted to, as well as information on industries that, although they are not directly related to aeronautical developments, they present similar behavior in the world market.

Industry, education and, in large part, governments must form joint efforts that allow a coordinated advance that could guarantee the efficient use of resources. H.S.Choi says in his publication on policies and mechanisms for technological development in developing countries that "Areas, where government leadership is needed, are particularly on those that require long-term and high-risk investments" [1], that holds true, since they are of the few institutions that can take on such long-term investments, however, it is important to note that although the results may be long-term, the speed with which space exploration has grown in recent years makes it an ideal time to start. Companies like SpaceX, Blue Origin, and Rocket Labs are proof of the viability of this idea. It is now that Central America (CA) has the obligation to initiate the process of organization and formulation of objectives to begin its incursion in the matter. Such an ambitious project must include multiple axes in order to generate integral solutions that seek a fairer and more equitable society.

This search for equity reveals unknowns such as the one raised by E. E Weeks: How can we ensure the benefit of participating countries? [2], as the author mentions, the answer lies in education.

The new world market has forced countries to change their approach in which they generate wealth and that is why the idea of knowledge societies emerge as a viable opportunity. The diversification of thought and free access to

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information is one of the multiple qualities that transform these societies into ideal environments for Research and Development (R&D) in space and aeronautical technologies.

Higher education is the key that allows the migration from an industrial economy, often limited by natural resources, to a society that is more focused on generating innovative solutions through critical, analytical and creative thinking. Despite the strong links that can be found between space sciences, aeronautics and STEMS, it is absolutely necessary that these knowledge-based societies do not limit their inputs to these specific topics since a multidisciplinary proficiency is essential to achieve a competitive advantage.

Research and development are fundamental for the technological advances necessary to enter the aerospace industry and it is through higher education and the creation of interuniversity networks that this mission can be promoted. Interuniversity networks implemented in countries such as USA, Canada, Japan, and Russia have allowed the exchange of knowledge and the incorporation of cultural diversity that enriches the learning process. [3] [4]

Nevertheless, in order for these efforts to become attractive to government entities and society in general, it is necessary to create a social and political environment that supports these ideas. H.S. Choi mentions that "Without the long-term benefits of these efforts, regardless of whatever other policies are pursued, it is clear that the foundations will be insecure". [1]

In the Outer Space Treaty, in its first article clarifies that "The exploration of outer space must be done for the benefit and interest of all humanity" [3][4][5] and based on this premise this project seeks inclusion of developing countries. Understanding outer space and its resources as "Common World Heritage" [6] give developing countries a purpose to access them, otherwise, they would be deprived of their benefits.

Despite attempts to define certain mechanisms in which the more developed countries should share the benefits (compelled or facilitated) of their aerospace development, set forth in Article 1 of the Outer Space Treaty [7], no consensus has been reached. Therefore, it is the responsibility of developing countries to proactively seek the means to achieve it.

In 2015 multiple leading countries signed the 17 Sustainable Development Goals set by the United Nations aimed to be achieved by 2030. So, it is of great importance that the objectives set to achieve this venture contain a sustainable core. There is no benefit in creating plans and programs if they don't align with the present rules and guidelines of the current world. Countries in the region have a great commitment to the preservation of the environment, which is why rational use of raw material present needs to be considered. As mentioned in the research carried out by the Sistema Nacional de Áreas de Conservación (SINAC), 80% of the population in Costa Rica believes that the government should invest more in the conservation of the environment [8], so it is necessary to take a sustainable approach to aerospace development. Some countries and industries are becoming more aware of this need and are changing their focus, but any new projects have to be constructed with this principle on top of every other need, not only adapt to it. That is why any effort of innovation or technological development must include a commitment to protect natural resources and its sources. Any project like the one proposed on this paper must contain an ethical responsibility mindset in their gestation for it to honor the real needs of these countries.

By incorporating a balance between development and sustainability, Costa Rica can prove to have a competitive advantage that differentiates its qualities from the rest of the world.

