4-2015

University of the Future Colombia-Purdue Workshop Report

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UNIVERSITY OF THE FUTURE COLOMBIA-PURDUE WORKSHOP

REPORT

October 28-29, 2014
Purdue University
West Lafayette, Indiana USA

PURDUE UNIVERSITY

University of the Future Report based on a Workshop held at Purdue University, October 28-29, 2014

Colombia-Purdue Workshop

Overview

The University of the Future Workshop was held at Purdue University in West Lafayette, Indiana, October 28-29, 2014. Led by Purdue President Mitch Daniels, participants included rectors and board members from six top universities in Colombia, along with executive directors of NGOs, government representatives from the U.S. and Colombia, and Purdue faculty and administrators.

The workshop was an important step toward broadening the dialog (a conversatorio) among all the participants at the workshop in defining what characteristics are essential for universities to be responsive to the 21st century needs of the Americas.

Executive Summary

Framing Statement and Advanced Workshop Overview

Framing Statement

Peace, prosperity, and sustainable development in the Americas are critical goals for robust economies and functioning govern-ments. How can the University of the Future prepare global leaders who are ready to meet this challenge?

Preceding the University of the Future Workshop, a framing statement, noted to the left, and an overview of the scope of the workshop were distributed to all the participants and are included in Appendix I. The spirit of the workshop was to build upon partnerships already developed with Colombia and work together to advance transformational change in the university system.

Key Themes and Recommendations

Key workshop themes included a) Transformative Education, b) Collaborative Networks of Excellence for Research, Education and Innovation, and c) Innovation Ecosystems. Within each themed session, framing presentations were offered to stimulate dialog on topics related to the three themes. Following the presentations, workshop participants engaged in open discussions. The workshop agenda is included in Appendix II. The recommendations proposed in this report are based on the discussions focused on the three key workshop themes.

Participant Input

Advance Questionnaire

Prior to the workshop, participants completed a questionnaire. A summary of the responses was presented at the workshop and is included in Appendix III.

Focused Discussions at Workshop

Participants discussed key goals, challenges, and opportunities for higher education, in both Colombia and the U.S., and explored approaches for multi-institutional, multi-sector, and multi-national collaborations.

Post-workshop Structured Interviews

After the October workshop, Liliana Gómez Díaz, Purdue's director of Colombian Partnerships and Engagement, conducted structured interviews with the participants. A summary appears in Appendix IV.

Comparison of U.S. and Colombian Universities

A comparison of U.S. and Colombian university systems is presented in Appendix V. The similarities and differences among major universities in the two countries provide important context for evaluating potential

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collaborations as well as efforts to transfer programs and best practices across national boundaries.

Proposed Follow-up Workshop

A follow-up workshop in Colombia is planned for 2015 with representatives from business, government, and universities in attendance.

Participants

The workshop included participation from rectors and board members from six top universities in Colombia, along with executive directors of NGOs, government representatives from US and Colombia, and Purdue faculty and administrators (led by Purdue President Mitch Daniels, pictured left). Purdue University hosted the workshop and participated in the discussions.

External Participants	Institution
Jorge Ivan Bula	Vice Rector, Universidad Nacional de Colombia
Pablo Navas	Rector, Universidad de los Andes
Alberto Uribe	Rector, Universidad de Antioquia
Juan Luis Mejía	Rector, Universidad EAFIT
Edgar Parra	Rector, Universidad de Cartagena
Julio Jairo Ceballos Sepúlveda	Rector, Universidad Pontificia Bolivariana
Juan Rafael Cardenas	Board of Directors, EAFIT
Juan Guillermo Ochoa	Board of Directors, Universidad Pontificia Bolivariana
Luis Carlos Villegas	Colombian Ambassador to the United States
Anne Slaughter Andrew	Former U.S. Ambassador to Costa Rica
Susan Bell	US Embassy in Colombia
Ann Mason	Executive Director, Fulbright Colombia
Jerónimo Castro	Executive Director, Colfuturo
Juan Camilo Quintero	Executive Director, Ruta N, Medellín
Juan Ernesto de Bedout	External Advisory Committee, College of Engineering
Steven Dorsey	International Institute of Education
John McDonald	General Electric Energy Management

Framing Presenters	Institution
Mitch Daniels	President, Purdue University
Suresh Garimella	Executive Vice President for Research and Partnerships, Purdue
John McDonald	General Electric Energy Management
Anne Slaughter Andrew	Former U.S. Ambassador to Costa Rica
Luis Carlos Villegas	Colombian Ambassador to the U.S.
Frank Dooley	Vice Provost for Undergraduate Academic Affairs, Purdue
Ananth Iyer	Director of Purdue NExT
Dan Hasler	President and Chief Entrepreneurial Officer, Purdue Research Foundation
Nathalie Duval-Couetil	Burton D. Morgan Center for Entrepreneurship, Purdue
Cliff Wojtalewicz	Burton D. Morgan Center for Entrepreneurship, Purdue
Juan Camilo Quintero	Director, Ruta-N
Gerhard Klimeck	Network for Computational Nanotechnology, Purdue
Michael Ladisch	Laboratory for Renewable Resources Engineering, Purdue

Steering Committee

Suresh Garimella, Executive Vice President for Research and Partnerships, and Goodson Distinguished Professor of Mechanical Engineering, Purdue University, sureshg@purdue.edu

Anne Slaughter Andrew, former US ambassador to Costa Rica.

