



Tecnológico  
de Monterrey

RESEARCH

EDUCATE

INNOVATE

TRANSCEND

# Research that Transforms Lives

2015



Tecnológico  
de Monterrey

**F**or Tecnológico de Monterrey research is a strategic activity; it is the engine that generates innovative solutions for the economic, social and environmental development of our country. We are committed to the idea that scientific and applied research should be used to add value to a society in a more rapid, measurable manner. We believe that there are three ways to accomplish this: 1) research to improve education; 2) research to achieve innovation; and 3) research to transform society.

Thus, research is a key cornerstone of education, as there is a need to continuously evolve scientific and technological knowledge in our learning process. The challenge is the use of scientific research to create value to develop a more educated society in a global world, regardless of that society's social and economic reality. We understand that science, technology and innovation will continue to add value to society. An innovation process is a driver for research activities and research is fundamental to innovation.

Therefore, the challenge is to enable a positive connection to bridge knowledge generation with value creation in order to address the most demanding problems humanity is facing: water, energy, environment, food security, global health, education, sustainable growth and poverty. Scientific and applied research should transform society. Open research and innovation models are key to address these challenges with a sense of community, collective knowledge and capacity to act.

At Tecnológico de Monterrey we combine two research approaches with open international collaboration: “knowledge driven creation” and “society driven innovation”. Our researchers have a responsibility towards value creation based on our scientific research that addresses society's demands.

But they also have to advance scientific knowledge to create new concepts, theories, and paradigms to advance the understanding of the world and the universe. We are committed to undertaking research to educate, innovate and transform in order to transcend in this lifetime.

Tecnológico de Monterrey has decided to focus this scientific activity on eight main strategic research areas, encouraging innovation, knowledge generation and knowledge transfer, with the goal of trying to solve México's and worldwide problems. These eight strategic areas include: biotechnology and food; mechatronics and engineering; information technology, sustainability; public policy; business; medicine; and education, the humanities and the social sciences.

This report gives an overview of Tecnológico de Monterrey's scientific and technological activity, offering facts and figures on the impact achieved by our research faculty's work. A general summary of the research and innovation results from 2002 to 2015 is presented, reviewing graduate programs, research areas, international collaboration networks, industrial agreements, patent application results and the institution's standing in the major world university rankings.

These areas are aligned to the eight strategic areas. The scientific work will start, then, from a strategic area that will take concrete form in a discipline and, more precisely, around a theme, where a group of researchers, professors and graduate students meets to generate and transfer new knowledge. To fulfill the scientific objectives, we have created 41 strategic groups that sustain the academic and research activities of the five schools of postgraduate studies and research programs: 1) School of Engineering and Sciences; 2) EGADE Business School; 3) School of Government and Public Transformation; 4) School of Education, Social Sciences and the Humanities; and 5) School of Medicine.

Research at Tecnológico de Monterrey fosters the learning process of our students, underpins the intellectual activities of our professors, and generates knowledge and innovative solutions that address society's demands.

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2015



# Tecnológico de Monterrey

- Privately funded, 1943
- Non-profit
- Independent
- Non operational support from the government
- **28** non-profit sponsoring organizations
- **542** board of trustees members



Eugenio Garza Sada (1892-1973) was born into a business family, the son of the man who founded the Cuauhtémoc Brewery in Monterrey in 1890. His experience at MIT was the basis for the organization of Tecnológico de Monterrey, which he established along with a group of Monterrey businessmen. With a prophetic vision, Garza Sada devoted considerable effort to the expansion of the city of Monterrey. He was a tireless defender of private and free enterprise. His leadership in Monterrey was very clear and fruitful, both in the field of business, and in education and social welfare. Both a successful businessman and an active promoter of community development, Eugenio Garza Sada consistently acted with great simplicity and humanity, focused on the progress of those around him, without distinction. The significance of this great man, industrialist and humanitarian, is undeniable and imperishable.

# Tecnológico de Monterrey

MÉXICO

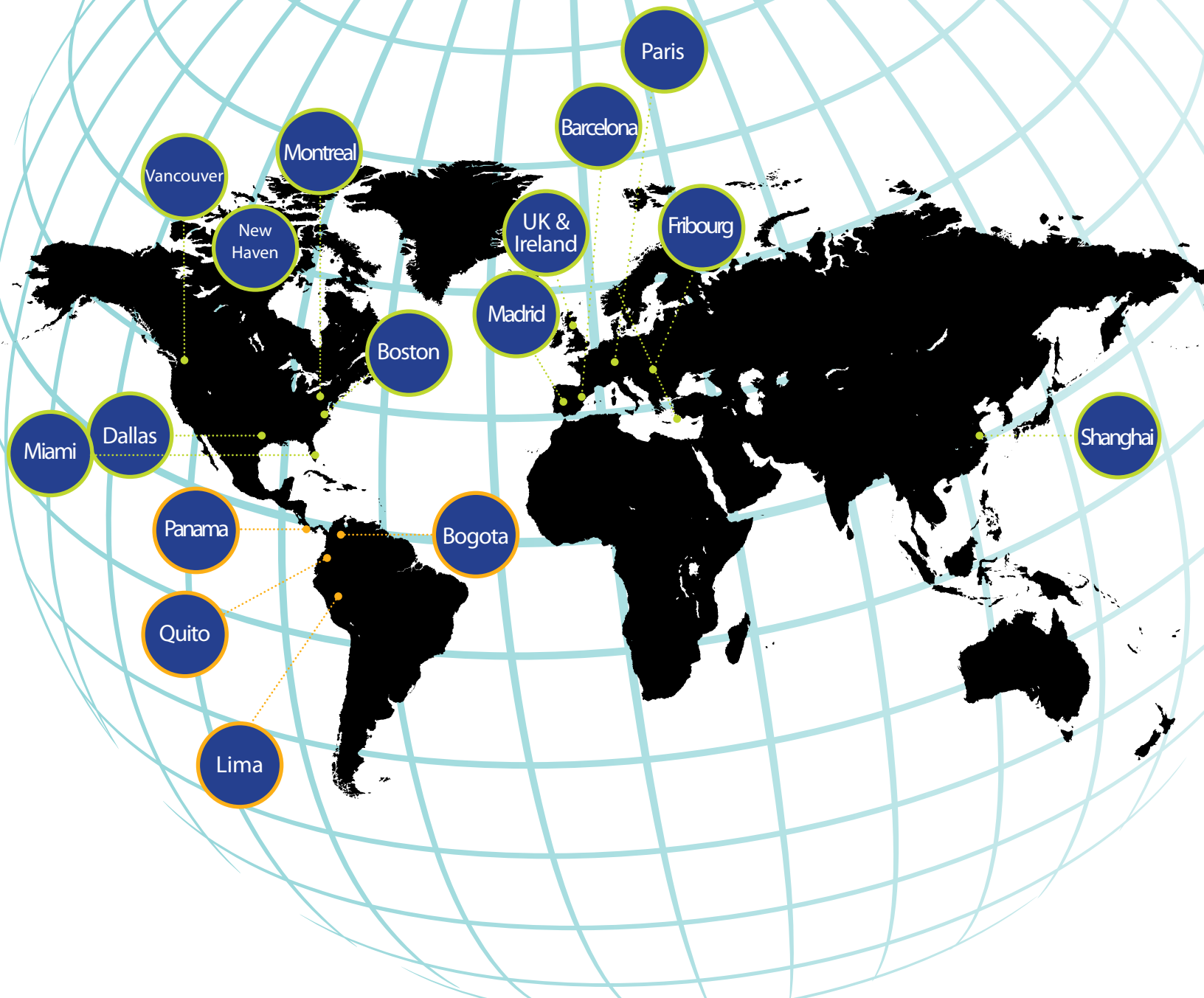


31 Campuses

25 Cities

5 Multi-campus Research & Graduate Schools

# 16 INTERNATIONAL LIASON OFFICES





# FACTS & FIGURES 2014

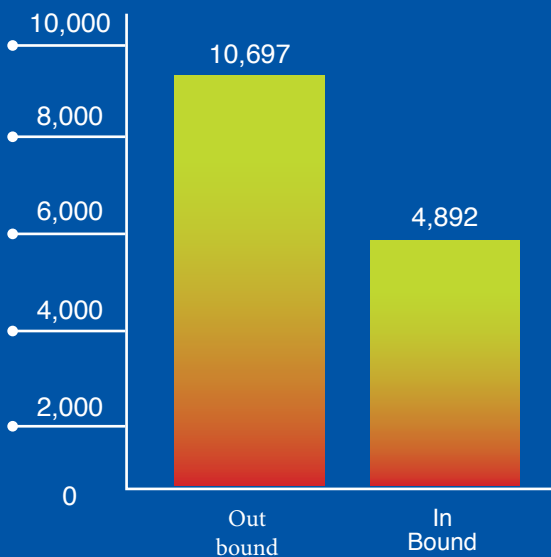
9,431

Professors

95,124

Students

## Student mobility



52% of graduate students had an international experience

Alumni  
281,162

220,229

undergraduate

60,842

graduate

# FACTS & FIGURES 2014

## Alumni Associations Worldwide



281,162 alumni distributed in:

- |                    |            |                        |
|--------------------|------------|------------------------|
| Arizona            | Florida    | Panama                 |
| Austin             | France     | Peru                   |
| Australia          | Germany    | Quebec                 |
| Boston             | Guatemala  | San Antonio, Texas     |
| Calgary            | Houston    | San Francisco Bay Area |
| California         | Ireland    | Scandinavia            |
| Chicago            | Mexico     | Seattle                |
| China              | Michigan   | Spain                  |
| Colombia           | Montreal   | Tijuana-San Diego      |
| Connecticut        | New York   | Vancouver              |
| Dominican Republic | New Jersey | Washington DC          |
| El Salvador        | Ontario    | Others...              |

# RESEARCH FACTS & FIGURES 2014

## PEOPLE

1,435

RESEARCH  
Faculty

12,587

GRADUATE  
STUDENTS

Postdocs

56

PHD  
STUDENTS

551

399

Undergrad Students Participating in  
Research Projects

# RESEARCH FACTS & FIGURES

## 2010-2014

### PUBLICATIONS

2,249

PUBLICATIONS

6,665  
Citations

Citations per publication

3.1

International  
Collaboration

Publications co-authored with institutions in other countries.

42.4%

(In Mexico is 39.2%)

Publications in  
top 10% journals  
by SNIP

(Source Normalized Impact per Paper)

19.2%

(In Mexico is 12.5%)

Academic-  
Corporate  
Collaboration

Publications with both academic and corporate affiliations.