2. Milestones reached in the past

In 1957, all around the world, the news published that the Soviet Union was launching the first artificial satellite to Earth orbit. Years later in 1961, a milestone in human history was achieved, a young Russian named Yuri Alekseyevich Gagarin had become the first cosmonaut to reached space, aboard Vostok 1. This was the event that encouraged Franklin Chang Díaz, a young Costa Rican, to seek an opportunity in NASA to be an astronaut [9].

In 1977, this young Costa Rican was already a mechanical engineer and a doctor in plasma physics. In 1979 having acquired the American nationality he was selected among thousands of applicants to become the next generation of astronauts of the western world. By 1980, he officially began his career at NASA. His dream of being part of a select number of astronauts became a reality on January 12, 1986. These were the initial steps that marked the path for many others to come. [33]

Between 1989 and 1990 the engineer Sandra Cauffman pursued her dream of working at NASA and with great effort, she was able to jump-start her career in NASA, setting the region on the map of space science.[10][11] In more recent times the Guatemalan Ph.D. Luis Zea has ventured into the bioastronautics development at the University of Boulder Colorado. He is currently working in the development of new ways to stop antibiotic-resistant diseases by executing experiments in the International Space Station (ISS).

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Some countries have already started to take advantage of the proliferation of the growing development of aeronautical and space technologies. Some examples can be seen in countries like Panama that take advantage of its strategic geographical positioning of the Tocumen airport to become a hub for many airlines, Nicaragua has made some proposals to develop businesses based on drones, El Salvador has formed institutions such as El Salvador Aerospace Institute (ESAI) and the San Jose Aviation Cluster, this are some of the efforts that show the viability of this kind of development. In Costa Rica institutions such as the Asociación Costarricense de Investigación y Difusión Espacial (ACIDE), structured in 1989 and then transformed into the Asociación Centroamericana de Aeronáutica y del Espacio (ACAE) in 2010[12], have been created with the purpose of positioning Costa Rica and the Central American region on the map of the aerospace sector.[13] In this same year (2010), Consejo Nacional de Investigación y Desarrollo Aeroespacial (CONIDA) was established to guide the efforts in aerospace development. [14]

The aerospace industry has permeated some areas of the economy in Costa Rica. Ad Astra Rocket Company, located in the province of Guanacaste, is currently developing the VASIMR® plasma engine, and by doing so giving jobs to people in the province. Companies like this one bring benefits to the country by sharing experience and know-how.[15] Other ones like Avionyx S.A work in development and verification of software and hardware embedded systems specialized in aeronautics.

New projects executed in the last 2 years include the development of the first Central American satellite Irazú-1 by the Instituto Tecnológico de Costa Rica (TEC) that was launched in 2018 aboard the Falcon 9 rocket using the Dragon space capsule. The second Central American satellite is scheduled to be launched in 2019 and is a project led by the Universidad del Valle de Guatemala that focuses in testing a prototype of a multispectral sensor for the detection of fires and other natural disasters [16].

3. Costa Rica at a glance

There is vast information about the technological advances of Costa Rica in recent years, but it is impractical to cover all these issues in this research. Instead, a selection of those that are considered the most important has been used to create a qualitative analysis. This first analysis does not draw a complete picture, but rather outlines the silhouettes of the most important subjects discovered and their impact on Costa Rica. Tools such as the State of the Nation (SOTN) [17] and the State of Science, Technology, and Innovation (SOSTI) [22] have been very useful tools and other countries are encouraged to create their own. With this initial analysis, it was observed that although there is an important technological advance, it is necessary to take measures in some other aspects for them to thrive, these topics are discussed later.