Liliana Gómez Díaz, Director of Colombian Partnerships and Engagement at Purdue, lgomezdi@purdue.edu

Arvind Raman, faculty lead for Colombia-Purdue Institute and Associate Dean of Engineering for Global Programs, Purdue University, raman@purdue.edu

David Janes, Professor of Electrical and Computer Engineering and Faculty Coordinator for Institutional Partnerships, Purdue University, janes@purdue.edu

Suzanne Nielsen, Professor of Food Science and Global Affairs Fellow for Special Initiatives, nielsens@purdue.edu

Key Topics and Recommendations

Workshop participants identified several key topics associated with the workshop themes during the discussion. These appear in this section of the report, followed by proposed recommendations. The recommendations synthesize the topical outcomes into structured enabling programs or capabilities designed to advance the workshop themes for transformational change. Topics such as "teaching and learning" and "faculty development" represent needs and goals across thematic areas and serve as the basis for a number of recommendations. "Networks of Excellence" are suggested for building collaborations among key stakeholders in order to develop the knowledge-based economy necessary for innovation. It is anticipated that additional stakeholders from government, NGOs, and companies will contribute to the dialog at future workshops.

Initial steps toward implementing the recommendations in a given category could be realized in the near future. However, full implementation of large programs may require several stages involving initial demonstrations with evaluations and refinements to achieve widespread adoption.
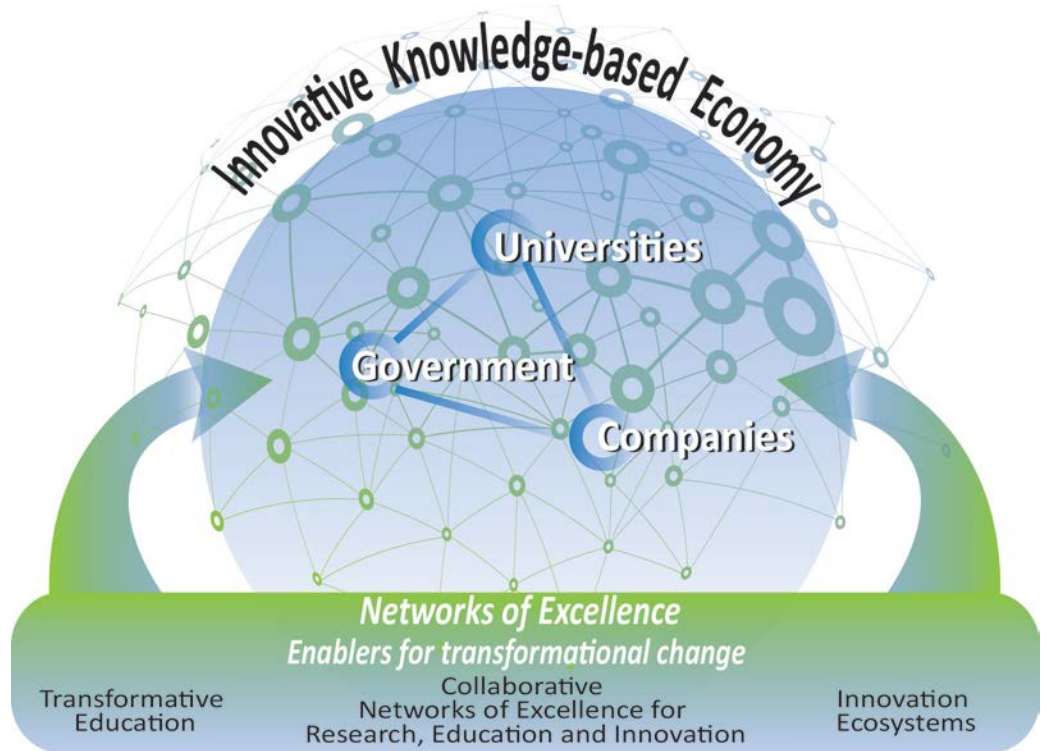
Theme: Transformative Education

