Strategic Model of Collaboration between University and Industry to R&D+I of astronomical and aerospace instrumentation PM4R-RIS3 approach: proposal Baja California-Sonora México

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Astronomy is a unique and profitable tool to promote sustainable global development, largely due to the impact and incorporation of its contributions in technological, scientific and cultural terms. It is an important link to boost economic growth through education, thus getting less developed countries to participate in cutting-edge scientific research, strengthening the capabilities of human capital and, on the other, generating opportunities for technological development itself. The International Astronomical Society (IAU) classifies Mexico in the group of Developed B Countries in astronomy research, these are IAU member states with fewer than 4 members per million population that participate in, or host, frontline astronomy research facilities.

The scientific and technological community of the Institute of Astronomy (IA) of the National Autonomous University of Mexico (UNAM), the leading institution in terms of scientific productivity and technological development in astronomical instrumentation. The SPM OAN currently has 7 telescopes which operate in the Sierra de San Pedro Mártir located in Baja California, at northwest of Mexico; more than 30 scientists and +30 technologists’ experts in the development of Astronomical Research, and Technological and Instrumental development, contribute to the formation of human capital at the PhD and Master’s programs. The areas of technological development of the OAN SPM are: Instrumentation (optical, electronic, precision mechanics, mechanical design, control systems), data sciences, artificial intelligence, communication and scientific computation.
Similarly, the aerospace and aeronautical components industry of Mexico is a competitive benchmark in the international market, for the past 9 years, the industry has maintained an annual export growth of 17.2%. Currently, there are +287 companies and support entities in the country. Government plans focus their efforts on defining strategies to identify and develop the production of aerospace clusters vocations in the country and strengthen the strategic link with research centers and educational institutions higher.

In Mexico, Technological Universities are decentralized public institutions of state governments and their Substantive functions are training of technical and undergraduate professionals, that respond to technological requirements and organizations of the productive sectors and regional strategic services in accordance with scientific advances and contemporary technologies. The educational model of the UT, establishes the link with the productive sector as the main mechanism to achieve the academic updating of the teachers and the rapid employability of the students, being the coordinated collaborative development of technological projects the key strategy.

There are currently 106 Technological Universities, in 26 states of the Mexican Republic, one of them being the Technological University of Hermosillo.
The results of the traditional models of collaboration between the Academy and the productive sector, mainly generate a) projects to generate response to demands (problem solving, improvement proposal and very rarely innovation proposals) detected by the productive sector, b) promote employability opportunities for students and teachers, basically because the financing of the projects is provided by the state science and technology councils and the sectoral funds, a factor that restricts (leaves subject to the availability of economic resources) the opportunities for generating innovation, and on the other hand, it limits the growth of development capacities of research centers and academies.
The traditional relationship model between academic institutions and the industrial sector, to carry out innovation and development projects is described by Vega González, L. R., (2015), this model is the scheme used by CONACyT and the Federal Economy Secretariat as a reference for define Sectoral financing funds to support the development of R & D & I projects, and therefore, are the models that academic institutions and productive sectors consider to generate proposals that they cannot fully finance with their own resources. Therefore, for the universities and research centers of Mexico, the establishment of alliances with the government and the industrial sector is the main alternative to increase their capacities and participation in the global technological scientific context.
The development of scientific and technological innovation projects that in addition to supporting regional and national economic growth, consider in their approach the needs and opportunities of similar economies in other countries and regions of the world, allow access to sources of financing of greater economic scope and therefore of scientific-technological impact.

The European Commission defines smart specialization strategies (RIS3 or S3) as a methodology to define national and regional strategies to develop competitive advantages by developing and matching the strengths of research and innovation with business needs, to address emerging opportunities and market developments in a consistent manner, avoiding duplication and fragmentation of efforts. They are also the backbone of national or regional strategic research and innovation policy frameworks. It is structured around six practical steps: 1) Analysis of the innovation potential, 2) Establish the RIS3 process and governance, 3) Develop a shared vision, 4) Identify priorities, 5) Define an action plan with a coherent combination of policies, and 6) Monitoring and evaluation.