3.1 Aerospace in New Zealand, Argentina, and Luxembourg as examples of aerospace industries

Companies like Rocket Labs have proven that aerospace development in small countries is possible. New Zealand with the help of foreign investment has managed to develop aerospace technologies that previously thought impossible. The creation of technologies such as the Curie engine that Rocket Labs built from metal 3D printing are an example of this. Launching satellites at low cost using boosters as innovative as the Electron Rocket has allowed other nations to have access to space. This not only shows that countries with similar populations (around 5 million) can reach aerospace development, but that they can open the opportunities to grow. New Zealand has proved that high GDPs are not always necessary to reach the stars.

Argentina with its National Commission for Space Activities (CONAE) and the national investment of $44 million (2019) has been able to achieve great advances, e.g., placing in orbit multiple satellites like SAC-A, SAC-B, and SAOCOM in 2018. [18] This has allowed them not only to be independent of other countries to access this technology but has generated profits with the sale of its services. Strategic alliances with Italy have generated important results to Argentina and has allowed the realization of an "Italo-Argentine Satellite System for Emergency Management (SIASGE)" [19]. Southern American countries have made similar progress, Peru with Peru-Sat1, Colombia with the production of the UAPSAT-1 satellite and Bolivia with the deploy of TKSat-1 communication satellite.[20] These are some Latin American countries that are now in space.

Luxembourg is another example where the population size has not been a limitation to aim at big goals. During the last years, Ispace has become one of the first companies to specialize its business in space mining. With a vision that may have been taken out of science fiction books, Luxembourg has set out to complete missions to the Moon by the year

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2020. [21] Luxembourg has found an opportunity in a little-explored niche and with it, they were able to call the attention of country powers like Russia, that are now interested in investing in those technologies. With so much development, it is not surprising that they encounter legal obstacles as well as ambiguities, especially with treaties like the Outer Space Treaty (OTS). With the legal difficulties, the country has encountered, they have decided to pioneer with the first space mining regulation.[34]

A closer geographical example of space development can be seen in French Guyana, that even though it is situated more thousand kilometers from France it has been a recurring launch site for Arianne Rockets. Being conveniently positioned as a specialized provider of some global needs has allowed them to grow as a whole and has given them the opportunity to move towards progress.

3.2 The right spark for development

The SOSTI analysis exhibits that there is a higher development in the country compared to other countries, however, the production of knowledge is less than expected. [22] This means that even though the conditions to probe S&T as sources of wealth are present there are some deficiencies that have crippled its expansion. Notwithstanding, the fact that there is some knowledge production indicates that the necessary quality standards are present and therefore is favorable for further evolution. From 2001 and 2011 the expansion in engineering and scientific advances doubled which is another sign of good health in the field. Having these levels of development provides the opportunity to take the first steps in the development of large-scale aerospace technologies.

Even when the public policies that reinforce this research community are poor and malnourished, the fruits collected by these groups have been of great value, e.g. the first plasma discharge in Latin America [23]. Another example of successful S&T research was the development of the first microcontroller for medical applications (SIWA) by SCILab of the School of Electronic Engineering of the TEC.[24] Non-governmental organizations (ONGs) such as Coalición Costarricense de Iniciativas de Desarrollo (CINDE) have made efforts to attract foreign investment and seek the diversification of knowledge of the workforce. It's this type of strategic initiatives that could give the starting point for an outburst of S&T commerce.

According to the State of The Region in 2016 (SOTR 2016),[17] similar possibilities are found in countries such as Guatemala and El Salvador. Central America have the fuel which is the great human capital it possesses, the new needs of the market can be seen as the oxidizing agent, the only key factor missing is the adequate spark that historically been lacking. Only then the fire triangle could be completed and full knowledge combustion can be achieved. With all this, it is possible to unleashing this chain reaction that would allow other fields such as agricultural and biomedical sciences to access state-of-the-art technologies. The inherent cost of the technological advances in those fields has been limiting them to analogous tech, with transnational corporations been the only ones that could allow the expense on the new systems. With in-situ development, this cost can be lowered and the more modest producers could access the most powerful tools available.