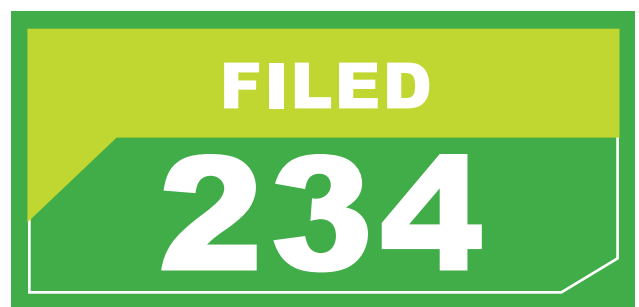
1.4%

(In Mexico is .8%)

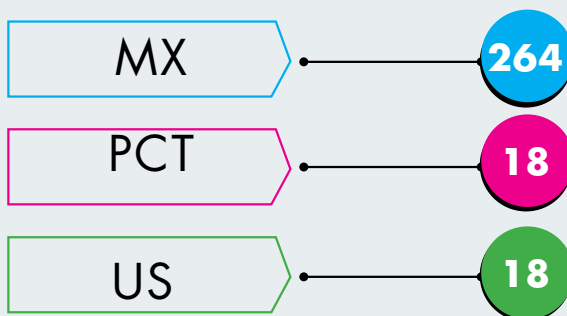
# PATENTING FACTS & FIGURES

## 2010-2015

### PATENTS



### FILED AND GRANTED



# ENTREPRENEURSHIP 2014

2,899

Companies being incubated in the entrepreneurial ecosystem

82

Incubators in the incubator network

25

basic

8

high impact

49

small companies

1,031

small companies

3,237

graduated companies

16

business accelerator in accelerator network

15

technology parks

170 companies in technology parks

# RESEARCH PROJECTS 2014



559

Industry

457

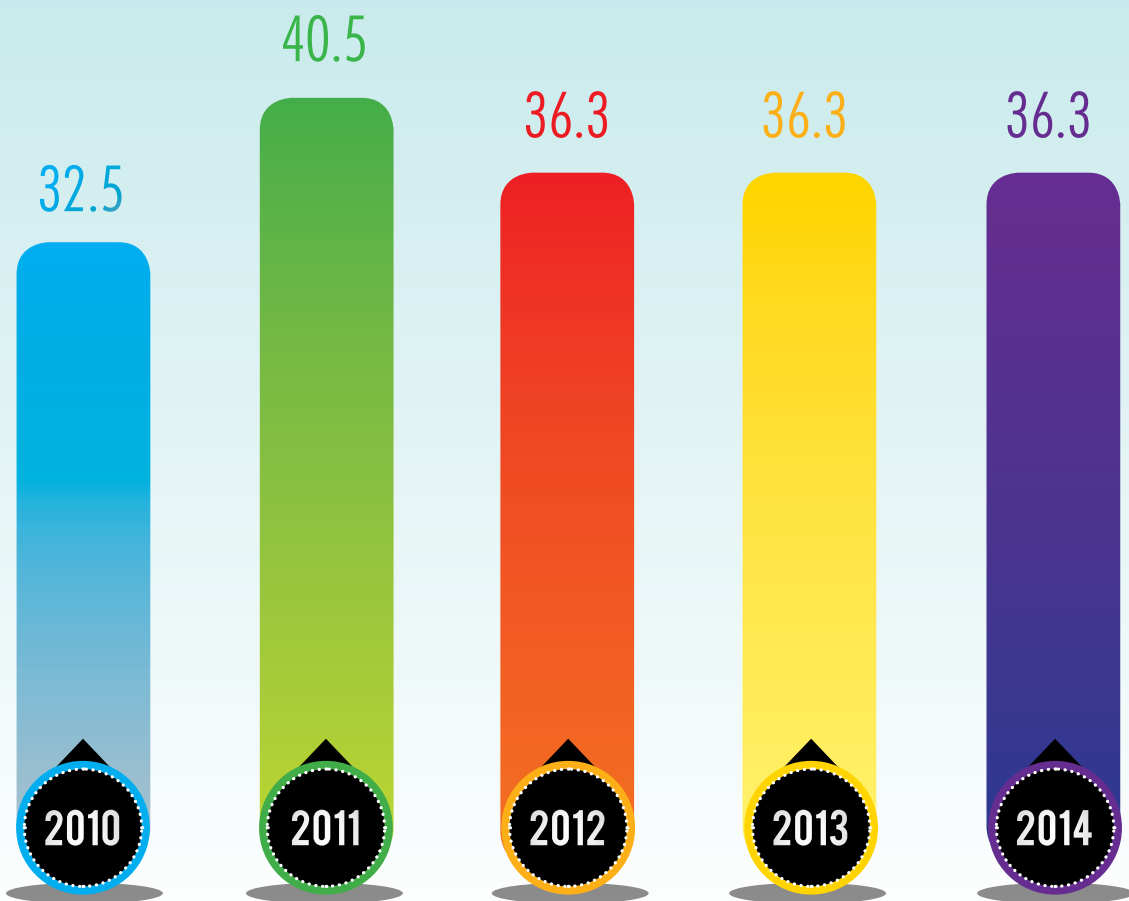
Public

102

# RESEARCH FUNDING

TOTAL » \$270.75

77% Private Funds  
23% Public Funds



Million USD



# RESEARCH PRODUCTIVITY: ARTICLES

TOTAL 2010 – 2014: 2,249



GOAL 2016 – 2020: 10,000

\*Scopus

# MEXICO

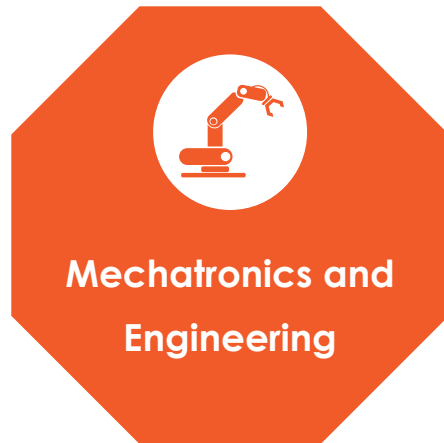
## NATIONAL PROGRAM OF SCIENCE, TECHNOLOGY AND INNOVATION

### 2014-2018

### Priority Areas




# TECNOLÓGICO DE MONTERREY



## RESEARCH AREAS WITH STRATEGIC FOCUS




# TECNOLÓGICO DE MONTERREY



**Biotechnology**

- Bioprocesses and Synthetic Biology
- Cellular and Engineering biofeedback
- Nutrionomics
- Stabilization of food




**Mechatronics and Engineering**

- Sensors and Devices
- Robotics
- Advanced Manufacturing
- Industrial Engineering and Numerical Methods
- Nanotechnology
- Coatings and materials
- Product Innovation



**Information Technologies, Electronics and Communications**

- Optics and Lasers
- Information Technology
- Networks and Telecommunications
- Intelligent Systems



**Health**

- Cell innovation and tissue engineering
- Bioinformatics, medical devices and nano-medicine
- Molecular Medicine
- Clinical development (chronic-degenerative diseases, cancer, growth and nutrition)

## RESEARCH GROUPS WITH STRATEGIC FOCUS



**Sustainable Development**

- Water Science and Technology
- Energy and Climate Change



**Education, Humanities and Social Sciences**

- Knowledge Society
- Innovation in educational models
- Cultural heritage
- Social transformations and sustainability
- Global issues
- Cultural industries



**Business**

- Corporate Sustainability
- Global Business
- Strategy and Management
- Service Management
- Consumer Behavior
- Finance
- Entrepreneurship
- Ethics and social responsibility
- Retail



**Public Policy**

- Public Economic
- Social policy
- Policies for urban transformation
- Transformation of public services and public entrepreneurship
- Democracy, Institutions, Security and Rule of Law

# RESEARCH GROUPS EXAMPLES

41

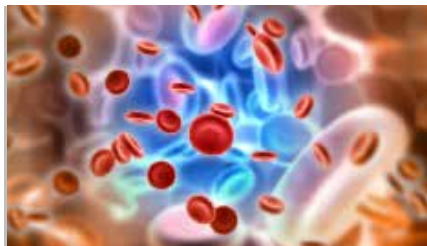
groups in the research areas with strategic focus, working in a collaborative and interdisciplinary manner. Generating knowledge and innovation.



## Cellular and Engineering Biofeedback - Leader: Mario Moisés Álvarez

Research topics: cell-mediated reactions and their components, tissue engineering and materials for culturing cells. We combine concepts of science and technology of materials, microfluidics, genomics, and cell culture in micro and mini-device and genomics applications.

01



## Innovation Cell and Tissue Engineering - Leader: Jorge Eugenio Moreno Cuevas

Study and development of cultures and cell isolation for the differentiation, treatment and restoration of damaged tissue through matrices of cell lines.

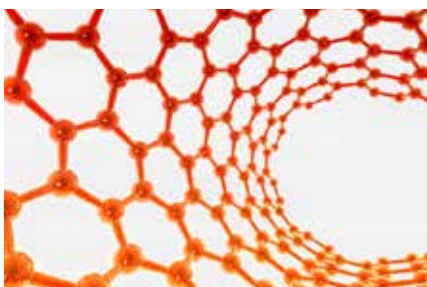
02



## Technologies and Networks - Leader: David Muñoz Rodriguez

Telecommunications and networks that focus on signal processing for image, optical communications, and wireless networks. The group's work includes radio over fiber, photonic crystals, and aspects from the levels of physical layer connectivity, modulation, configurable architecture and sensor networks, optimizing optical and wireless networks.

03



## Nanotechnology and Materials Science. Joaquin Oseguera Peña

Characterization of materials: Scanning and transmission Electron microscopy; Synthesis of Thin Solid Films produced by plasmas.

Nano and multi component films for functional applications: tribomechanical systems, metal dusting, biomedical applications, sensors.

Development of processes assisted by plasma: Nitriding, Physical Vapor Deposition, Reactive Magnetron Sputtering, Post-discharge processes, High Impulse Magnetron Sputtering.

04



### Nanomaterials - Leader: Alex Elías Zúñiga

Development of high technology, intelligent biocompatible materials reinforced with carbon nanotubes, nanoparticles, and/or fullerenes to improve their physical properties.

05



### Advanced Manufacturing - Leader: Ciro Ángel Rodríguez González

Advanced manufacturing focusing on applied research associated with the manufacture of high value-added products. The disciplines of interest include biomanufacturing, additive manufacturing, eco-design, and green manufacturing.

06



### Nutrigenomics - Leader: Sergio Serna Saldívar

Extraction, fragmentation, purification and identification of phytochemicals with novel instrumental analysis techniques. We focus on chronic inflammation, oxidative stress, diabetes, high cholesterol, and different sorts of cancer. The research activities also include studies in nutrigenomics.

07



### Innovation of Educational Models. - Leader: María Soledad Ramírez Montoya

Research in the educational impact of innovation, models and technologies in education; studying the influence, effects, changes and outcomes of innovation in teaching and learning processes with particular emphasis on the pedagogical and cognitive issues.

08



### Cultural Heritage and Cultural Industries: Analysis and trends. Leader: Blanca López, María de la Cruz de Fátima Castro

The study of cultural industries (the production of cultural goods and services), covering the generated values through traditional sectors, such as publishing printed, audiovisual analogue or advertising, but also via digital media, such as newspapers and magazines online, digital transmission of radio and television; the involvement of social networks, sound and film production, etc.

09

# RESEARCH FACULTY



**Dr. David Muñoz Rodríguez**

He specializes in the areas of position location, cognitive radio in 4th and 5th generation wireless systems and intelligent transportation systems. He is the leader of the research group in Electronic Communications and Networks. He has done applied research for Motorola, Telmex, PEMEX, Arthur D. Little, Bell-Northern Research, Nortel Networks and COFETEL. He is also a senior member of the Institute of Electrical and Electronics Engineers. He has published in prestigious international journals and holds several patents. In 1993 and 1999 he was named "Distinguished Professor in Telecommunications" for his work at Bell Northern Research and Nortel Networks, respectively, and received the Ericsson National Technology Prize.



