

TOWARDS AN ECOSYSTEM FOR AERONAUTICAL RESEARCH IN MEXICO

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Abstract

Emerging aeronautical nations face a unique challenge related to the availability of skills necessary and the role that research and development plays in developing these skills. These nations face growing pressures to leverage their industrial base to integrate into the global aeronautical supply chain while addressing the complexity of developing the necessary skills for a competent workforce in a rapidly changing environment. This challenge becomes ever more difficult to solve as aeronautical systems grow in complexity. As a result, strong collaboration between industry and academia in these countries is necessary to support the identification of necessary skills and research activities that help maintain a competitive workforce. This paper presents models for ecosystems around the world and how they can be established in Mexico to enable high-impact aeronautical research and development through industry and academia synergies. Furthermore, ICAS through its Global Academic Institutes Network (GAIN) plays the role of a catalyzer in this process. To contextualize the Mexican aerospace landscape, we present a capability assessment of the academic institutions, complemented by a survey of the industry to identify areas of focus and needs. One of the key findings is the need for formalized mechanisms for industry and academia to develop a workforce with relevant skills for the evolving aeronautical technologies. These insights motivate the vision of a cohesive ecosystem in Mexico where the ICAS global network supports this integration. Activities towards establishing this ecosystem formally started in April 2025 with the official induction of Mexico as an ICAS member and the inclusion of two academic institutions as part of the GAIN initiative. A direct outcome of this initiative is the development of a seminar at the Georgia Institute of Technology for students from Universidad Panamericana, one of ICAS associate members through the GAIN initiative. The goal is to expand these activities in the following years and identify specific areas where opportunities can emerge. Finally, this model can serve as a reference in other emerging aeronautical nations to support their development thanks to the global network provided by ICAS.

Keywords: workforce development, emerging aeronautical nations, industry and academia ecosystem

1. Challenges in workforce development in emerging aeronautical nations

The aeronautical sector has been profoundly marked by the economic globalization of recent decades. Various countries around the world have seen a transformation in their industrial activities, with the aeronautical industry typically being regarded as one of the most complex. Developing economies historically anchored in low-complexity manufacturing are increasingly experiencing an expansion into advanced industries such as aerospace. A natural step in the evolution of these countries is to focus on taking part in activities of higher value in the value chain. This evolution in the aeronautical industry involves going from manufacturing small components for an airplane to activities related to systems integration and sustainment.

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A crucial component for the evolution into activities of higher value in the value chain for the aeronautical industry is education and skilled-workforce development. Although workforce development strategies extend beyond the scope of a single industrial sector, developing the specific skills required by the aeronautical industry faces several challenges. These challenges are exacerbated by the profound transformation brought by the shift to digitalization in the aeronautical industry. This shift has created the need for new skills related to computer-aided-engineering, data science, and digital literacy to succeed in the aeronautical industry. These skills evolve at a rapid pace constantly changing the desired skills within the workforce. As such, now more than ever, it is imperative for every player in the industry to be engaged in the latest developments to maintain competitiveness.
Countries with established aerospace industries have the benefit of an established relationship between industry and academia to develop the basic research and implement training programs that support these trends through collaborative partnerships. However, countries with developing aeronautical industries like Mexico struggle to develop these type of partnership for various reasons [1]. This implies a great risk not only for these countries' strategic priorities, but also for the companies investing in these countries, as the implementation of evolving technologies faces headwinds due to a lack of current skill development programs. In this context, global academic organizations and professional societies can play a distinct role in supporting the development of these networks as they facilitate mechanisms for knowledge transfer in an international network. This paper showcases the efforts being made in Mexico to establish an ecosystem that facilitates these exchanges with the aid of ICAS and the ICAS Global Academic Institutes Network (GAIN) initiative. The rest of the paper is organized as follows: first, examples of the ecosystems developed around the world are presented, with their role in workforce development. With this in mind, the vision statement for the ecosystem in Mexico is presented. This includes a survey of the industrial needs and academic capabilities of Mexico along with a survey of global research trends within the aeronautical industry to illustrate scenarios where global collaboration can support the establishment in the ecosystem. Once the vision is established, a progress report of the activities so far is presented, indicating the main steps taken towards this vision. Finally, we present the next steps in building this ecosystem in Mexico and expansion opportunities through the ICAS global network.