It is impossible to think that such initiatives can be carried out overnight, but with the simple change in the paradigm on how R&D is approached by public eye [25], the results can be seen quicker than what is thought. As Neil Armstrong said, "That's one small step for a man, one giant leap for mankind." these efforts are a small step in society and a big step for the region and the entire world. To get there is necessary to appeal for a more user-friendly approach that enables people from different backgrounds and skill sets to access the aerospace industry.

3.3 A new hope

At this point, it is necessary to make a distinction between technical know-how, technology, and science.[26] As G. Coronado explains, the technical know-how is mainly a sequential-causal process, which means that by completing several steps it is possible to obtain the same result while disowning the in-depth reasons for why. On the other hand, Science (with a capital S) is based in philosophy which advocated for the understanding and the origin of all phenomena.[26] Technology instead was created (or discovered) to transform the production processes, that permits to create dynamic solutions to ever-changing problems in the world.[27] This flexibility is what gives developed countries its

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dynamism and resilience, an example of this the huge technological advancements made after WWII. This exact reason is why CA needs S&T to become a more solid economy.

With a Gini coefficient (an index that represents inequity) on the rise in many countries [17], it is needed to insert as many people as possible in all production strata, from purely manufacturing jobs to the more specialized scientific endeavors, albeit this coefficient is not only based on economic markers. In the technical field, it is necessary that more people obtain know-how, so it can improve, this can be achieved by partnering with countries and industries that are in need of workforce. The technological standpoint needs to generate solutions to the necessities of the population and science research needs to keep going so it can keep updating the other branches with the latest discoveries. The more specialized and sophisticated an industry the greater the value is added, moreover the greater benefit it will bring to the stakeholders. Finding a niche in which the capabilities of the region can be maximized is a necessary requirement and should be investigated in depth in further studies.

In knowledge societies, schooling and free access to information can reduce inequality rates greatly. With a planet that is constantly changing due to globalization, it is strange to find that aeronautics and space sciences continue to be limited to certain countries. With the right mix of inspiration, knowledge, and support, it is possible to achieve actions that, although small, can change the world. Young minds and their thirst for knowledge can break the chains of inequality that give this new hope. It is necessary to detach from old production practices in order to develop new technologies that adapt to the new world regime.

3.4 Security concerns and the phantom menace

One of the biggest concerns is that with access to these technologies development of military uses could represent a risk for other nations and a global security peril.

Within the Costa Rican idiosyncrasy, there is a dissociation between technological development and the militia. This is by itself a strange feature to find in any country in the world, this deficiency in military thoughts can be seen as a disadvantage, but with the correct approach, it can be transformed into an attribute the country can avail.

With the approach of developing only pacific uses of space, it is possible to show the world that peaceful ways do exist. With the growth of space technologies, countries such as the United States have called for increased surveillance of the use of space in other countries. This threat is, in fact, a phantom menace. With the correct management and supervision of international organizations, it can be ensured the peaceful and secure use of aeronautics and space. As a leader in the field, Costa Rica demonstrated that the absence of an army should not be considered as a weakness, but with the investing of that budget in education, it can be transformed into a strength. Moreover, the OST explains the right to access space must not distinguish or discriminate in any way as long as the use of technology alight with the objectives of COPUOS (Peaceful Uses of Outer Space) and in benefit of all the human race.

It is important to acknowledge there is, in fact, an intrinsic risk in granting access to aerospace knowledge to other countries but many other technologies have been criticized with the same judgment. It was once said that the civilian use of electric power was a deathly risk but nowadays is widespread. Costa Rica was once a leader in the application of electrical power to light the streets in its capital and now it should be a leader in R&D of aerospace sciences. Let's not forget that with electricity humankind was able to bring light where only used to be darkness.

3.5 Higher Education as a hybrid propulsion system for development

Institutions like the Universidad de Costa Rica (UCR), the Instituto Tecnológico de Costa Rica (TEC), the Instituto Nacional de Aprendizaje (INA), the Universidad Estatal a Distancia (UNED) and the Universidad Técnica Nacional (UTN) are fundamental in the formation of high-quality professionals in Costa Rica.