**Dr. Carmen Hernández Brenes**

She is an active researcher specializing in emerging technologies for stabilization of essential nutrients: food design based on nutrigenetics. Currently she is a research professor in the Department of Biotechnology and Food Engineering and the Biotechnology-FEMSA Center. In her scientific career, she has published numerous articles in refereed journals, has applied for an international patent and is the author of several books and book chapters. At the undergraduate level, she teaches courses in Human Nutrition, Food Safety (HACCP Certified Alliance) and Sensory Evaluation; and at the postgraduate level, the Enzymology and Biocatalysis course.



**Dr. Julio César Gutiérrez Vega**

He is a physicist who has done pioneering work in wave propagation of optical fields; specifically, he introduced the Mathieu family of non-diffracting optical beams and the Helmholtz-Gauss beams. He is the leader of the research group on Optics. His areas of expertise include wave propagation, laser beam shaping and laser cavities. He has authored and co-authored more than 185 articles in international journals, conference proceedings and books. He was the first Mexican to be named senior member of the International Society of Optics and Photonics, serving in this organization as conference chair, editor and student chapter advisor.



**Dr. Guillermo Torre Amione**

He is the leader of the research group in Molecular Medicine. His research focuses on applied clinical investigation in the areas of heart failure and cardiac transplantation. His lab conducts a variety of clinical research protocols, including multinational studies and investigator-initiated protocols. He is also Chief of the Heart Failure Division, Department of Cardiology at Houston Methodist Hospital, dividing his time between an active clinical practice and research on heart failure. Dr. Torre's clinical and basic laboratories are committed to the development of better therapies focused on the modulation of immune responses in patients with heart failure and cardiac transplant. He received the SCOUPS Award for the most-highly cited author on medicine in 2012.



**Dr. Sergio Román Othón Serna Saldívar**

He specializes in food science, and is the leader of the research group in NutriOmics. He has worked and consulted for Mexican and international businesses and agencies, such as the National Food Research Center in Rio de Janeiro, Brazil, SUSTAIN (US Agency for International Development), Gamesa, GIMSA, Química SUMEX, Omega Tech and other organizations related to food and nutrition. He is also the director of the Protein Research and Development Center (Centro de Investigación y Desarrollo de Proteínas-CIDPRO). His research specialties are the processing of cereals and oil-producing seeds, the extraction of phytochemicals for medicinal use and fermentation enzyme biotechnology. He has published seven books, 29 book chapters, 98 articles in peer-reviewed journals, eight encyclopedia articles and holds two patents, and has applications pending for eight more. He also developed a type of winter wheat used in the United States.



**Dr. Dora Elvira García González**

She is the leader of the research group Transformation and Sustainability. She specializes in ethics, political philosophy, hermeneutics and the philosophy of culture. Her research lines include ethics, the culture of peace, human rights, water, and sustainable cities. She investigates strategies, methods and tactics to self-sustain human social processes in the present and in the future. She has been a visiting scholar at the University of Granada, Spain, the National University of Comahue and the University of Barcelona. She also serves as the academic leader of strategic projects in the humanities since 2009 and the coordinator of the UNESCO group in ethics and human rights.

# RESEARCH FACULTY



**Dr. Raquel Minerva Castaño González**

She is the leader of the research group Consumer Behavior. Her research lines include brands and adoption of innovations, marketing strategies, cultural meanings of consumption, responsible consumer behavior and social welfare. Her purpose is to understand the factors that influence consumer behavior in the context of the globalization process to identify market opportunities and develop business strategies based on preferences and consumption patterns. She has participated in consulting and training courses for international companies, such as Cervecería Cuauhtémoc-Moctezuma, Gamesa, Cadena Comercial OXXO, HEB and Whirlpool. She received the best paper award from the American Marketing Association (AMA) for the paper published in 2012 "How Close Brands Are Included in the Self: Psychological and Neural



**Dr. Carlos Manuel Urzúa Macías**

With a Ph.D in economics, he specializes in economic theory and econometrics. He was Secretary of Finance in the Mexico City government (2000 to 2003). He has worked as a consultant to the World Bank, as well as the United Nations Economic Commission for Latin America and the Caribbean, the United Nations Development Programme and the Organisation for Economic Co-operation and Development. He has published eight books on economics, two books on poetry, and written dozens of articles in various international journals.



**Dr. Isidro Morales Moreno**

He has a Ph.D in international relations; his main research areas include geopolitics, geo-economics of energy, trade and investment markets; the political economy of regional integration; Mexico-U.S. trade and security relations; and U.S-Latin American relations. He has published extensively on energy, integration, and trade-related and security topics, including Mexico's oil



**Dr. Blanca Guadalupe López Morales**

She is the leader of the research group Cultural Heritage and Cultural Industries: Analysis and Trends. Her specialties include colonial Latin American literature, the history of books and reading, and travel journals and sermons from the 16th to 18th centuries. She founded Tecnológico de Monterrey's *Revista de Humanidades*, acting as editor from 1996 to 2006. She has also been the editor of the *Boletín de la Asociación Internacional de Hispanistas*. Her book *Harvest Birds* was nominated "Notable Book" by the Smithsonian Institute in 1995. She is a member of the Asociación Internacional Siglos de Oro, the Rocky Mountain Modern Language Association and the Asociación Internacional de Teatro Español y Novohispano de los Siglos de Oro.



**Dr. José Florencio Fernández Santillán**

He holds two doctorates in political ideas and in political science. He has taught courses, carried out research projects and had fellowships with Harvard University's John F. Kennedy School of Government since 2003 as a specialist in political analysis. He is also a visiting scholar at Georgetown University. He regularly writes for *El Universal* (a Mexican newspaper); he has been named an electoral advisor for the General Council of the Federal Electoral Institute (Instituto Federal Electoral), as well as for the editorial committee of the journal of the Mexican Senate, and for the magazine *Este País*.



**Dr. Rajagopal**

With a doctoral degree in marketing, he specializes in marketing related topics that include competitor analysis, marketing strategy, consumer behavior, selling systems, international marketing, services marketing, and new product development. He has been teaching in undergraduate, graduate and doctoral programs since 1984 in various management schools of high rank in India and at international destinations. He has a vast number of publications on marketing, including 42 books and more than 125 research papers.



# RESEARCH FACULTY



**Dr. Mario Moisés Alvarez**

Specializing in biopharmaceutical engineering, he is the leader of the research group Cellular and Engineering Biofeedback. His research specialties include design of bio-reactors, transport phenomena and mathematical modeling of biological systems. He has published more than 100 articles in prestigious international journals in his field, and given papers in several international forums and conferences. His activities have included the creation of a way to mass-produce a vaccine against the AH1N1 virus during the 2009 outbreak. More recently his group became involved in the design and fabrication of chips capable of producing monoclonal antibodies through anchorage dependent mammalian cell culture.



**Dr. Bryan William Husted Corregan**

He is the leader of the research group Social Innovation. He has worked at the Instituto de Empresa, Madrid, Military School in Bolivia and School of Business at York University. He currently holds a joint appointment with the Schulich School of Business, York University, where he is a member of the Haub Chair in Business and Sustainability. His main research interests are in: business and international management business, economics and econometrics, finance, technology and Innovation management, and marketing. He received the SCOUPS Award for the most-highly cited author on Social Sciences in 2011.



**Dr. Marco Antonio Rito Palomares**

He is the leader of the research group Bioprocesses and Synthetic Biology. He is recognized as one of the most important biotechnologists in Mexico in the recovery and purification of bioproducts. He has been honored with the Jubilee Award 2003 granted by the International Foundation for Science (IFS) and the Rómulo Garza Research Award 2002, at Tecnológico de Monterrey. He is a member of the prestigious Mexican Academy of Sciences and president of the Mexican Society of Biotechnology and Bioengineering, Nuevo León State Section. He has published more than 80 research papers and book chapters and holds five patents.



**Dr. Jorge Santos Welti Chanes**

He is the leader of the research group Emerging Technologies for Stabilization of Essential Nutrients: Food Design Based on Nutrigenetics. He is CEO and founder of the company, Integral Solutions Consulting for the Food Industry (ISFI). His research interests include: process engineering, water activity, minimal processing of fruits, emerging technologies (high hydrostatic pressure and high electrical pulse voltage) and development of technologies with social impact. He has been a consultant for various companies (Adams, Gerber, Conagra, Sabritas, Nestlé, Qualtia, Gamesa, La Morena, Italian Coffee, Baler San Marcos), and member of several professional associations. He was president of the International Association of Food and Engineering (IAFE) from 1997-2000. In May 2011 he received the Life Achievement Award from the International Association for Engineering and Food for his career as a researcher and his academic work.



**Dr. María Soledad Ramírez Montoya**

She is the leader of the research group Innovation Educational Models. Her research interests are teaching strategies, technological resources for education and educational researcher training. She is the principal organizer of the Regional Open Network for Social and Educational Research in Latin America (CLARISE), and the UNESCO chair on "Movimiento Educativo Abierto para América Latina" (Latin America's Open Educational Movement-OEP). She was designated by the ICDE (International Council for Open and Distance Education) as holder of the Chair of Open Educational Resources for Latin America (ICDE Chair in OER) for the period 2014-18. She has several publications in refereed journals and is the author of more than ten books.



**Dra. María Inmaculada Castilla de Cortázar**

Inma Castilla Cortazar Larrea holds a doctorate in medicine from the University of the Basque Country, with postdoc in Marburg (Germany) at the Department of Basic Hepatology. She has won awards for biomedical research, "Gil-Vernet" of the Royal Academy of Medicine of Catalonia; "Juan Antonio Garcia Torres" of the Royal Academy of Medicine of Granada; Institute of Spain. Currently She is the Director of the Clinical Doctorate of the National School of Medicine at Tecnológico de Monterrey and she is the Group leader of the Molecular Medicine Research Group, where she develops the study of the molecular and cellular alterations in diseases development and treatment. Her research lines are focused on the study of pathophysiology at the cellular and molecular level.

# RESEARCH CENTERS



The center focuses on the training of researchers and specialist consultants seeking to participate in the identification and resolution of issues raised by the challenges of globalization of design and product engineering, intelligent manufacturing processes and reconfigurable and logistics systems. CIDyT is based on the use of its intellectual capital, infrastructure and strategic alliances with key technology providers and universities of international prestige for maximum results.

## CIDYT

Center for Innovation in Design and Technology

## CAALCA

Water Center for Latin America and the Caribbean

The center conducts research and does consulting, providing new knowledge, training and disseminating knowledge for sustainable management and use of water resources in Latin America and the Caribbean.



There are three main areas: bioprocess engineering, food biotechnology and pharmaceutical biotechnology. The research is focused not only on knowledge generation, publication of scientific articles and preparing human resources' level of excellence, but also on the generation of patents, technology solutions for industry, technology transfer and the generation and incubation of new technology-based businesses.