PM4R (Project Management for Results) is a methodology developed by the Inter-American Development Bank (IDB) and the Inter-American Institute for Economic and Social Development (INDES) that provides the essential tools in accordance with good international practices, to achieve the success of development projects (social, economic, technological) in their different elements of time, cost and quality. The tools he uses are planning: Task design structure, schedule, S curve, procurement matrix, communications matrix, risk matrix and resource allocation matrix; and although it uses other tools in the previous and subsequent phases, specific tools considered as the basic ones to achieve effective planning in project management.

In Mexico, the Commission of Science and Technology (CCyT) of CONAGO (National Governors Conference), promotes the structuring of technological development projects through the state science and technology councils, using this reference RIS3 and PM4R. This allows that through international financing platforms such as those of the European Commission (EC) or the Inter-American Development Bank (IDB), extraordinary financing resources can be captured.

This study presents the linkage and collaboration model proposed (en proceso de implementacion) by the National Astronomical Observatory SPM, Astronomy Institute of UNAM (Baja California) and the Technological University of Hermosillo (Sonora) for the development of research projects and technological development in the Aerospace sector, to influence the development of technology as well as the incorporation of researchers and professionals in the industry, generating opportunities for the development of national technology, transfer and certification of human capital competencies.
Model of connections of Astronomy with other disciplines. The colours in the inner ring represent the colours of the UN Sustainable Development Goals (SDGs) to which astronomy can contribute (this “wheel” is an adaptation of the IAU Strategic Plan 2010–2020).

Space Economy Model of OCDE and Sustainable Development Goals (SDGs)
PROPOSED MODEL

STRATEGIC MODEL OF COLLABORATION BETWEEN UNIVERSITY AND INDUSTRY TO R&D+I OF ASTRONOMICAL AND AEROSPACE INSTRUMENTATION - PM4R-RIS3 APPROACH

STAKEHOLDERS
- STATE GOVERNMENT
- REGIONAL GOVERNMENTS
- NATIONAL GOVERNMENT
- PRODUCTIVE SECTOR
  - CLUSTER: AEROSPACE
  - TEC INFORMATION TECHNOLOGY
  - MANUFACTURE
  - BIOENGINEERING
  - RENEWABLE ENERGY
- RESEARCH CENTERS
  - HIGHER EDUCATION
  - SPECIALIZED TECHNICAL INSTITUTIONS
- SCIENCE AND TECHNOLOGY CONSUL.

INPUT
- CLUSTER + GOVERNMENT TECHNOLOGICAL DEVELOPMENT NEEDS
- INSTALLED CAPACITY RESEARCH AND DEVELOPMENT CENTERS
- HIGH SPECILTY HUMAN CAPITAL

PROCESSOS
- DEVELOPMENT OF PRECOMPETITIVE AND COMPETITIVE TECHNOLOGICAL PROTOTYPES
- INNOVATION AND DEVELOPMENT OF TECHNOLOGICAL AND SCIENTIFIC PROJECTS
- SPECIALIZED CERTIFIED TRAINING PROGRAMS

OUTPUT
- HIGH TECHNOLOGICAL VALUE PRODUCTS
- INCREASED VALUE SERVICES
- INCREASE IN THE CREATION OF OWN TECHNOLOGY (SPIN-OFF)

CLIENTES
- STRATEGIC ECONOMIC PRODUCTION SECTOR
- GOVERNMENT
- RESEARCH CENTERS
- INSTITUTIONS OF HIGHER EDUCATION

(re)STRATEGIC PROCESSES

LEGAL
- RESEARCH INNOVATION AND DEVELOPMENT (AVAILABLE RESOURCES)
- INTELLECTUAL PROPERTY
- SATELLITE INSTRUMENTATION MECHANICS DESIGN
- ARTIFICIAL INTELLIGENCE
- DATA
- TEC 4.0
- ELECTRONICS
- MECHATRONIC OPTICS
- ANALYSIS
- EVALUATION OF PROJECTS
- MAINTENANCE
- CONTROL SYSTEMS
- AVIONICS SYSTEMS
- MACHINING LEARNING