Workshop-identified topics in:
Teaching and Learning

- Process of teaching and learning
- Information and Communications Technologies (ICT), including online
    - Nontraditional classroom
    - Pedagogy
    - Virtual presence by external professors
    - Competency-based system
- Curriculum development and content sharing
    - Address emerging technical areas and focus areas of relevance for Colombia
    - Share content for advanced courses across institutions and regions
- Role of the university in sustainable development of nation
    - Colombian universities could consider a version of the U.S. "land-grant" model
    - In addition to urban settings, universities should serve less-populated areas
    - Workforce development can be included in university focus

Recommendations: Teaching and Learning

Student-Focused Learning

Student-focused learning can include such nontraditional classroom approaches as online course modules and "inverted" classroom approaches in which lecture material is presented online and class time is dedicated to interactive activities with groups of students. Successful implementation of these approaches requires understanding concepts as well as developing specific methodologies optimized for the local setting. Specific recommendations include:

a. **Develop teaching workshops to illustrate concepts of non-traditional classroom approaches and online educational modules.** Such workshops represent a first-step in illustrating the concepts and identifying potential participants for more extensive implementation.

b. **Develop a cadre of experts in Colombia on non-traditional classroom approaches and online educational modules and provide infrastructure and resources to train and mentor others.** Such a cadre could provide the core for implementing novel classroom approaches as well as developing experts for training the next generation of faculty in the associated techniques. Collectively, this cadre should provide expertise in various disciplines, as along with scholarly activities in course design and assessment. This phase should include resources and release time to allow participants to make extended visits (weeks to months) to a university with an established program in nontraditional classroom approaches.

c. **Define infrastructure and rewards system for widespread adoption of nontraditional classroom approaches and online educational modules.** Infrastructure includes classroom spaces suited for interactive exercises with students. Faculty incentives may include release time for course development, financial compensation, or promotion and recognition.

Information and Communications Technologies (ICT)

Information and Communications Technologies (ICT) refers to a broad set of capabilities, including computer programming, visualization, human and computer interfaces, and use of computational tools in the classroom. ICT represents an important capability for students and an important set of tools and resources for faculty.

a. **Develop training programs for university instructional staff and professors in ICT**. Training programs for instructional staff will provide a direct benefit in terms of classroom implementation. Well-trained

instructors will be able to provide better instruction for students in the use of computational technologies.

b. **Define infrastructure and incentives for widespread adoption of ICT technologies in university classes.** Widespread implementation of ICT in the classroom (and beyond) can have a significant impact on educational methodologies as well as the student experience. Particularly in early stages, resources will be required for both development and classroom implementation. Appropriate structures must be in place to incentivize faculty members to lead these developments.

Workshop-identified topics in:
Developing the Whole Student (beyond merely technical knowledge)

- Values and ethics
- Bilingual (particularly English)
- Beyond classroom learning (projects, experiential learning, socially relevant projects)
- International programs
    - Increase mobility to Colombia
        - Undergraduates, PhD students

Recommendations: Developing the Whole Student

A common theme in both the questionnaire responses and comments at the workshop addressed the need for developing the "whole student." Broadly, the comments referred to providing student experiences beyond typical subject-matter courses and included educating students in societal and ethical issues and increasing international experiences for students. Specific recommendations for the near future include experiential learning, English-language programs, and programs to increase mobility to Colombia. Increasing international student exchanges to Colombia would have a positive impact on achieving this goal. The focus should be on building

citizen leaders of tomorrow, and making opportunities available in an inclusive way across all sectors of society.

Experiential Learning

a. **Develop experiential learning programs, including components on societal issues and service learning.** Experiential learning programs provide strong complements to traditional classroom approaches, including opportunities to address open-ended problems, focus on societal problems, and connect to communities beyond the university campus. Collectively, these activities provide a more complete education for students and prepare them for a proactive role in society and a productive career.

Develop English-language Programs for Students

a. **Develop English as second language (ESL) programs that can be shared across multiple institutions.** English-language skills are considered important both in enabling more extensive international experiences for students as well as in preparing students for careers in multi-national settings. While ESL programs exist in a number of institutions, there continues to be a need to develop more accessible programs for students, particularly off-campus students.

b. **Develop partnerships with universities in English-speaking countries to foster student mobility to those countries and enable students to develop English skills.** International programs provide an important incentive for students to focus on developing foreign language skills. Long-term partnerships would provide immersive experiences for students and opportunities for students to establish lasting relationships with peers from other institutions.

International Programs —Mobility to Colombia

Although several programs address mobility of Colombian students to study abroad, the number of international students traveling to Colombia has been limited. Discussion at the workshop highlighted the need to increase the number of inbound students in order to provide mutually beneficial interactions and raise the profile of Colombian programs.

a. **Define infrastructure and resources required to increase mobility of students to Colombia.** While many universities have highly regarded academic programs with the capabilities to accept international students, real and perceived barriers exist for inbound students. Dedicated offices working with international partner universities can address academic, logistical, housing, and other issues.