## CB-FEMSA

Biotechnology-FEMSA Center

## CITES

Center for Innovation and Transfer in Health

Center specialized in research, innovation and transfer in the area of health. The principal lines of investigation include: cardiology, cell therapy, hematology and cancer, ophthalmology, nutrition, health system management.



# INTERNATIONAL COLLABORATION

## BIOTECHNOLOGY

Cornell University  
Texas A&M University  
St. Jude Children's Research Hospital



## MECHATRONICS AND ENGINEERING

Massachusetts Institute of Technology  
Rice University  
University Of California



## INFORMATION TECHNOLOGIES, ELECTRONICS AND COMMUNICATIONS

University Of California, Berkeley  
Carnegie - Mellon University



## SUSTAINABLE DEVELOPMENT

Arizona State University



## PUBLIC POLICY

Princeton University



## BUSINESS

Babson College  
Northeastern University



## HEALTH

Johns Hopkins University  
Houston Methodist Leading Medicine  
USP Universidade de São Paulo



## EDUCATION, HUMANITIES, AND SOCIAL SCIENCES

University Of California, Berkeley  
UNESCO





# MIT – TECNOLÓGICO DE MONTERREY

## Research Agreement

On October 31, 2014 a cooperation agreement was signed with MIT. Collaboration with MIT represents a strategic opportunity to enhance the research initiative with Tecnológico de Monterrey in nanoscience and nanotechnologies. The possibilities of this cooperation and collaboration agreement include:

- Promotion of student and researcher exchange
- Enhancement of scientific production
- Encouraging creativity and active learning to exploit the most sophisticated technological knowledge network in the world
- Developing superior competencies and capacities to meet growing industrial competitiveness, foster environmental sustainability and improve the quality life of people.

## MIT – Tecnológico de Monterrey





# MIT - TECNOLÓGICO DE MONTERREY

## Research Agreement

### MIT.NANO Research Areas:

- Personal Medicine
- Energy Systems
- Ubiquitous Computing
- Multiscale Manufacturing
- Sustainable Infrastructure
- Quantum Science and Technology

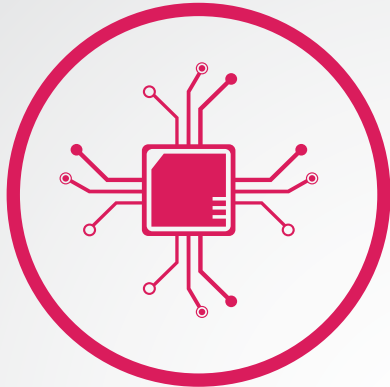
### TEC.NANO Research Areas:

- Personal Medicine
- Energy systems
- Multiscale Manufacturing
- Quantum Science and Technology



# STRATEGIC INITIATIVES

TEC.NANO



ENERGY



EDUCATION ENTREPRENEURSHIP



# STRATEGIC INITIATIVES: TEC.NANO

Initiative with the aim of supporting research in areas of nanoscience and nanotechnology through interdisciplinary projects in:

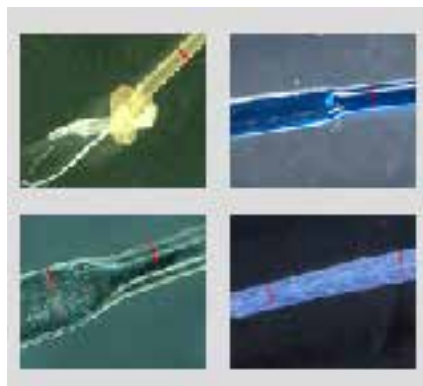
- Biotechnology
- Mechatronics
- Sustainability
- Information and Communication Technologies
- Health
- Education
- Entrepreneurship
- Public Policy



# STRATEGIC INITIATIVES: TEC.NANO

## Ongoing Projects at Tecnológico de Monterrey

- Chemical and electrochemical synthesis of metallic nanoparticles
- New constitutive models of nanostructured materials
- Intelligent surgical meshes
- 3D printing for scaffolds in tissue engineering
- Surface engineering
- Biomems: C-MEMs, dielectrophoresis, CD-microfluidics
- Micromachines and micro-factories
- Development of micromixers for mass transfer in microfluidic cells
- Nanoelectronics (nanosystems; low-power consumption, statistical circuit theory)
- Quantum information processing
- Designin of nanostructures for sensor development
- Design of nanoplatfoms for controlled release of genetic material and drugs
- Nano-optics: Interaction of light with nano-systems
- Interactions between nano-optical systems





# STRATEGIC INITIATIVES: ENERGY

Our goal is to contribute to the competitive development of the energy sector in Mexico.

Research:

- Research in political economy of the Mexican energy reform
- Assessment of social impact, urban risk and strategic opportunities at the local level with energy projects
- Public policy analysis for renewable energy
  - Impact analysis of hydraulic fracture technology

Outreach:

- Regional strategic plan for the energy sector
- Capital budgeting in gas & oil
- Identifying business opportunities for the value chain energy sector



**School of  
International Law**

# STRATEGIC INITIATIVES: EDUCATION

Serve as a reference for how to educate in order to have an impact on learning processes at different levels:

- Educational policy
- Management of educational institutions
- Curriculum design
- Processes of teaching and learning in the classroom (intensive use of educational technology as a learning mediator)

Projects:

- Assessment for improving external educational evaluation system for public schools with low academic achievement
- Virtual Learning Center
- Center for improvement and educational innovation
- Institutional repository
- Resource Center for Academic Writing
- Culture of legality in primary and secondary schools



# STRATEGIC INITIATIVES: ENTREPRENEURSHIP

- Fostering the entrepreneurial spirit among students and professors
- The Eugenio Garza Laguera Institute for Entrepreneurship is the largest entrepreneurship ecosystem in Latin America.
- All the entrepreneurship initiatives contribute to generating jobs and to strengthening the national economy by means of knowledge transfer to create wealth and the growth of companies.
- In 2013, we created INC MTY, an entrepreneurship and innovation festival in which Mexican entrepreneurs, innovators and investors participate. INC MTY is the most important celebration of the entrepreneurial spirit.
- Strategic collaboration: Babson College's Global Consortium



# 518 COLLABORATING INSTITUTIONS

2010-2014



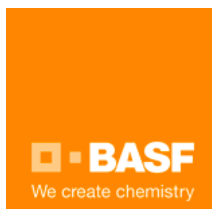
# 1,200 CO-AUTHORED PUBLICATIONS

2010-2014

Examples of Collaborating Institutions

Institution	Country	Citations per Publication	Citations	Co-authored publications
Centre Hospitalier National d'Ophtalmologie des Quinze-Vingts	France	123	123	1
University of Adelaide	Australia	73	73	1
University of Manchester	United Kingdom	43.3	173	4
Columbia University	United States	41	123	3
Harvard University	United States	40.2	201	5
University of Leeds	United Kingdom	24	48	2
Johns Hopkins University	United States	15.8	189	12
Chung Yuan Christian University	Taiwan	13	169	13
Massachusetts Institute of Technology	United States	10.3	72	7
Universidad Autonoma de Nuevo Leon	Mexico	2.4	269	114
Universidad Nacional Autonoma de Mexico	Mexico	2.3	196	85
Instituto Politecnico Nacional	Mexico	2.3	154	67

# INDUSTRIAL PARTNERSHIPS



# EXAMPLES OF RESEARCH INDUSTRIAL PROJECTS

## Navistar



Project: Road Load Data Acquisition

The project has a multi-year horizon and has the primary purpose of developing RLDA (Road Load Data Acquisition) systems that allow collection of information, data and knowledge about the behavior of vehicles on Mexican roads, with the aim of providing feedback to the design process and finding different failure causes in durability and load during operation

## Prolec GE International



Impulsando soluciones confiables

- Development of a nano-structured cover to increase the corrosion resistance of transformers
- Development and characterization of nanofluids for electric transformers
- Optimization of low-frequency magnetic properties of amorphous-nanocrystalline steel

## Roberto Rocca Research Chair



- Energy efficiency in electric and thermal industrial applications
- Energy conversion and power electronics

# EXAMPLES OF RESEARCH INDUSTRIAL PROJECTS

## Industrial Consortium in Energy

Companies: Schneider Electric, Ternium, TenarisTamsa, AMI-GE, Cerrey, Prolec-GE, Nutec Bickley, Tenova, Acciona Energy, Diram

Main research areas: Power electronics, design of electrical equipment, optimal dispatch of energy in interconnected power systems, combustion systems, heat transfer and modeling and simulation of industrial processes



Examples of projects:

- Power control optimization of AC electric arc furnaces
- Heat transfer simulation of windings in power transformers for estimation of hot spots
- Compliant mechanisms in miniature circuit breakers

## FEMSA



Project: Emerging Contaminant Biodegradation by Enzymatic Processes

This project focuses on the study of the potential use of enzymatic processes for bioremediation of aquatic systems by enzymes extracted from a microorganism obtained from the northwestern region of Mexico, to implement processes of degradation of various compounds. The investigation is focused on kinetics, the major way of degradation of the analysis of interest and toxic by-products.

## Metalsa



Project: Design and development of electric propulsion system and semi-active suspension for a light load vehicle  
In this project Tecnológico de Monterrey designed a control system for a semi-active suspension in an embedded

architecture based on a CAN network. The goal of the algorithm is comfort and individual surface grip on each corner of the car, besides a control system that coordinates each independent corner. The control system is based on the specification and modeling of electrohydraulic dampers, including tolerance to some faults. The system was validated in a commercial vehicle.

# EDUCATION IMPACT

## Education Model

MODELO EDUCATIVO  
**TEC21**





# EDUCATION IMPACT

MODELO EDUCATIVO  
**TEC21**



# EDUCATION IMPACT

## Graduate Programs

10 PhD Programs

57 Master Programs

	PhD	Master
Biotechnology	1	1
Mechatronics and Engineering	1	6
Information Technologies, Electronics and Communications	1	6
Sustainable Development	1*	7
Public Policy	1	5
Business	2	9
Health	1	16
Education, Humanities and Social Sciences	3	7