The high investment education (7,6% of its GDP) and the political stability that Costa Rica is living since 1948 makes it the perfect candidate to lead and orchestrate the efforts generated in the region. Due to the fact that industries like biomedical and aeronautic industries require high investments in R&D a joint effort is needed that could allow the distribution of this expense. Countries such as the United States, China, India, and the European Union have carried out these development processes over the years, which has allowed them to capitalize and monopolize access to its resources.

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The venture of creating university spinoffs can be considered as one of the most viable options to start, because of its potential to create bridged between companies and universities. [28] The Center for Turbulence Research operated by Stanford University and NASA is an example of this.

As H.S. Choi says these (developed) countries have a temporary advantage what represents a big barrier for developing countries to cross.[4] This is one of the difficulties that limit the advances of aerospace engineering in CA. Technologies such as satellite maps and the use of unmanned aircraft are often seen as a dream.

As Rodrigo Facio (Founder of the second republic of Costa Rica) once said "Higher education is the last instance within a country to create responsible citizens that can benefit society. Education becomes a generating entity of citizens with critical thinking that seeks not only personal profit but to the service of the community and humanity in general" Universities face a series of new challenges that must be attacked moral and ethical responsibility. Costa Rica has managed to demonstrate that through investment in primary and secondary education it has achieved significant progress in citizenship and this is one of the differentiating factors with the other countries like China and India that are direct competitors in the matter.

With Universities being the last chance for a country to shape citizens, it is imperative that these institutions lead the efforts on technological development not only because they are responsible to generate the professionals of tomorrow, but because they need to lead humankind into the future.

3.6 Infrastructure needs.

Costa Rica possesses a modest network of R&D centers in different disciplines associated with S&T. Many of these research centers are used to provide services to the community; however, most of them are located within the universities, which makes difficult for private companies to make use of them. Many of the equipment present in these research centers are outdated and investment is necessary to be able to move forward.[22] In past years there have been strategic alliances with some companies to be able to buy their equipment, however, due to the cost of maintenance and poor planning, many of it has degraded. In addition to that, many of the facilities are restricted to be used only by highly trained professionals and students are often discriminated instead of being taught. There is a lack of responsibility and a lack of vision towards the future. The rigidity of regulations makes it very difficult to share infrastructure with private industry, political will and public interest is needed for this to change.

What is preventing smart investments? Is there a single factor that is an opposing force or is it multicausal? It is often a cause of pride to see the advances that have been made even with the lack of the right technology, but no country should be deceived by this idea. Limiting access to technology by not investing in R&D is eroding the bases of knowledge-based societies and is a regressive mindset. The youth are the ones that will suffer the most if actions are not taken on time, the aging world population is threatening food sources and other limited resources, hence, the world is demanding new innovative ideas. It is the future of Costa Rica, Central America, and the world that is hanging by a thread.

In the same fashion that many countries seek to provide the best weapons technologies for their soldiers, Costa Rica needs to provide the best medium for their scientists, students, and teachers to develop. This is the only way out of the yoke of inequality.

4. Proposals.

The next step on this investigation would be to generate a proposal that can denote and demonstrate the economic, social and political viability of this endeavor, and in that way bring foreign investment.

4.1 Together but not mixed, joint efforts in the development

Central America with its cultural, political and economic diversity has the challenge to work together in unison to be able to succeed. A way to create the perfect environment for R&D to bloom is important to incorporate all present efforts into one. Clusters, universities and government policies need to be shared between the participants, so each party

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can be updated on the latest accomplishments. Right now, due to the novelty of the subject and ineffectiveness of outdated laws and executive decrees, a lot of misinformation is present in the governments. The challenge here is, how to avoid losing the competitive advantages that each country has? By exploiting the diversity present in the region, countries must take advantage of their strengths and on the other hand complement their weaknesses with one another. The creation of bridges of information is one of the simplest ways to accomplish this, universities should open their knowledge between them and grow together, thereby avoiding the duplication of tasks.