Theme: Partnerships and Networks of Excellence for Research, Education and Technology Transfer

Workshop-identified topics in:
Faculty Development

- Focused PhD cohort programs
  - Move beyond "one-at-a-time" training of PhDs abroad
  - Focus on English-speaking countries (to build English proficiency)
- International programs
  - Increase mobility to Colombia
    - Undergraduates, PhD students, service learning, faculty
- Mentoring in research, teaching, and entrepreneurship
- Re-entry program (for faculty and corporate leaders)
- Look for "leapfrog" opportunities versus aiming to simply catch-up

Recommendations: Faculty Development

Networks of Excellence

Research and experience indicate that established networks focused on areas of interest among stakeholders impact results-driven development of partnerships and programs. Networks of Excellence among faculty within the Colombian university system and with international universities and companies are necessary to accelerate programs that will advance the needs

of the universities of the Americas. Such networks would enable universities to leapfrog from existing systems and develop effective partnerships and programs for faculty development.

Focused PhD Programs

a. Develop Networks of Excellence and partnerships with universities in North America, Europe, and Asia involving cadres of PhD students focused on preparing future faculty for Colombia and the region. It was discussed during the workshop that *individuals* pursuing PhD degrees abroad in an isolated manner represent a relatively inefficient process. Partnerships that focus on *cohorts of students* can provide advantages both in potential financial models and professional development activities for the students lasting well beyond the experience abroad. In light of the structural differences between universities in Colombia and the U.S. (Appendix V), preparation for a faculty position or corporate R&D career in Colombia may require a different set of extracurricular programs than preparation for a career in the U.S. Broader agreements with partner universities would allow a stronger focus on required activities as well as stronger connections to institutional mentors in Colombia.

b. **Develop Networks of Excellence around basic and applied research focuses.** To establish a sustainable pipeline of innovation, fundamental or basic research should be an integral part of an overall university research program. A network of stakeholders could identify areas of basic research expertise in Colombia that may align with research activities at partnering universities. These networks could leverage capabilities and research strengths in both basic and applied research.

Re-entry Program for Faculty and Corporate Leaders

In addition to the differences in Colombian and U.S. universities (Appendix V), there are also differences in corporate R&D settings between the two countries. In the short term, there are concerns associated with the lack of developed professional and technical networks available for returning MS graduates and PhDs, particularly those who will be asked to establish new research themes or new capabilities at their institutions.

a. **Develop a re-entry program for MS graduates and PhDs returning to Colombia, including both university and corporate positions.** A re-entry program could include financial resources for scientific equipment, laboratory development, professional networks, conference travel, and infrastructure for research administration. Ideally, the student's overseas PhD institution (through a partnership with the PhD advisor) would

participate in the definition and implementation of a re-entry strategy and would maintain contact with the former student during the early years of their new career.

b. **Develop a mentorship program for new and developing faculty members**. At U.S. universities, it is common for junior faculty to be mentored, either formally or informally, by a senior colleague in their technical area. On campuses undergoing significant transformations in their research focus, junior faculty may not have a local mentor in their technical area with long-term experience in developing research themes. A mentorship program, including mentors from Colombia as well as the U.S. (or other countries), is important for providing advice and guidance to junior faculty on the processes for defining research themes, developing collaborations, and identifying suitable equipment and infrastructure for the local context.

International Programs —Mobility to Colombia

a. **Define infrastructure and resources required to increase mobility of faculty and professionals to Colombia.** Increasing the opportunities for faculty and professionals to come to Colombia and work within the university system will require development of an infrastructure and appropriate resources. A mutual value proposition for university faculty and professionals from other countries should be developed to encourage mobility to Colombia.

Workshop-identified topics in:
University–University and University–Company Partnerships
- Joint programs involving multiple universities
- Corporate involvement and sponsorship in university programs
- Shared equipment infrastructure accessible by universities and companies

Recommendations: Partnerships

Partnerships between Universities and University–Company–Government

In general, collaborative partnerships between universities and companies are less common in Colombia than in the U.S. In addition, research equipment resources and infrastructure are not typically shared between universities or accessible to companies. While extensive partnerships between universities, companies and government will be discussed in greater

detail in future workshops, the recommendations below represent initial steps that could be addressed in the near future.

Basic and Applied Research

To establish a sustainable pipeline of innovation, leading universities in Colombia are seeking to increase the scope and impact of their respective research programs. A network of stakeholders will accelerate development of strategic research areas by aligning research activities at partnering universities and focusing government programs.

a. **Develop Networks of Excellence around basic and applied research focuses.** These networks could leverage capabilities and research strengths in both basic and applied research areas.

b. **Develop public policies and funding that promote strategic research areas.** Governments must ensure that good peer-review processes are developed. Respected non-governmental leaders should identify strategic research areas for investment. Support for chosen areas of research should transcend changes in agency leadership and governments so that sustained efforts may continue to have support.