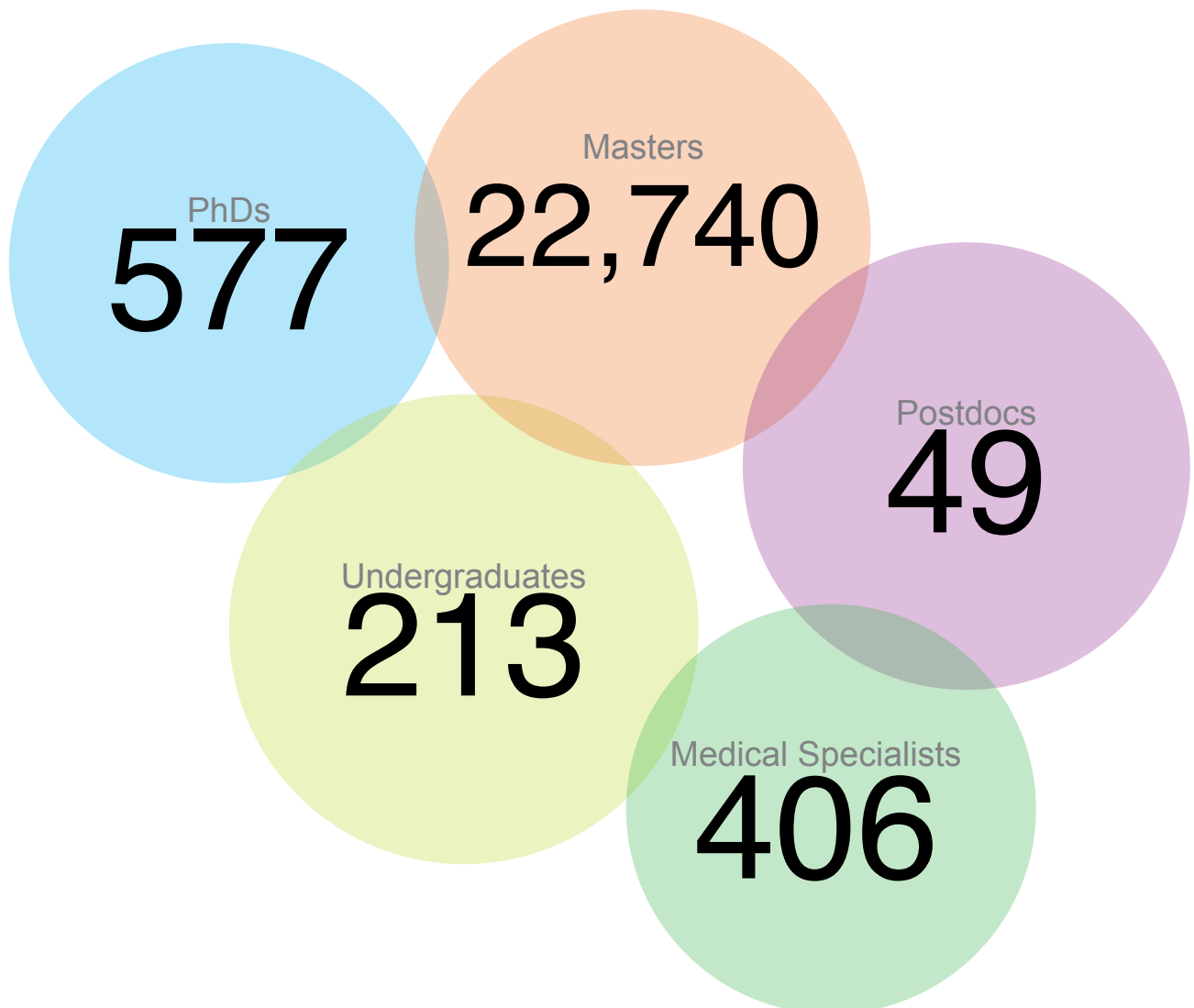
\*Within the engineering PhD

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# EDUCATION IMPACT

## ALUMNI: Research Students

GRADUATED : 2007 - 2014



# EDUCATION IMPACT

## Undergraduate Students with Research Experience



### ANA VIANEY SÁNCHEZ SANTOSCOY IBT'09

Two of her articles were published in the journal with the highest impact factor in the discipline: Magazine Lab on a Chip (2009) Impact Factor: 6.260

### RODRIGO HERNÁN VÁSQUEZ LEÓN IBT'10

He co-authored a patent (MX / a / 2010/009229) for obtaining and purifying the carotenoid Fucoxanthin, that has different properties: antioxidant (anticancer), decreased white adipose tissue (obesity), reduced glucose (antidiabetic). He incubated the tech-based company



### CARLOS HUMBERTO ANDRADE CABRERA IMT'09

He did research stays at NASA Space Center and at MIT to develop algorithms for formation flying maneuvers and docking (physical coupling of two satellites or spacecraft). He also implemented algorithms for robust control of a distributed system using techniques that allow each element having its own autonomous control and cooperate with other satellites. He published his work on international conferences.

# AWARDS & PRIZES



## WHARTON - QS Award 2014

1° Prize Latin America  
3° Prize World Wide

Category of Innovation in Teaching  
Delivery

Project: **“Augmented Reality: Towards  
a visual and tangible mathematics”**

Leaders: Eduardo González  
Patricia Salinas

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# SCIENTIFIC IMPACT

## RELEVANT PUBLICATIONS

Rodríguez-Sánchez, D., Silva-Platas, C., Rojo, R.P., García, N., Cisneros-Zevallos, L., García-Rivas, **G.**, **Hernández-Brenes, C.**

Activity-guided identification of acetogenins as novel lipophilic antioxidants present in avocado pulp (*Persea americana*)

(2013) *Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences*, 942-943, pp. 37-45.

Perez-Garcia, B., Lopez-Mago, D., Garcia-Gracia, H., Garza-Alanis, J.A., Hernandez-Aranda, R.I., **Gutiérrez-Vega, J.C.**

Orbital angular momentum of optical vortices from power measurements and the cross-correlation function

(2014) *Optics Letters*, 39 (7), pp. 1929-1932.

Cortés-Ceballos, E., Pérez-Carrillo, E., **Serna-Saldívar, S.O.**

Addition of sodium stearyl lactylate to corn and sorghum starch extrudates enhances the performance of pregelatinized beer adjuncts

(2015) *Cereal Chemistry*, 92 (1), pp. 88-92.

Perez-Gonzalez, V.H., **Munoz-Rodriguez, D.**, Vargas-Rosales, C., Torres-Villegas, R.

Relational position location in ad-hoc networks

(2015) *Ad Hoc Networks*, 24 (PA), pp. 20-28.

Marin, A., Reimann, **M.**, **Castaño, R.**

Metaphors and creativity: Direct, moderating, and mediating effects

(2014) *Journal of Consumer Psychology*, 24 (2), pp. 290-297.

Trachtenberg, B.H., Cordero-Reyes, A.M., Aldeiri, M., Alvarez, P., Bhimaraj, A., Ashrith, G., Elias, B., Suarez, E.E., Bruckner, B., Loebe, M., Harris, R.L., Zhang, J.Y., **Torre-Amione, G.**, Estep, J.D.

Persistent blood stream infection in patients supported with a continuous-flow left ventricular assist device is associated with an increased risk of cerebrovascular accidents

(2015) *Journal of Cardiac Failure*, 21 (2), pp. 119-125.

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# SCIENTIFIC IMPACT

## RELEVANT PUBLICATIONS

Lara-Gil, J.A., **Álvarez, M.M.**, Pacheco, A.

Toxicity of flue gas components from cement plants in microalgae CO<sub>2</sub> mitigation systems

(2014) Journal of Applied Phycology, 26 (1), pp. 357-368.

González-González, M., **Rito-Palomares, M.**

Aqueous two-phase systems strategies to establish novel bioprocesses for stem cells recovery

(2014) Critical Reviews in Biotechnology, 34 (4), pp. 318-327.

**Ramírez Montoya, M.S.**

Challenges and perspectives for the open education movement in the distance education environment: A diagnostic study in a SINED project.

(2013) RUSC Universities and Knowledge Society Journal, 10 (2), pp. 414-430.

Escobedo-Avellaneda, Z., Gutiérrez-Urbe, J., Valdez-Fragoso, A., Torres, J.A., **Welti-Chanes, J.**

Phytochemicals and antioxidant activity of juice, flavedo, albedo and comminuted orange

(2014) Journal of Functional Foods, 6 (1), pp. 470-481.

**Husted, B.W.**, Allen, D.B., Kock, N.

Value Creation Through Social Strategy

(2015) Business and Society, 54 (2), pp. 147-186.

Melo-Máximo, L., Salas, O., Melo-Máximo, D., **Oseguera, J.**, López-Hirata, V.M., Torres, R.D., Lepiński, C.M., de Souza, R.M.

Performance of Cr oxide coatings on 304 steel against metal dusting

(2013) Surface and Coatings Technology, 237, pp. 39-50.

Camíña, J.B., Hernández-Gracidas, C., **Monroy, R.**, Trejo, L.

The Windows-Users and -Intruder simulations Logs dataset (WUIL): An experimental framework for masquerade detection mechanisms

(2014) Expert Systems with Applications, 41 (3), pp. 919-930.

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# SCIENTIFIC IMPACT

## RELEVANT PUBLICATIONS

Ojesina, A.I., Lichtenstein, L., Freeman, S.S., Pedomallu, C.S., Imaz-Rosshandler, I., Pugh, T.J., Cherniack, A.D., Ambrogio, L., Cibulskis, K., Bertelsen, B., Romero-Cordoba, S., **Treviño, V.**, Vazquez-Santillan, K., Guadarrama, A.S., Wright, A.A., Rosenberg, M.W., Duke, F., Kaplan, B., Wang, R., Nickerson, E., Walline, H.M., Lawrence, M.S., Stewart, C., Carter, S.L., McKenna, A., Rodriguez-Sanchez, I.P., Espinosa-Castilla, M., Woie, K., Bjorge, L., Wik, E., Halle, M.K., Hoivik, E.A., Krakstad, C., Gabiño, N.B., Gómez-Macías, G.S., Valdez-Chapa, L.D., Garza-Rodríguez, M.L., Maytorena, G., Vazquez, J., Rodea, C., Cravioto, A., Cortes, M.L., Greulich, H., Crum, C.P., Neuberger, D.S., Hidalgo-Miranda, A., Escareno, C.R., Akslen, L.A., Carey, T.E., Vintermyr, O.K., Gabriel, S.B., Barrera-Saldaña, H.A., Melendez-Zajgla, J., Getz, G., Salvesen, H.B., Meyerson, M.

Landscape of genomic alterations in cervical carcinomas  
(2014) *Nature*, 506 (7488), pp. 371-375.

López-Camacho, E., **Terashima-Marin, H.**, Ross, P., Ochoa, G.  
A unified hyper-heuristic framework for solving bin packing problems  
(2014) *Expert Systems with Applications*, 41 (15), pp. 6876-6889.

De-J Lozoya-Santos, J., **Morales-Menendez, R.**, Ramirez-Mendoza, R., Tudón-Martinez, J.C., Sename, O., Dugard, L.  
Magnetorheological damper - An experimental study  
(2012) *Journal of Intelligent Material Systems and Structures*, 23 (11), pp. 1213-1232.

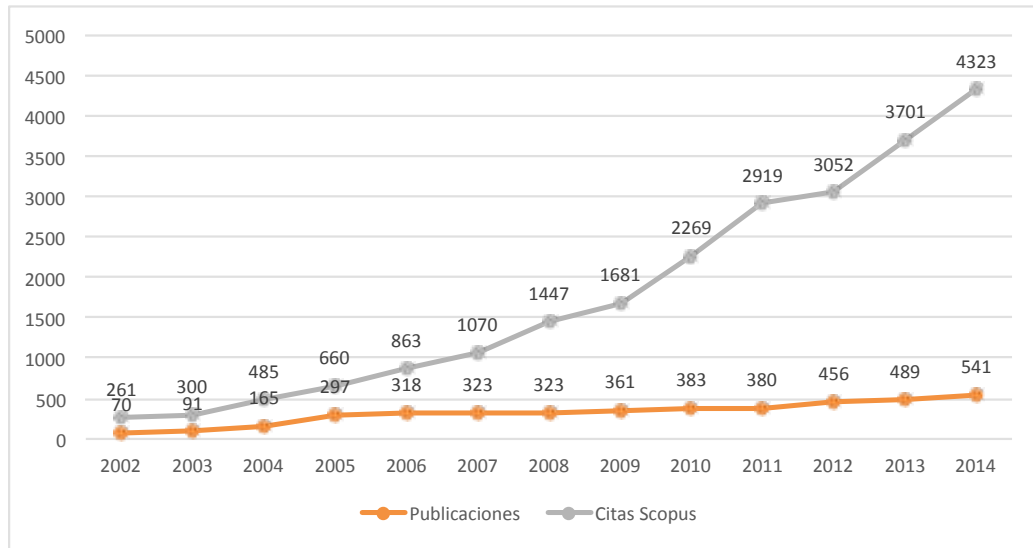
Ponce, H., Ponce, P., **Molina, A.**  
The development of an artificial organic networks toolkit for LabVIEW  
(2015) *Journal of Computational Chemistry*, 36 (7), pp. 478-492.