This is a sustainable mechanism that could allow developing countries to reach the limits of technology and thus be able to innovate with indigenous solutions. The initial research and development processes of space-faring countries cannot be compared to the industrialization processes of developing countries since there is a transversal difference in the historical and economic social axes that prevent them from taking the same routes previously traveled, but CA can, and hopefully will construct their own.

> "We regard the sending of the rocket into outer space, and the delivering of our pennant to the moon as our achievement, and by this word 'our,' we mean the countries of the entire world, i.e., we mean that this is also your achievement and the accomplishment of all the people living on earth." -Nikita Khrushchev, 1959.

4.2 The first education revolution

The promotion of universities as a point of contact can foster a suitable environment for the emergence of space and aeronautical sciences. With the resurgence of citizen interest in aerospace technologies, the possibility of positioning the region as a world benchmark is available. Universities must take action since they are by all means the starting point. Is indispensable to let loose the ties of the traditional academic learning schemes and aim for more innovative ways of teaching. Inter-institutional and international alliances can unite universities with industries and universities with other universities. All this without losing contact with their students. Organizations like TECSpace at TEC can give a point of contact between students and the outer world. A more practical approach to the learning tactics can be utilized in R&D centers, and thus create a win-win situation. This can be seen as obvious approaches to many however as obvious as it may seem it has never been implemented in its entirety. Actions and not reactions must be taken because the need for a better education will trigger the first education revolution in CA.

5. Between two Americas

Due to its geographical positioning in the continent CA has the advantage of being surrounded by powerful lands like Canada, Mexico, the United States, and Brazil to name some. That simple fact on its own could bring unparalleled benefits to them and the rest of the world. CA and Costa Rica can use this opportunity to centralize and unite forces between countries to make better advancements in Space sciences. Costa Rica with access to both Atlantic and Pacific oceans linked with the fact that is close to the equator could become a spaceport for many countries that have a specific need on space orbits. By getting close to the equator heavier payloads and more efficient launches can be possible.

The big ocean area that is available in the region could the become a great place to deorbit spacecraft, minding the possible contamination it could cause, and taking actions to reduce it and prevent it. This opens the possibility for amateur rocket testing and even bigger commercial missions.

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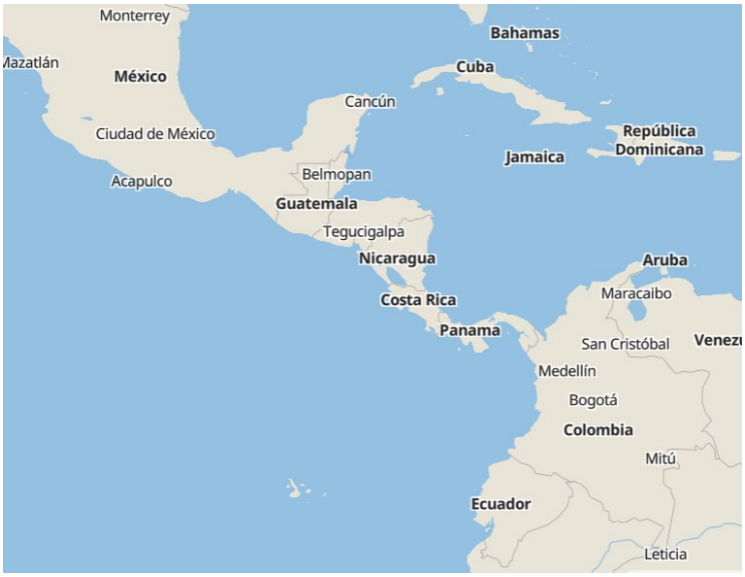

Figure 1: Geographical positioning of Costa Rica [35]

5.1 A new age of development

The opportunity for a Central American industry in aerospace technology is open, the high-quality industries that thrive in countries like Costa Rica make the aerospace business the perfect candidate to extract the potential of the region. Undoubtedly the aerospace industry has presented a continuous growth through the last years and in the last decade has seen a rebound in its popularity and importance. The creation of private companies interested in space exploration like SpaceX, ULA, Rocket Labs, etc. has accelerated this trend. This new era of private space and aeronautical development opens the door for an international and fast-paced industry in developing countries such as Costa Rica, Panama, and Guatemala.