2. Ecosystems to enhance skilled workforce development

Ecosystems that foster exchange between research and industry facilitate the exchange of relevant domain knowledge, which highlights the need for collaboration between these facets [2]. One of the most studied models to explain this ecosystem is the triple-helix model for innovation that states the interdependence of academia, industry and government to support innovation [3]. However, creating an ecosystem where there are established interfaces that facilitate interactions between these actors relies on establishing a specific role for each of them. In the case of the aeronautical industry, one of the most commonly used vehicles to establish this ecosystem is through research and development [4]. In this context, the relationship relies on close collaboration between industry and academia to ensure that research activities leverage the domain knowledge and target relevant directions based on industry feedback with government providing support through funding policies [4]. These research activities then serve to inform the educational curriculum developed in each of these universities, shaping the skills the workforce that industry will then leverage. Figure 1 synthesizes the interplay between these entities in the relationships that can form this ecosystem.

2.1 Examples of ecosystems around the world

Similar models to the one presented in Figure 1 for the aeronautical industry have been deployed in different countries around the world, highlighting the global significance of these type of efforts. To illustrate the global prevalence of these models, several institutional frameworks identified in the literature are examined below.
The example presented in Figure 1 comes from the description of the Swedish ecosystem. This example presents the Swedish Aerospace Research Center (SARC) as a catalyst that supports the collaboration of academia, government and the relevant aeronautical industries in the country to make the best of their resources [4]. It details the specific needs from each of the main industry

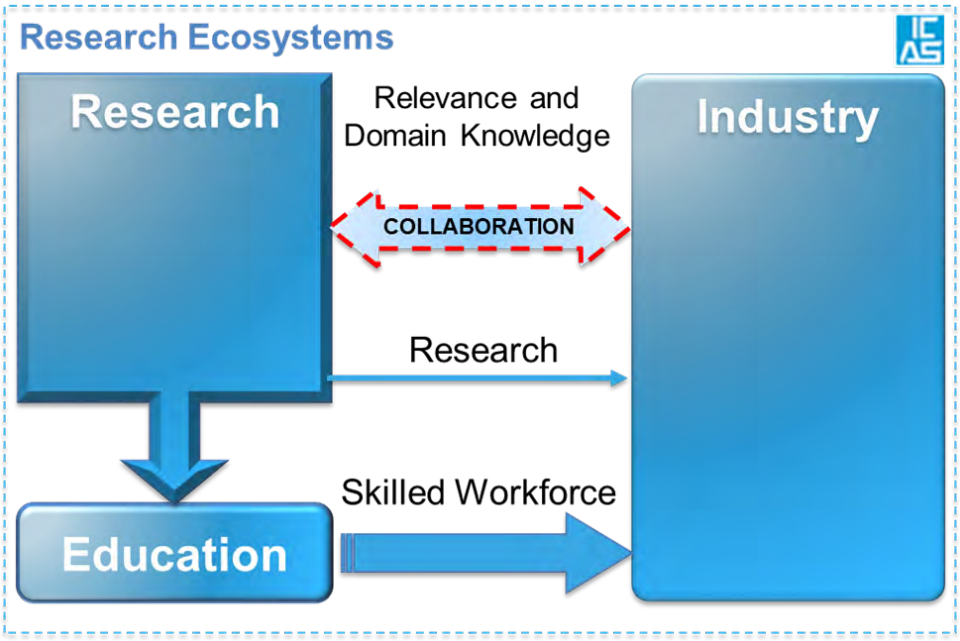


Figure 1 – Research Ecosystem Interaction Model

players in the country and how the most important academic institutions react to these. However, it also highlights challenges such as securing funding to maintain a enduring initiative.

Another example is the established ecosystem in the United States of America across various fields. The funding coming from industry and government agencies to support academic research creates an environment where constant dialogue can occur to align the educational curriculum with the skill needs of industry and government sponsors In particular, this approach is exemplified at the Aerospace Systems Design Laboratory, at the Georgia Institute of Technology through the integration of *Grand Challenge* projects within the curriculum [5]. These projects expose students to real problems faced by industry and government sponsors and enhance the learning of necessary skills as they are developed to be applied in a relevant context. While institutional approaches to these partnerships vary across universities, the overarching framework in the United States inherently fosters collaborative research and development.

In other nations where the aeronautical activities are emerging, different efforts to establish these types of ecosystems have been reported. In Malaysia, an Industrial Collaboration Program has been established to support the transition of the aeronautical industry towards a knowledge-based economy along with the skill development necessary for it [6]. Similarly in India, the collaboration between industry and academia supports the identification of gaps in skills that prevent reaching the industrial development objectives [7].