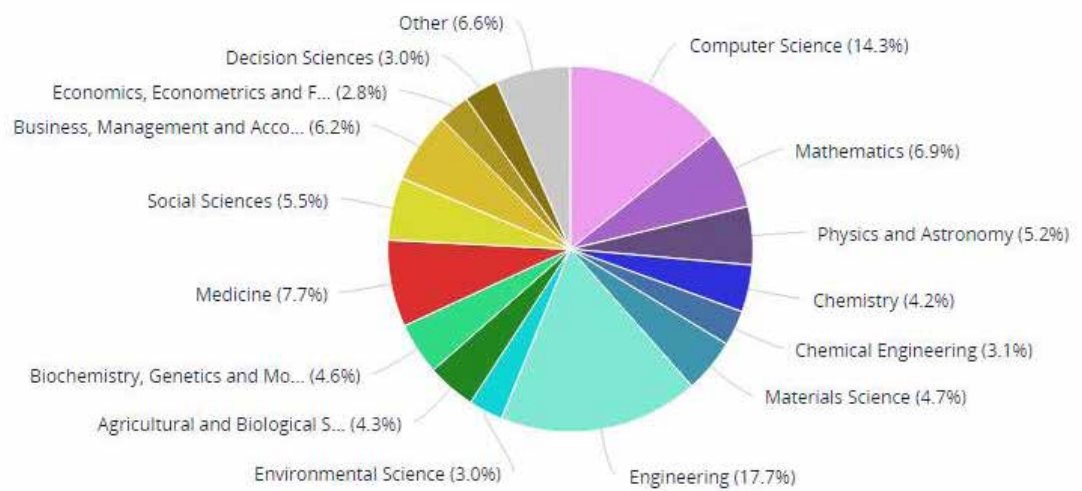
# SCIENTIFIC IMPACT

## Papers and Citations in Scopus

PAPERS AND CITATIONS  
IN SCOPUS

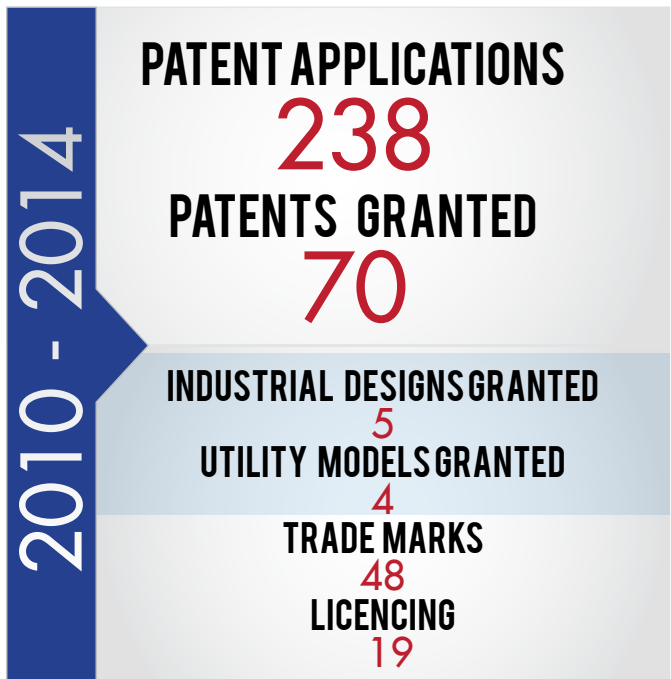


PUBLICATION AREAS



# ECONOMIC IMPACT

Technology Transfer Office Network

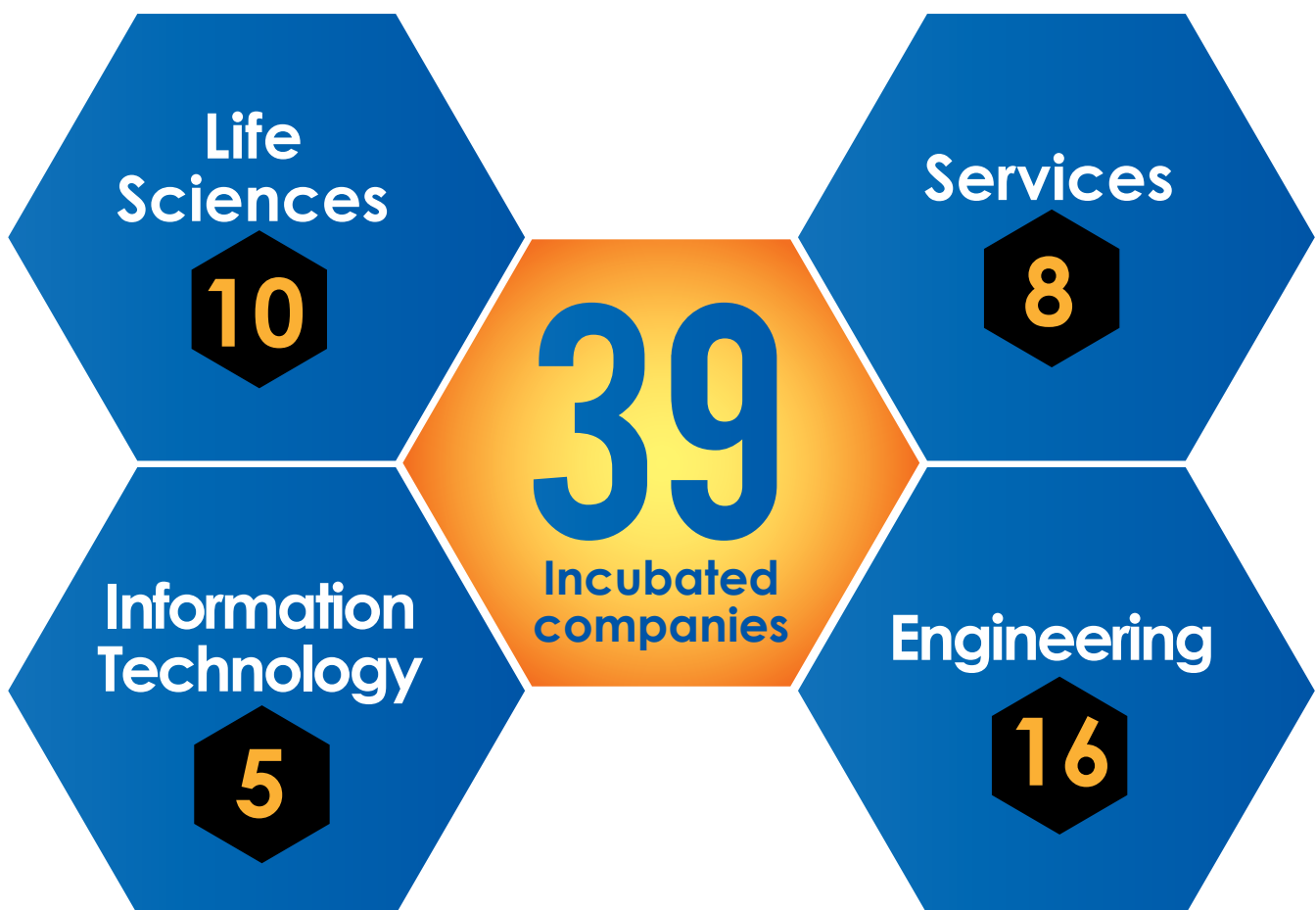


**10**  
**CERTIFIED**  
**P&TTOs**

# ECONOMIC IMPACT

Technology-based companies incubated by professors and students per sector

2010 - 2014



# ECONOMIC IMPACT

## Examples of tech-based companies



### Soluciones en Dispositivos Médicos (SDM), S. de R.L. de C.V.

A high technology company that aims to establish a progressive dynamic for the development and commercialization of technology based on the use of innovative technology in medical devices. At present SDM is commercializing a cervical cancer medical diagnosis device that is reliable, affordable, portable, user-friendly, and minimally intrusive.



### EZKATC S. de R.L. de C.V.

A biotechnology company devoted to innovating, researching and developing probiotic formulations that do not require cold chain for the dairy and pharmaceutical industries. The technology is an integrated high performance process to obtain biomass of probiotic lactic acid bacteria (probiotic), a dairy-based nutritional serum product that improves the quality and health of the general population.



### WeaRobot S.A.P.I. de C.V.

Devoted to designing, developing and producing rehabilitation devices.

The use of muscle and brain signals to control robotic rehabilitation can help greatly in the rehabilitation of limbs to supplement control over crucial parameter movement therapy. Aukera Foundation (the social partner of WeaRobot) is an online open innovation platform and crowdfunding offering free prosthetics, orthotics and exoskeletons.



### Authentic Illusions - JARA A.I. Solutions S.A.P.I. de C.V.

Authentic Illusions is a company devoted to the development of videogames and videogame-related software for different platforms and gaming consoles, using research areas in the field of artificial intelligence, such as: augmented reality, evolutionary algorithms for the creation of dynamic worlds, societies and character interaction; artificial emotions; artificial societies; and multi-agent systems and autonomous learning; and decision-making algorithms. The company already has support and a signed contract with Sony to develop independent games for the PS4 (PlayStation 4) and PsVita (PlayStation Vita) consoles.



### Bio-Recombine Technologies, S. de R. L. de C.V.

A biotechnology company devoted to designing, developing and producing biomolecules of high commercial value (recombinant proteins) to serve the biopharmaceutical market developing vaccines and drugs, and the diagnostic and food sectors through disease-causing enzymes with high commercial value.