To get in context, in the aerospace industry, suppliers are categorized into tiers or levels, from 1 to 4. These levels denote the proximity of the suppliers with the integrator or final client. [29] Right now Costa Rica is providing products in Tier 4 and Tier 3. To climb this ladder, it is important that companies work together with the government and the academy as close as possible. Tier 1 usually reserved for high technology companies like Rolls-Royce and General Electric but that doesn't mean that this option should not be explored. For this to happen an internal demand for this technology would be necessary. In the lower tiers usually, there is a dissociation between the final products and the need of the manufacturing companies, due to an overhead created by the production chain. By strengthening the ties with companies on the upper levels, higher tiers could become available for Central America. An example of this can be seen in the biomedical industries where the implementation of clean rooms by companies like Boston Scientific have proven to be fruitful. Another example of this can be the successful creation of the manufacturing and testing plant of microprocessors by Intel, the biggest silicon company in the world.

As shown in table 1, and based on how the market has been moving the last couple of years it can be seen that the world is on the doorstep for Space Exploration 3.0, and with it the opening of the private market of aerospace technology. This new era is the perfect chance for CA to start investing in technology.

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Table 1: Classification of space exploration era.[28]

Exploration phase	Time period	Characteristics
Proto-space Age	Before WWII	The leadership of individuals (and societies) such as Robert H. Goddard, Konstantin Tsiolkovsky, Hermann Oberth, Hermann Potocnik, Robert Esnault-Pelterie, et al. Influenced by Herbert G. Wells, Jules Verne, and other science fiction authors
Space Exploration 1.0	Cold War	Competition between the USA and the USSR with cooperation limited mostly to intra-bloc partnerships driven primarily by political considerations (duopoly situation)
Space Exploration 2.0	The 1990s - present	Exploration plans with new countries willing to participate, driven primarily by scientific motives (oligopoly situation)
Space exploration 3.0	Near future	The era of participatory human exploration (nations, industries, universities, and other NGOs) driven primarily by the quest for knowledge (including Arts and Humanities disciplines) as well as the economic potential (open-market situation)

- The table is taken from the paper "Toward a paradigm shift in managing future global space exploration endeavors" by P. Ehrenfreund, N. Peter

6. World Wide Challenge

Even if the solutions proposed are mainly based in CA the benefits of an aerospace industry expansion could be seen worldwide.

6.1 Equity and distribution

It would not be acceptable that after taking into account all the difficulties that CA have to face to get to the goal it repeats the same story with other regions or countries of the world. The OST is not explicit on how countries should share the benefits of this exploration but it's the ethical duty of the next generation of technician's engineers and scientists to ensure this inequity situation would never happen again.

In times when nationalism and patriotism are exhorted, it is necessary to recognize that science and technology have been a mediator of international cooperation and that it has allowed many people to break the chains of exclusion. The coordinated and cooperative work has managed to allow humanity to achieve goals that at some point were believed impossible and it is these ambitious goals should be shared with the world for them to be fulfilled.

7. Conclusion

The solution is not a simple one, to reach it joint work will be required, but it is not impossible. Costa Rica has the best opportunity to develop peaceful and demilitarized uses of space exploration, thus positioning into the vanguard, only then Costa Rica could become the hub of knowledge and production of space technology that humankind needs for outer space exploration.

At the same time, it would be only natural for many other nations to join into creating and collaborating on an even bigger and more impressive aerospace hub. Each country should contribute with their specific expertise and thus becoming an inclusive solution. This would help to make a change in mindsets about what is possible to achieve in the world. Central America is waiting for the possibility and opportunity to change, but it should rather create its own.

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