In summary, establishing R&D ecosystems where industry and academia collaborate is a proven strategy deployed across diverse global contexts to support workforce specialization. However, these ecosystems are not organically established in every country leading to possible missed opportunities due to lack of support. Furthermore, the global nature of the aerospace industry motivates the need for a global perspective to the problem as the supply chains span throughout the globe. This challenge can be alleviated through the concerted efforts of inclusion from international organizations and professional societies. The development of the Global Academic Institutes Network (GAIN) within ICAS is an example of this possible support. The GAIN initiative provides universities with an international forum to exchange ideas, best practices and collaborate in academic projects. This brings a global perspective in the integration of industry and academia and supports the global alignment of the various efforts. The rest of this paper focuses on addressing the specific example of Mexico, detailing its context, progress made so far and future directions.

3. Developing an ecosystem in Mexico with ICAS as a catalyzer

Mexico formally joined the council in 2025 with a ceremony at the *Feria Aeroespacial Mexicana* (FAMEX) through the representation of the Mexican Federation of the Aerospace Industry (FEMIA), with close involvement from the Mexican Council of Aerospace Education (COMEA). This signing was part of the recent expansion by ICAS into more countries with emerging aeronautical capabilities. Part of the shared vision by FEMIA, COMEA and ICAS in this signing is to have ICAS' support in establishing this ecosystem of collaboration between industry and academia. To present the vision on how to achieve this, we'll present a survey of the industrial context in Mexico. This is followed by a presentation of the existing academic capabilities in the country. With this in mind, the main stakeholders are introduced and the vision for the ecosystem is established.

3.1 Aeronautical Industry Context in Mexico

The aeronautical industry has experienced exceptional growth in Mexico for the last 20 years. The average yearly growth in exports between 2004 and 2019 is 14% [8] and while disrupted by the Covid19 pandemic, it has recovered its earlier pace. In 2024, the country presented a positive 18% trade balance with the exports in 2023 being $9.4 billion USD and $10.7 billion for 2024 with similar growth rate expected in the final 2025 calculation [9]. This positions Mexico within the top ten of the largest exporters for the aerospace industry. The composition of facilities is distributed into manufacturing, with 76% , maintenance, repair and overhaul with 12.5% and design and other engineering services with 11.5% [10]. The domestic aerospace sector accounts for more than 65,000 direct jobs, primarily concentrated in commercial aviation. These jobs are distributed across the country as shown in Figure 2. These facilities represent foreign and domestic investments, with OEM's and Tier 1 suppliers setting up activities in the country. This level of economic activity highlights the need for a skilled workforce that can handle the growing complexity of aerospace systems, along with a strategic industry in the country that needs to remain competitive. This not only implies the development of the skilled workforce required to support the industry, but also the adaptation of these programs to develop the skills in new technologies [10].