### ELVIA Nanofluids, S.A. de C.V.

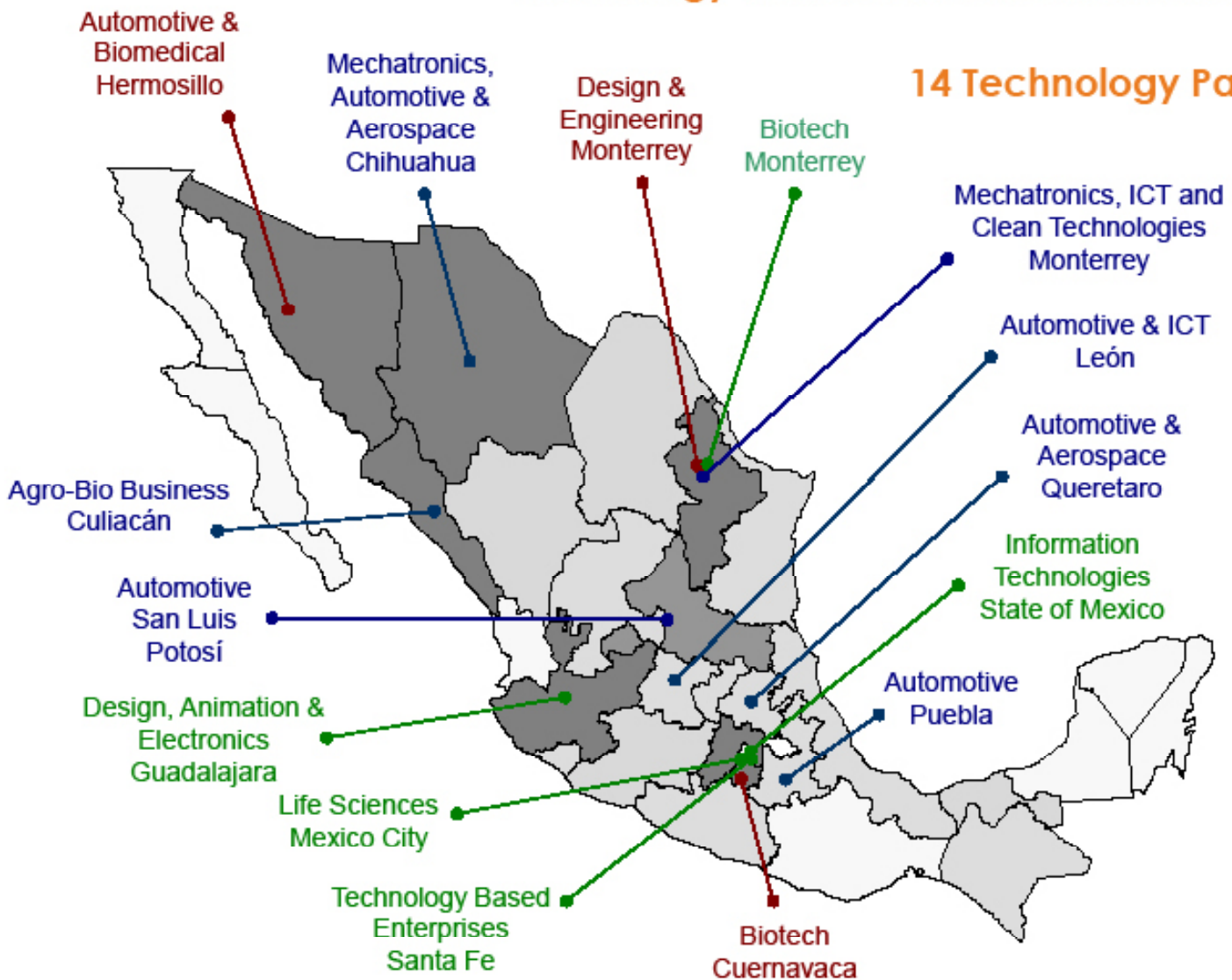
A nanotechnology company devoted to the development of nanofluids for coolants and lubricants. These refrigerants contain nanoparticles dispersed and stabilized to provide better heat conduction properties and wear reduction; applications in electrical transformers, automotive systems, and the metalworking industry in general. This technology was recognized as a TechConnect Global Innovation Awardee at the "TechConnect National Innovation Summit", Washington, D.C., 2014.

# ECONOMIC IMPACT

## Technology Parks and Industrial Sectors

### Technology Parks and Industrial Sectors

#### 14 Technology Parks



# ECONOMIC IMPACT

Incubator and Accelerator Networks



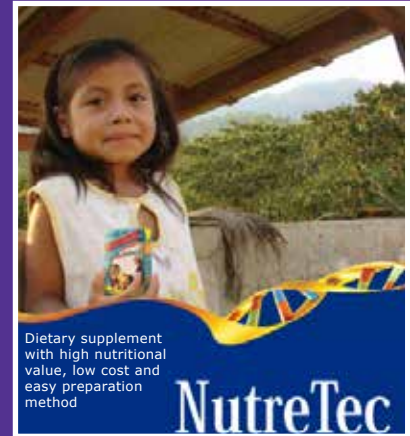
**26 INCUBATORS**

**16 ACCELERATORS**

# SOCIAL IMPACT

## NutreTec

Tecnológico de Monterrey seeks to support communities with fewer resources and promote social development to enhance the growth of children, thus contributing to a better quality of life. NutreTec is a low-cost nutritional supplement that was created to combat the high rate of malnutrition in children in Mexico. It is unique in its class, as it provides an excellent balance of protein, vitamins and minerals. After seven years of research, it is now a product on the market. The government agency, DIF (Integral Family Development), and Health Services in the state of Nuevo Leon support the implementation of NutreTec in various municipalities.



## TECNOVIVIENDA-TECNOCASA, TECNODOMO

The original idea was to develop a response to housing emergencies resulting from natural disasters. The answer has been the development of construction systems using alternative materials and innovative geometries to build resistant housing offering thermal comfort at low-cost. Tecnoviviendas have a construction period of seven days and are designed to withstand the forces of wind and earthquakes under standards specified by the Mexican government. To date around 250 projects in different locales have been built with these technologies in collaboration with several funding institutions in Mexico and Peru.

## Social Housing - Rosenda's House

Urban Pulse is a program in which students work with low-income families in the rehabilitation, creation or transformation of small public places. This program was recognized in 2012 in the contest "Design like you care" organized by the group Architecture for Humanity in the city of New York, obtaining second place in the competition with "Rosenda's House". Rosenda's House was a one bedroom dwelling located in the municipality of Guadalupe, Nuevo Leon, that was transformed from a hut of 30 square meters into a two-story house using recycled materials.



# SOCIAL IMPACT

## Base of the Pyramid Legacy Project

This project does studies of the population located at the base of the economic pyramid to design programs that improve the living condition of low-income people. These studies include job generation through social incubators, education to develop skills and training, and health services. A study was conducted on the social incubator network at Tecnológico de Monterrey and the Prepanet high school.



## Santos y De la Garza Evia Foundation

Here, physicians, residents and nurses offer a comprehensive service of the highest quality to the most vulnerable sectors of the community.

In addition, this clinic is an academic campus where students and faculty of Tecnológico de Monterrey's School of Medicine share knowledge and contribute to the social development of communities, especially the neediest.

## Mati-Tec Education for Every Child

Mati-Tec is a pilot research study designed to determine the efficacy of the use of mobile cellular technology as means to improve math and digital skills in Mexican and Latin American children at elementary schools, aged 10-13. Mobile resources were created as part of the official syllabus of the Secretaría de Educación Pública (Mexican Ministry of Education). These resources are illustrated in an informative and entertaining gaming environment allowing children to win medals for their performance in the platform, and allowing teachers and headmasters to have access to real-time statistics to create preventive and corrective actions.

From 2011 to 2015, the overall participation accounts for 3,700 students from 42 schools, 130 teachers and 42 headmasters. Since the project has achieved positive results (showing up to 11% overall averaged and pondered knowledge gain in math skills), it will continue towards a phase of massive implementation in 2015 supported by the collaboration of Telefónica México and Fundación Telefónica.