HUMAN CAPITAL
- RESEARCHERS TECHNOLOGIES SPECIALISTS

CONTRACTS AGREEMENTS
- COLLABORATION AGREEMENTS
The focus of this model is mainly to support the strengthening of the installed capacities of the IAE-OAN SPM, as well as of the allied research institutions and centers (UTH, UABC, ITE, UNISON, UTT,) in the following activities: The focus of this model is mainly to support the strengthening of the installed capacities of the IAE-OAN SPM, as well as of the allied research institutions and centers (UTH, UABC, ITE, UNISON, UTT,) in the following activities:

a) Management of strategic partners for the development of astronomical and aerospace projects;
b) Support in the design and development of technological solutions to meet the needs of companies and the public sector in the region.
c) Promote strategic initiatives for the technological transfer of value-added products/services (high specialty) developed
d) Support the steps related to the protection of the intellectual property of the university,
e) Support the valuation efforts of promote the generation of value-added services catalog, which generate extraordinary income to IES/CI such as the provision of specialized training services, characterization studies and certification services, by academic staff, optimizing the infrastructure and installed laboratory capabilities and workshops, e) Support the valuation efforts of promote the generation of value-added services catalog, which generate extraordinary income (such as the provision of specialized training services, characterization studies and certification services, by academic staff, optimizing the infrastructure and installed capacities of laboratories),
f) Support the entrepreneurial efforts of academics and students in the community, among others.

The essential basis of the model is the direct collaboration and cooperation with the clusters of the aerospace sector as well as the clusters that provide technology, services and other resources and services to the space and aerospace sector. It is essential to establish strategic alliances with the productive sectors (such as clusters, chambers, associations, consortiums, among others), which allow the permanent updating of academics (especially, academic technicians) for high-specialty certification purposes. Also, it is important for the model to support the dissemination in the industrial society (in addition to the scientist) of the results of research and technological development, thereby strengthening the presence and importance of the contributions of the academy and collaboration with the productive sector.

Another important factor to promote and support are inter-institutional academic initiatives aimed at the development of scientific-technological projects, dissemination and professional training. Equally important is to develop a niche of opportunities for the generation of sources of income to obtain external resources and generate a source of financing to promote the development of projects and support for students who develop them.

The structure of this model started the construction and implementation process from February 2019, as of the date of this presentation it is in the development of the internal diagnostic work of the capacities to initiate strategic actions of effective linking, in terms of: experience/knowledge (know-how) of the technical (scientific-technological) group. Availability of human resources and infrastructure, we have identified the initial strategy, the following catalog of value-added services. Similarly, the training of academic personnel in intellectual property, technology transfer, project management, as well as the exploration of sources of financing has been included.
This strategic model of collaboration, in its initial phase, and for now is carried out by a team of scientists, technologists and executives of OAN SPM -IAE (UNAM) (Baja California), CNyN (Baja California), ITE (Baja California), UABC (Baja California), UTH (Sonora). However, there are already preliminary results of this first stage, which focus on support actions for the diagnosis of technological capabilities, courses with specialized certification objectives, as well as joint financing analysis for the development of border science projects. It is expected that during 2020-2021, important results will be achieved in terms of own technological development.
Participants of the Course on Selected Topics in Space Engineering: 75 undergraduate students (electronics, mechanics, mechatronics, industrial, aerospace, computer systems). August 2019.


Workshop of Financing of technological and scientific development projects in international systems, attended 21 participants among scientists, technologists and responsible for technology transfer offices. June 2019.

Participants of the Course Intellectual Property. 24 participants among scientists, technologists and responsible for technology transfer offices. June 2019.
Currently, the political, economic and social situation of Mexico, plan important challenges for the scientific and technological development in terms of financing for industry and academia, in this context, the development of inter-institutional projects and the establishment of collaboration networks with the Cluster and state science and technology councils represent an opportunity to access international financing platforms, driving innovation and effective technology transfer, and strengthening the professional capacities of academia and industry.

The active and close participation of entrepreneurs, in general terms, in the model facilitates the identification of innovation, entrepreneurship, and technological transfer capabilities of research centres. Although this model is in the initial phase of design and diagnosis, it is recognized that as the strategy is developed and implemented, there is a need to modify conventional passive link structures and generate active and proactive collaborative links with the sector productive and government, by academic institutions. Finally, it is contemplated that the model is in its operational maturity in a term of 2-3 years.
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