Shared Research Infrastructure

In the U.S., a "cost center" is a common model employed to finance infrastructure equipment. In this model, equipment is operated as a "user facility" in which a number of users (internal and external) have access to the equipment. Users pay fees for using the equipment and the total fees collected in a year typically covers the overall cost of operating and maintaining the equipment. Such a model could help Colombian institutions build essential equipment infrastructure relatively quickly and reduce the need to replicate systems at every university.

a. **Evaluate the legal and cultural barriers to "cost centers."** In light of perceptions that companies are not allowed to use facilities at public universities, it is important to understand whether a cost center model is legally and culturally acceptable in Colombia.

b. **Evaluate the potential users in the local setting that would share a few representative pieces or groups of infrastructure equipment.** Local users would include universities, companies, and government or privately-sponsored laboratories.

Company–University Partnerships

To foster research, development, and technology transfer activities with companies, it is important to establish an infrastructure that allows research groups from the university and development groups from the company to

interact freely. A Network of Excellence could assist in this transformation. Infrastructure and master agreements can address issues associated with licensing, confidentiality, and intellectual property developed under collaborative programs.

a. **Develop an infrastructure for intellectual property licensing and technology transfer from universities to companies.** Technology commercialization offices typically focus on advertising the available patent portfolio and negotiating licensing agreements between the university and companies.

b. **Define master agreements between universities and companies related to intellectual property, patent licensing, and technology transfer.** Particularly in cases involving company-sponsored research, "up-front" agreements are essential for strong programs. An existing master agreement between a given company and a university can establish a framework so that sponsored or collaborative work could begin quickly with each new project needing only a statement of work and budget.

Define Areas for University–Company Partnerships in Research and Education

Defining and building *relevant, successful and sustainable* partnerships is recommended as a focus area for a second workshop.

Theme: Innovation Ecosystems

Workshop-identified topics in: Commercialization

- Build on innovation and commercialization centers in Colombia
  - Link research and commercialization
- Create a culture of innovation (e.g., across entire university)
- Entrepreneurship programs
- IP licensing (particularly U.S. to Colombia)
- Company–university partnerships — define value propositions for corporate investments in university programs

Recommendations: Commercialization

To leverage university research programs, commercialization activities should be supported — including patents, entrepreneurship programs, and technology transfer to companies. While a variety of company–university partnerships are of potential interest, the specific recommendations in this section address licensing of intellectual property and agreements that could foster investments in university research programs.

Intellectual Property Policies

a. **Evaluate current intellectual property policies and associated incentive programs.** Generally, patents arise from research projects, and the patent process is initiated by the investigators leading the project or perhaps with encouragement from the sponsor. In this scenario, the university should provide suitable policies and rewards to encourage research groups to expeditiously patent promising results.

Entrepreneurship Programs

One pathway toward commercialization involves faculty and student inventors starting companies. In this case, the company founders would typically license the inventions from the university and then obtain independent start-up funding for the effort. Because most faculty members are not trained in starting a company, it is necessary to provide training and mentorship activities for these efforts.

a. **Create entrepreneurship training programs**. Training programs focused on technical, business, and financial issues of starting a company can help encourage entrepreneurship as well as identify potential entrepreneurs.

b. **Define an incentive program that encourages faculty, staff, and students to participate in innovation and technology transfer activities.** Starting a company may take several years of dedicated effort. This is a difficult task even for someone without full-time teaching, research, and service responsibilities. Even transferring a technology to an established company may take significant time and effort. Faculty, staff, and students will need release time and potentially other resources.

c. **Develop a mentorship program for potential entrepreneurs.** Experienced entrepreneurs (from Colombia and overseas) can provide valuable guidance for people looking to start a company.

d. **Identify business-related resources for potential entrepreneurs.** University researchers typically understand their technology but rarely understand the financial, marketing, production or legal aspects of a successful business. Local personnel well-versed in these activities might be CEOs or CFOs for start-up companies and require an equity interest in the company.

Conclusion

A clear outcome from the first workshop indicates that all of the participants have a vested interest in continuing the dialog with broader participation from key stakeholders including government, NGOs, and companies. There is a keen sense of urgency to act on the imperative to change within the university structure and become more responsive to the 21st century needs of the Americas. Aware that collaborations and partnerships are essential to enable change of this scale, Networks of Excellence have been proposed to accelerate the process. Networks of Excellence provide an environment that brings together the diverse views, experiences, expertise, and connections needed to enable the kinds of transformational changes that lead to an innovative knowledge-based economy.

Acknowledgements

Appendix I

Framing Statement and Advanced Workshop Overview

Framing Statement

Peace, *prosperity* and *sustainable development* in the Americas are critical goals for robust economies and functioning governments. How can the University of the Future prepare global leaders who are ready to meet this challenge?