# RANKINGS

Prestigious Ranking Agencies



# The New York Times

Employability Rankings

# QS WORLD UNIVERSITY RANKINGS



**OVERALL  
RANKING  
2015-2016**

**238**

**N° 62 at Global**  
Level in Employer  
Reputation

**WORLDWIDE  
PRIVATE  
UNIVERSITIES  
RANKING  
2015-2016**

**40**

**N° 1 in Mexico**  
in Employer Reputation

# QS WORLD UNIVERSITY RANKINGS



QS WORLD UNIVERSITY RANKINGS 2015-2016 OVERALL RANKING

**238**

ACADEMIC REPUTATION

**274**

EMPLOYER REPUTATION

**62**

FACULTY STUDENT

**176**

CITATIONS PER FACULTY

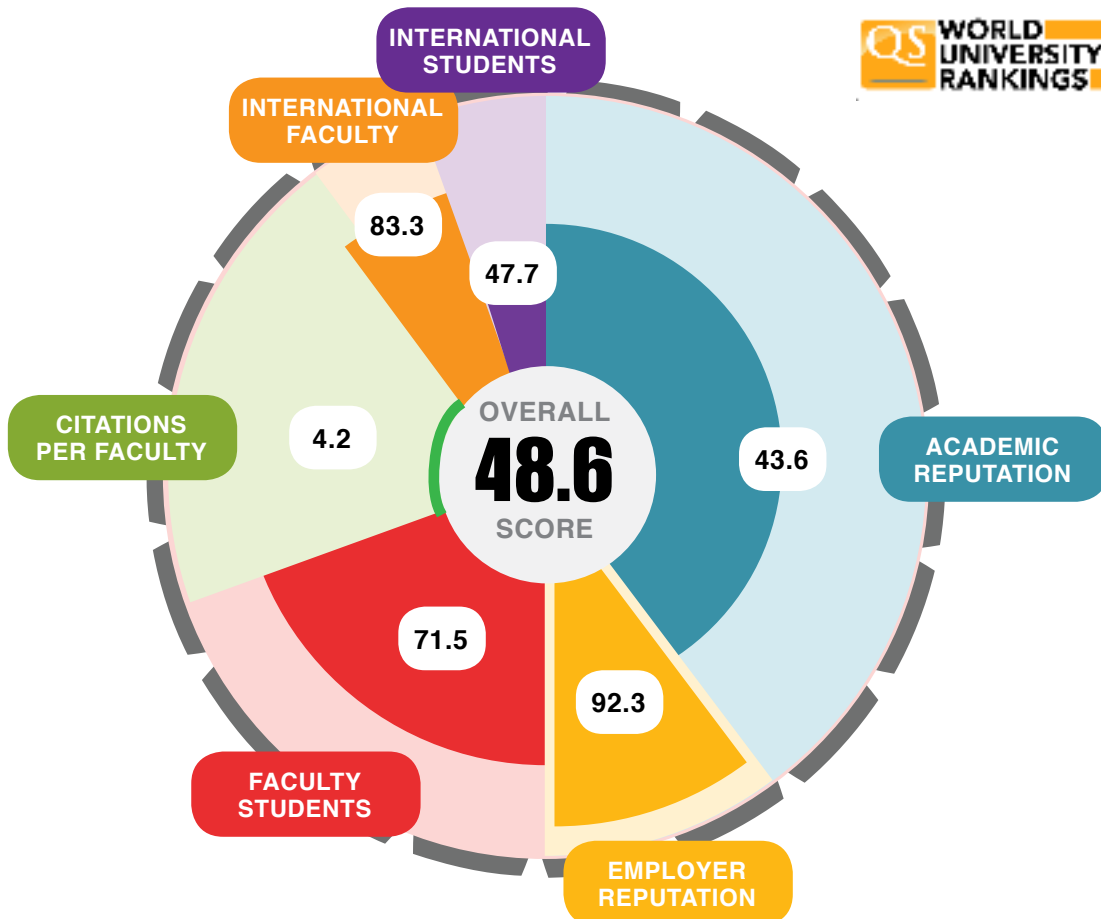
**401+**

INTERNATIONAL FACULTY

**160**

INTERNATIONAL STUDENTS

**308**



# QS WORLD UNIVERSITY RANKINGS



189

Social science and management

160

International faculty

274

Academic reputation

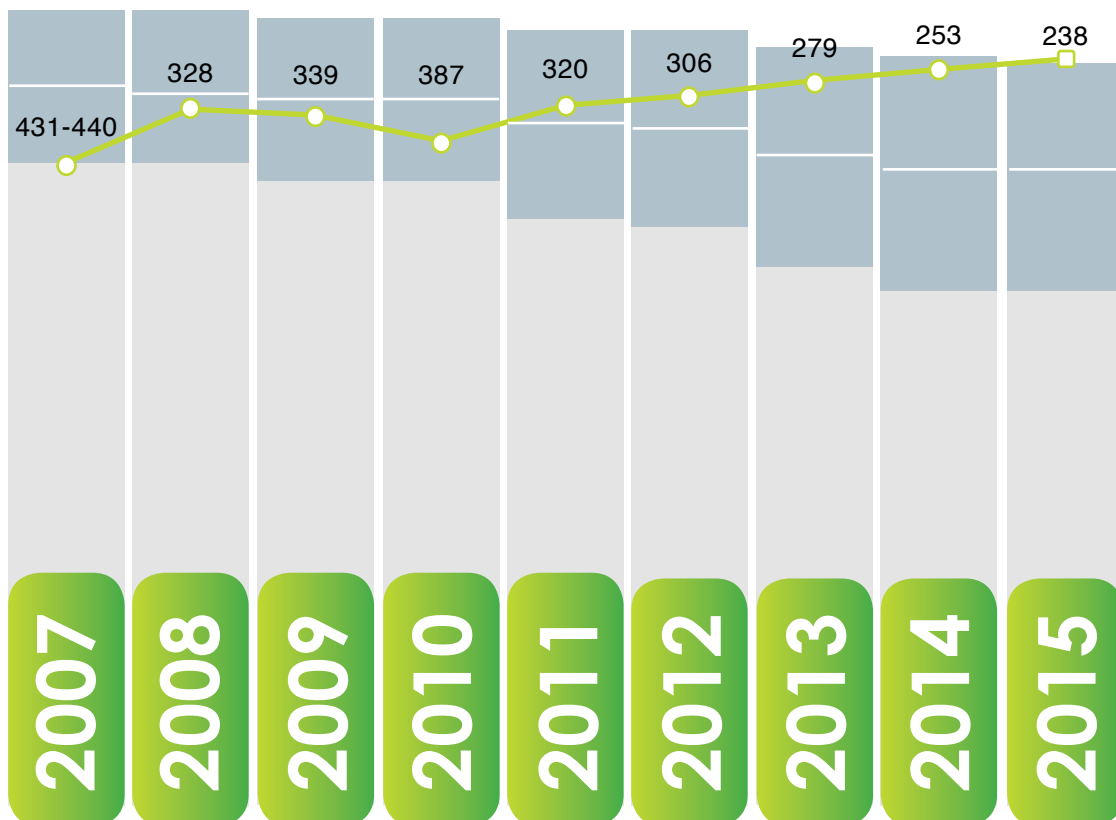
250

Engineering and technology

# QS WORLD UNIVERSITY RANKINGS



Ten year overall ranking with respect to median and interquartile range

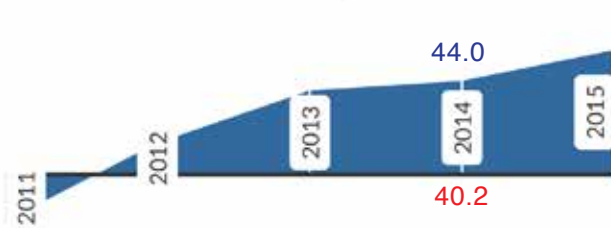


# QS WORLD UNIVERSITY RANKINGS

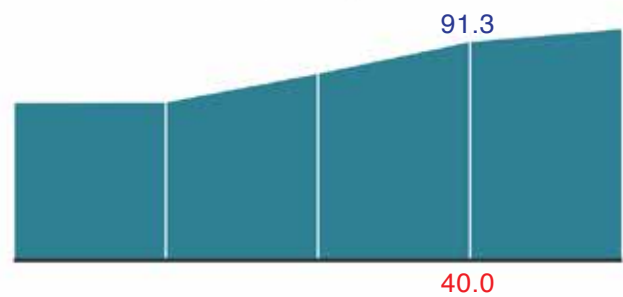


Five year performance by indicator relative to global average

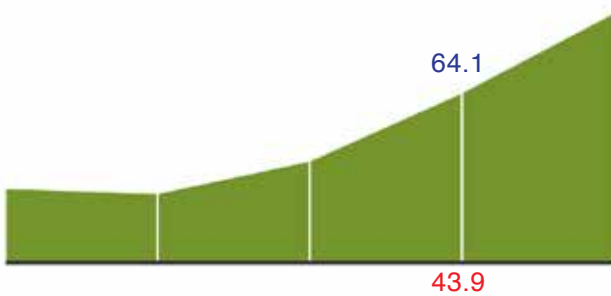
Academic Reputation



Employer Reputation



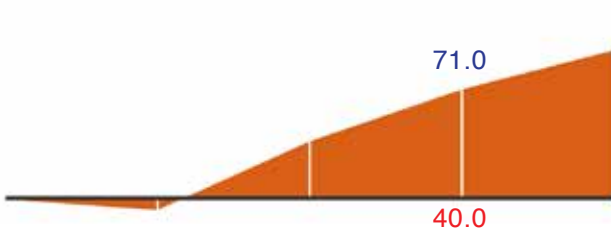
Faculty Student



Citations per Faculty



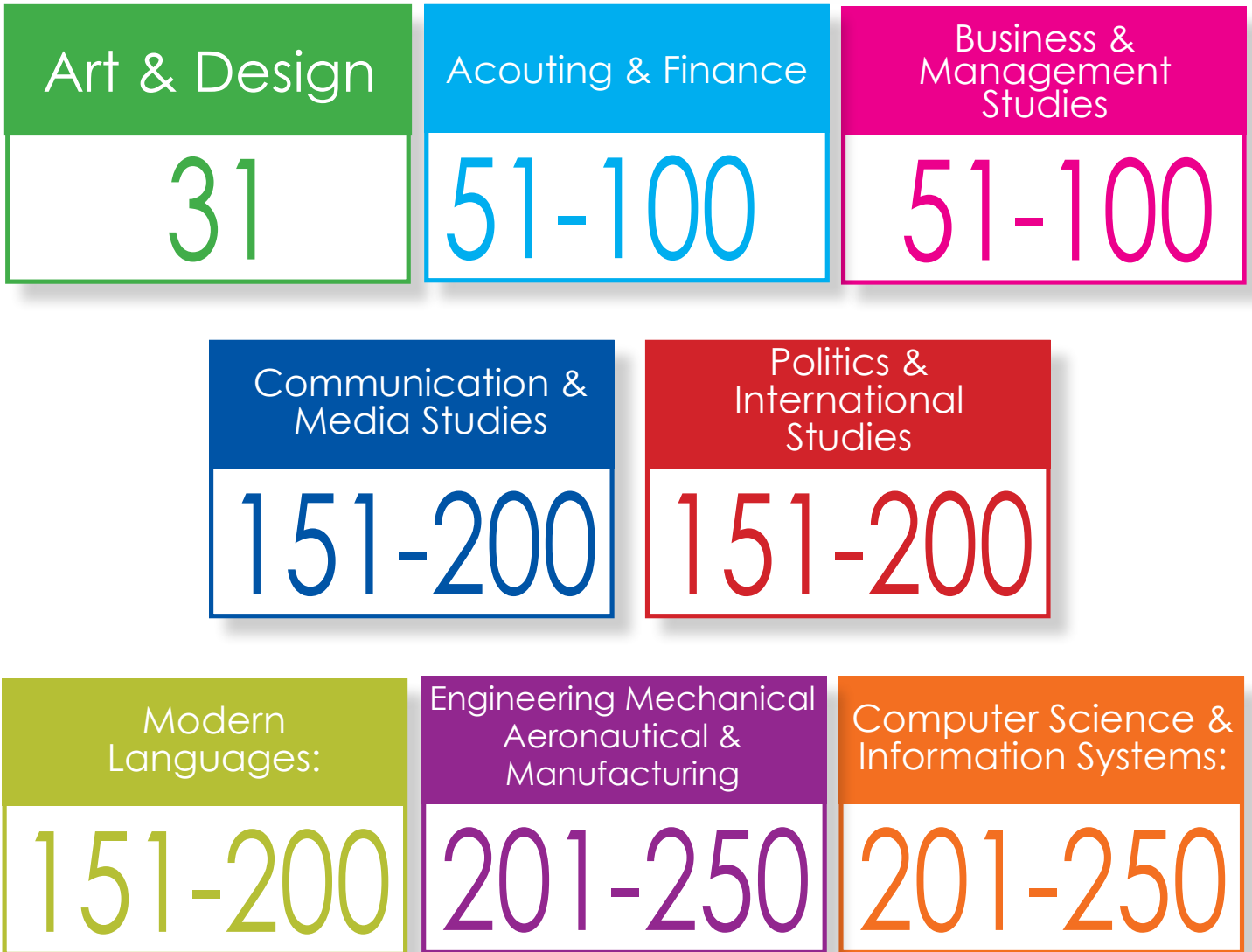
International Faculty



International Students



# QS RANKING BY SUBJECT



# QS LATINAMERICA



**EGADE Business School**

**N° 1 in TOP MBA**

**Latin American  
Rankings**



# QS STARS



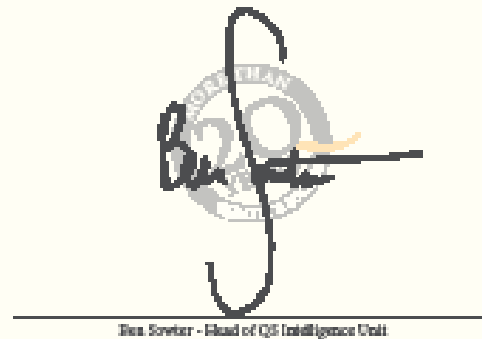
## Tecnológico de Monterrey

The QS Intelligence Unit has, through rigorous and independent data collection and analysis of performance metrics as set out in the QS Stars™ methodology, rated Tecnológico de Monterrey as a Five Star institution.



The QS Stars™ rating system is operated by the QS Intelligence Unit, the independent compiler of the QS World University Rankings® since 2004. The system evaluates universities across a wide range of important performance indicators as set against pre-established international standards. By covering a broader range of criteria than any world ranking agency, QS Stars™ shines a light on both the excellence and the diversity of the rated institutions.

CATEGORY	STAR RATING
Research	★★★★★
Employability	★★★★★
Teaching	★★★★★
Internationalisation	★★★★★
Innovation	★★★★★
Facilities	★★★★★
Engagement	★★★★★
Social Sciences & Management	★★★★★
OVERALL	★★★★★



Rita Soriano - Head of QS Intelligence Unit

# TIMES HIGHER EDUCATION



## BRICS and Emerging Economies 2014

71

*The New York Times*

## Employer Reputation 2014

116





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[www.itesm.mx](http://www.itesm.mx)