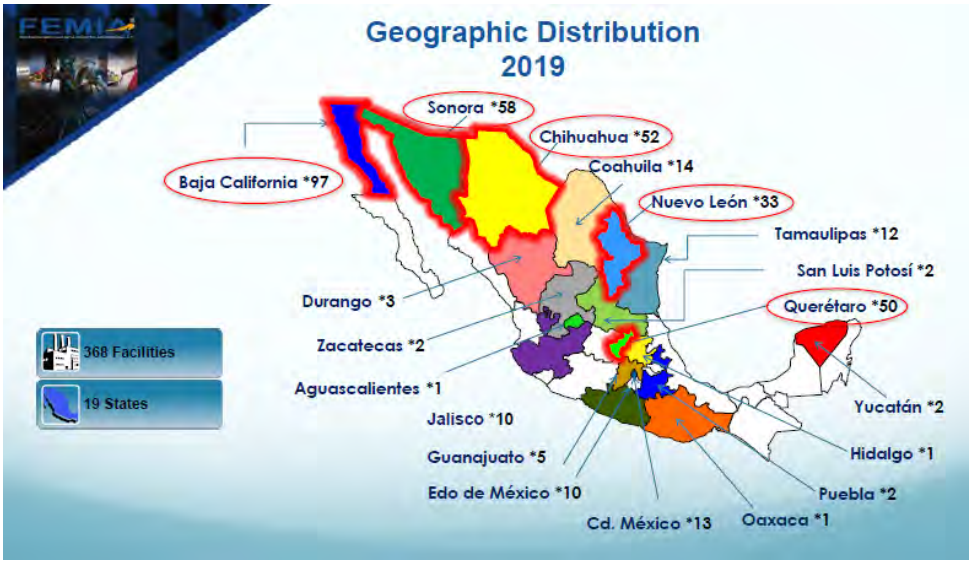


Figure 2 – Geographical distribution of facilities across the country

3.2 Academic Context related to Aeronautics in Mexico

The academic setting in Mexico with aeronautical activities includes 41 institutions across 15 states, with most of them in the northern and central regions of Mexico [10]. These 41 institutions include 71 programs that range from associates' degrees for technicians to doctoral degrees. The majority of these programs are related to manufacturing, maintenance and operations (including flight attendant training). The total enrollment adds up to 7,257 people in 2020 with a vast majority (98.5%) of these being associate's and bachelor's degrees [10]. However, the academic environment has

several opportunities for improvement identified by the Secretary of Education's strategic agenda. The academic faculty specialization remains heavily concentrated in manufacturing. This reveals the need strengthen research and development capabilities in emerging relevant areas in the current digital transformation. Furthermore, this context can provide an opportunity to propose original research that leverages existing expertise in manufacturing or materials science to address the new challenges. Another key gap identified is to design programs that support lateral career moves to leverage talent from other established industries in the country, such as the automotive industry, while developing the specific necessary skills for aeronautics [10]. Furthermore, only 30% of the institutions have strong relationships with industry for research and innovation projects.

3.3 Vision for an ecosystem in Mexico with ICAS as a catalyzer

One of the strategic initiatives that are identified by the Mexican Secretary of Education in its roadmap for aeronautics is the establishment of enduring initiatives that support the development of relationships between industry and academia to support high-impact research and development activities [10]. With this context Mexico formally joined ICAS in March 2025. The organization representing Mexico is the Federacion Mexicana de la Industria Aeroespacial (FEMIA by its Spanish acronym). Its members include 120 companies that account for 80% of the economic activities related to aerospace in Mexico. A crucial partner of FEMIA is the Mexican Council of Aerospace Education (COMEA by its Spanish acronym) which includes 30 academic institutions from around the country with aeronautical activities. These two entities provide a nationwide institutional mechanism to support industry and academia collaborations. Furthermore, two universities have joined ICAS as associate members under its Global Academic Institutes Network (GAIN) program: Universidad Panamericana (UP) and Universidad Aeronáutica en Querétaro (UNAQ). These entities together provide the basis for the vision to establish an ecosystem between the aeronautical industry and academia in Mexico.

The envisioned ecosystem operates on a tri-centric approach where research capabilities are steered by local industrial needs aligned with global trends to support the development of the future workforce. In this vision, universities, including UP and UNAQ but not limited to them, provide academic research capabilities and provide educational programs for skill development. The global trends in the sciences are identified by the discussions taking place in ICAS congresses and forums, with the GAIN initiative providing specific capability alignment and development opportunities for the universities. The role of FEMIA centers in the identification of needs for research and development and skills from the aeronautical industry in the country with COMEA acting as a intermediary to align these needs with the specific academic institutions. The intersection of these three fronts provides the base for the development of an ecosystem that supports more meaningful opportunities for research that develop the necessary skills in the country's workforce, with figure 3 showing a synthesis on how they interact. Furthermore, the participation of the different government actors in this ecosystem is considered through academia as there is a large component of public universities directly supported by government budgets. While certainly the potential scope of government's reach is wider than its influence on academic institutions, according to the strategic agenda its involvement is mostly through university funding justifying this choice in the model's framing [10] The interaction of these entities is presented in Figure 3.

4. Progress Report for the establishment of this Ecosystem

During this year different discussions took place to shape this vision presented in section 3.. These started with a visit to Mexico City on the occasion of Universidad Panamericana's induction as an associate member and part of the ICAS GAIN program. This visit also presented an opportunity to discuss with the leadership of FEMIA the vision for an ecosystem and the role ICAS can play in it. As a result, the formal induction of Mexico to ICAS through FEMIA's representation took place at the FAMEX airshow, the most important airshow in Latin America in April 2025. The presentation at this airshow created opportunities to engage with other relevant stakeholders in industry and academia in Mexico and cemented the impression that an ecosystem can flourish with global support from ICAS. A key outcome of this was the engagement of Universidad Aeronautica en Queretaro, resulting in its induction as an associate member later in the year under GAIN program. Figure 4 contains some of the photographs that marked the main events taken so far.