Common Understanding

"Conversatorios" on a few select topics, with the understanding that:

- We are seeking new initiatives that build upon, or advance beyond, the existing status quo for universities.
- In addressing the challenges facing universities, we value a collaborative framework to cross-cutting themes such as preparing future faculty, financing, and the required infrastructure.
- We recognize this is a collective effort – no one institution can do this alone; nor can universities tackle this comprehensive effort without the active engagement of the private sector, government, and international partners.
- We are committed to addressing these challenges with sustained and sustainable efforts, and intend to continue both the conversations and programs over the long-term, with regular follow-up workshops.

Specific Workshop Goals

- Consider national/regional/global contexts for educational, research and innovation initiatives (to be highlighted in keynote and invited presentations and plenary remarks).
- Share examples of successful programs as best practices, as well as challenging problems (participants are asked to provide input both in response to an advance questionnaire and in informal remarks at the Workshop as seeded by lead presenters).
- Identify common issues and opportunities for partnering (all participants), including opportunities for partnering to address the need for greater financial resources for the universities and their faculty and students.
- Discuss frameworks for educational innovations, collaborative networks, and innovation ecosystems (all participants).
- Generate position papers and policy proposals to be distributed to institutions, companies, governments, NGOs and the media to effect broader systemic solutions and longer term opportunities.

Key Follow-Up Activities

- Forum report on *University of the Future* and framing of key issues for future events.
- Next workshop (six months) in Colombia with a regional focus, with Colombia as a hub.
- Explore specific partnerships and networking frameworks.

- Explore joint funding opportunities.

Thematic Areas

The two-day workshop will include participation from knowledgeable leaders of universities, companies and government agencies in Colombia and the US. While national initiatives provide long-term frameworks, the workshop will focus on institutional goals, challenges and opportunities in thematic areas: Transformative Education, Innovation/Commercialization and Partnerships and Networks for Excellence in Research, Education and Technology Transfer. A number of issues are expected to be cross-cutting themes within the sessions, including student programs, faculty development and sustainable financial models.

Session Format

Sessions will include keynote talks and brief introductory presentations by Colombian and Purdue representatives, primarily aimed at framing potential topics and raising key questions. The introductory presentations will be followed by 60-90 minutes of open discussion. In the spirit of a *conversatorio*, we hope to encourage a spirited and frank conversation involving all participants, in preference to prepared remarks. The proposed thematic areas are relatively broad, in order to allow participants to define specific topics for discussion. Simultaneous translation will be available, so that remarks can be made either in Spanish or English and participants will be able to listen in either English or Spanish.

Purpose/Outcomes

The event is expected to provide a forum for conversations related to key goals, challenges and opportunities for transforming higher education. One of the outcomes of the workshop will be a position paper that will summarize the key goals, opportunities and challenges for universities and provide a framework for strategic partnerships to accelerate progress. This position paper will be distributed to participants and can be shared with government and corporate leaders in order to encourage programs and investments addressing the key issues.

Purdue's Role in Workshop

Purdue professors and senior officials will be participants in the focused discussion sessions. While specific Purdue programs and existing partnerships are likely to be mentioned in the discussions, the workshop will focus on a broader dialog regarding future goals, challenges and opportunities. Like universities in Colombia, Purdue strives to serve the needs of our country and our state and we are transforming to be relevant for the 21st Century. We anticipate a series of frank and open conversations in which we discuss our challenges as well as our successes, and we expect to learn from Colombian participants.

Appendix II

Workshop Agenda

Tuesday, 28 October

7:30 am   Shuttle Bus departs Union Club Hotel lobby entrance

                 Coffee and light breakfast will be available at the Kurz Center

8:00 am   Session I: Framing the Workshop (Kurz Center)

                 Welcome and Framing Presentation -- Suresh Garimella, Executive Vice President for Research and Partnerships, Purdue University

8:20 am   Session II: Transformative Education (Kurz Center)

                 Framing Presentation -- Frank Dooley, Interim Purdue Vice Provost for Undergraduate Academic Affairs, with participation by Ananth Iyer, Director of Purdue NExT

11:15   Keynote – Company/University Partnerships (John McDonald, GE)

11:40 am   Shuttle Bus departs Kurz Center for Purdue Memorial Union Union (PMU)

12:00 pm   Lunch with Colombian Students at Purdue (CSAP) (East Faculty Lounge, PMU)

                 12:40 Introductions/Brief Presentations by Colombian Students

                 1:00 Importance of Education in Colombia and US-Colombian Partnerships: *Luis Carlos Villegas, Colombian Ambassador to US (*with participants and students*)*

1:30 pm   Extended Discussion with Ambassador Villegas (Anniversary Drawing Room, PMU)

2:00 pm   Session III: Innovation/Commercialization – (Anniversary Drawing Room, PMU)

                 Framing Presentation: Dan Hasler, President and Chief Entrepreneurial Officer, Purdue Research Foundation, with participation by Joseph Pekny and Nathalie Duval-Couetil, Burton Morgan Center for Entrepreneurship, Purdue

                 Framing Presentation: Juan Camilo Quintero, Director, Ruta-N

4:30 pm   End of sessions; participants may return to hotel rooms

6:15 pm   Shuttle Bus departs Union Club Hotel lobby entrance

6:30 pm   Hosted Dinner and Plenary Remarks with Purdue President Mitch Daniels

9:00 pm   Shuttle Bus departs dinner, returns to Union Club Hotel

Wednesday, 29 October

7:30 am   Coffee and Light Breakfast available in Anniversary Drawing Room, PMU

8:00 am   Session IV: Partnerships and Networks for Excellence in Research, Education and Technology Transfer (Anniversary Drawing Room, PMU)

                 Keynote – Anne Slaughter Andrew (former US Ambassador to Costa Rica)

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Framing Presentation -- Gerhard Klimeck, (Electrical and Computer Engineering) Network for Computational Nanotechnology

Framing Presentation – Michael Ladisch, (Agricultural and Biological Engineering/Biomedical Engineering) Laboratory for Renewable Resource Engineering

11:00 am   Session V: Reports on Discussion Sessions and Future Pathways

12:00 pm   Lunch with Purdue Participants and Delegations (East Faculty Lounge, PMU)

1:30 pm   Colombia Purdue Institute Agenda – Participants and accompanying delegations.

Appendix III

Advance Questionnaire

Overview of Advance Questionnaire

In advance of the workshop, a questionnaire was distributed to all participating institutions. Participants were asked to provide up to three (3) priority areas or top goals/challenges in each of the following areas:

- Transforming Undergraduate Education
- Priorities for Faculty Member Skills
- University Research Programs
- Innovation and Commercialization
- Partnerships, including single institutions, networks consortia and public/private

The full questionnaire is provided in this Appendix.

The responses to the questionnaire were compiled and a summary of the responses was presented at the workshop. Participants were asked to comment on the summary. Common themes from written responses as well as comments by participants were incorporated into the overall workshop summary.

Summary of Questionnaire Responses

The questionnaire responses have been grouped according to common themes, and tabulated in terms of frequency of a given category of response. The charts below present a summary of the compiled responses. Since each institution was asked to provide up to three items in response to each question, the responses to a given question may total above 100%.

There were insufficient responses to the question on institutional partnerships to allow generation of a representative summary.
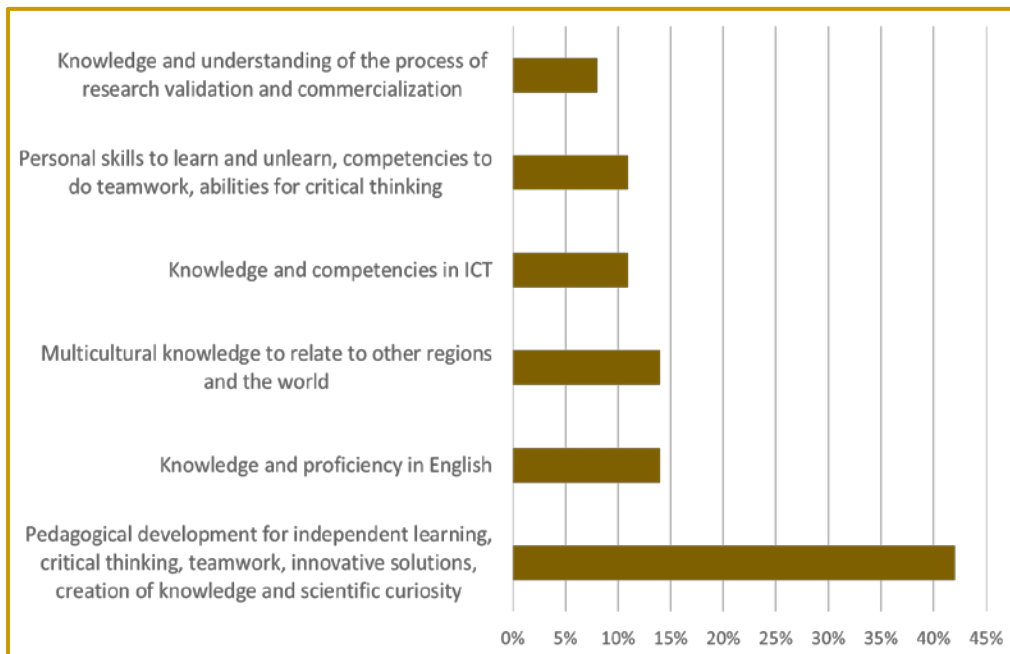
Transforming Undergraduate Education