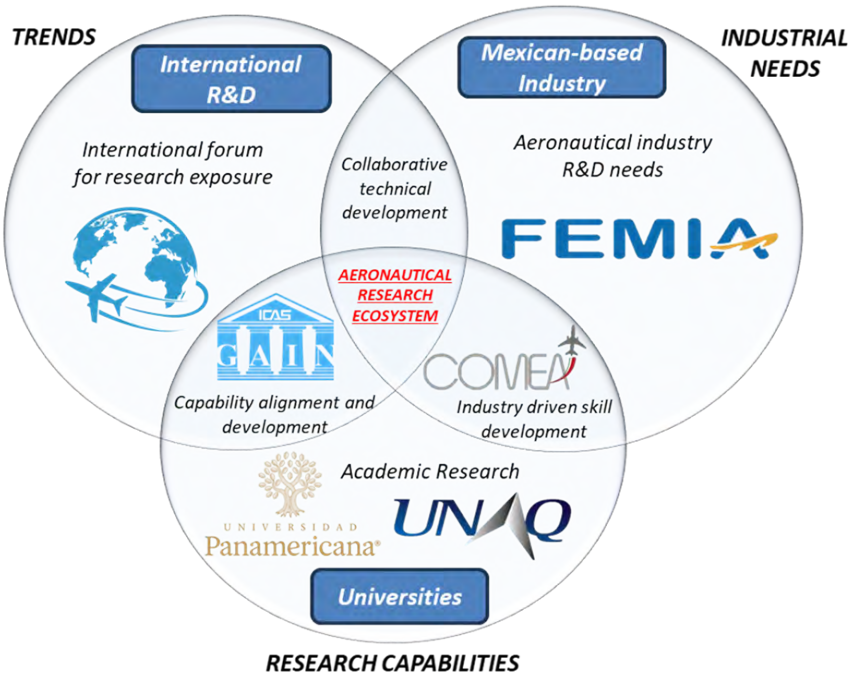


Figure 3 – Envisioned actors and their roles in building an aeronautical research ecosystem in Mexico

A key outcome of this collaboration so far is a seminar for students and faculty of Universidad Panamericana. They visited the Aerospace Systems Design Laboratory at the Georgia Institute of Technology during the summer of 2026 for a week-long symposium, learning about the latest in aerospace innovation and getting support in their projects. This exchange highlights some of the opportunities for knowledge transfer that the ICAS GAIN program can promote. These outcomes suggest that while the initiative is just starting there are promising signs towards the establishment of this ecosystem.

5. Concluding Remarks and Future Steps

The growing complexity of the aeronautical industry creates the need for new skills in the workforce. The establishment of strong partnerships between industry and academia, especially through research activities, supports the identification and development of these skills. These ecosystems are present in different countries throughout the world with different levels of success. However, emerging aerospace countries can face challenges in creating these ecosystems. Through this paper, the efforts taken in ICAS to support the development of such an ecosystem in Mexico are presented. The activities in Mexico are still in the early stages but indicate significant potential.

Future work presents a wide array of pathways for institutional expansion. The International Society of Air Breathing Engines (ISABE) and ICAS' partner society is hosting its 2027 conference in Queretaro, Mexico. This creates a great opportunity for additional engagements and visibility about opportunities in Mexico and motivates Mexican industry and academia to share their work. However, beyond the benefits of hosting international conferences domestically it can be challenging to sustain and formalize the opportunities for this knowledge transfer. One initiative that is undertaken in fields like medicine in Mexico is the organization of conferences presenting the latest research trends from international conferences. This provides a great opportunity to formalize some knowledge sharing from the state-of-the-art throughout the field while lowering the barriers to access it. Other activities that can be undertaken include the leverage of the GAIN program to formalize academic exchange or similar training programs that support the development of specialized academic and industrial talent. Additionally, it is important to engage with industry further to ensure their participation towards this ecosystem. Finally, while the application of these activities focuses on Mexico, the model can be replicated in other countries through the ICAS GAIN initiative.



(a) FEMIA signing at FAMEX 2025



(b) Universidad Panamericana Induction Ceremony



(c) Keynote from Prof. Mavris at National Aerospace Innovation Congress in Querétaro, Mexico, including Universidad Aeronáutica en Querétaro induction



(d) Universidad Panamericana visit to Georgia Tech for a week-long seminar

Figure 4 – Activities conducted in Mexico until June 2026 towards the ecosystem

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