Which are your three priority issues for transforming undergraduate education?
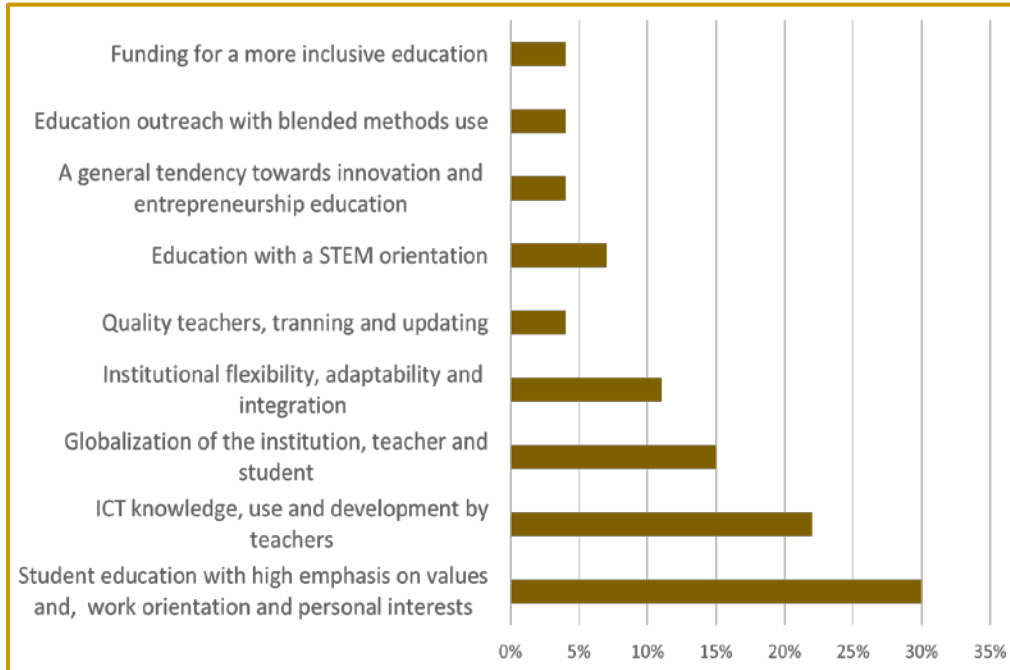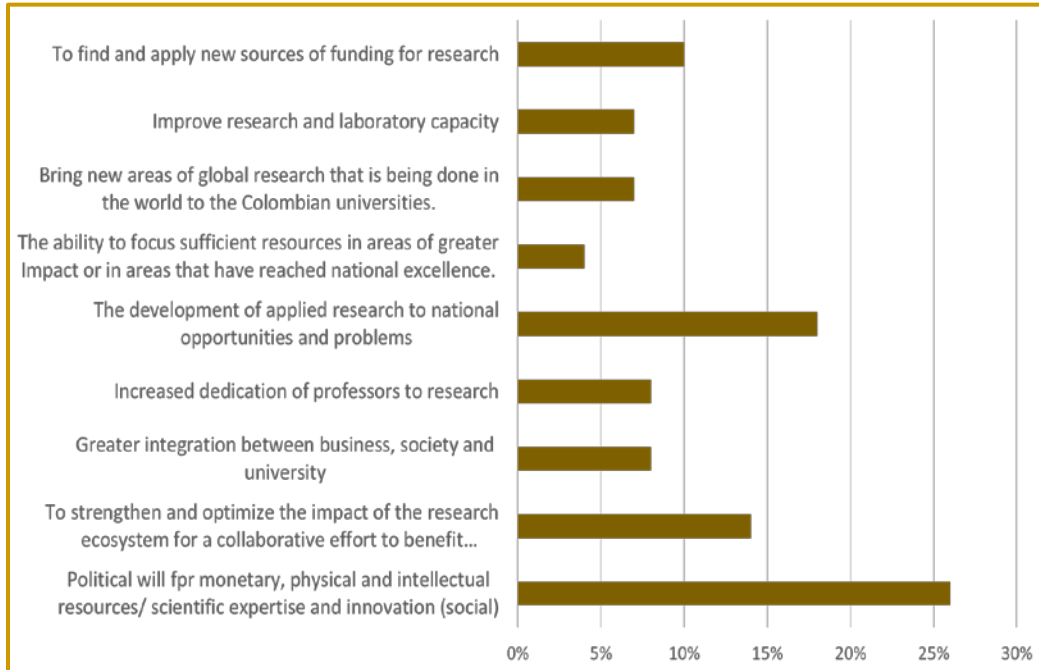

Priorities for Faculty Member Skills

What are the primary skills required for future faculty members (professors, instructors)?
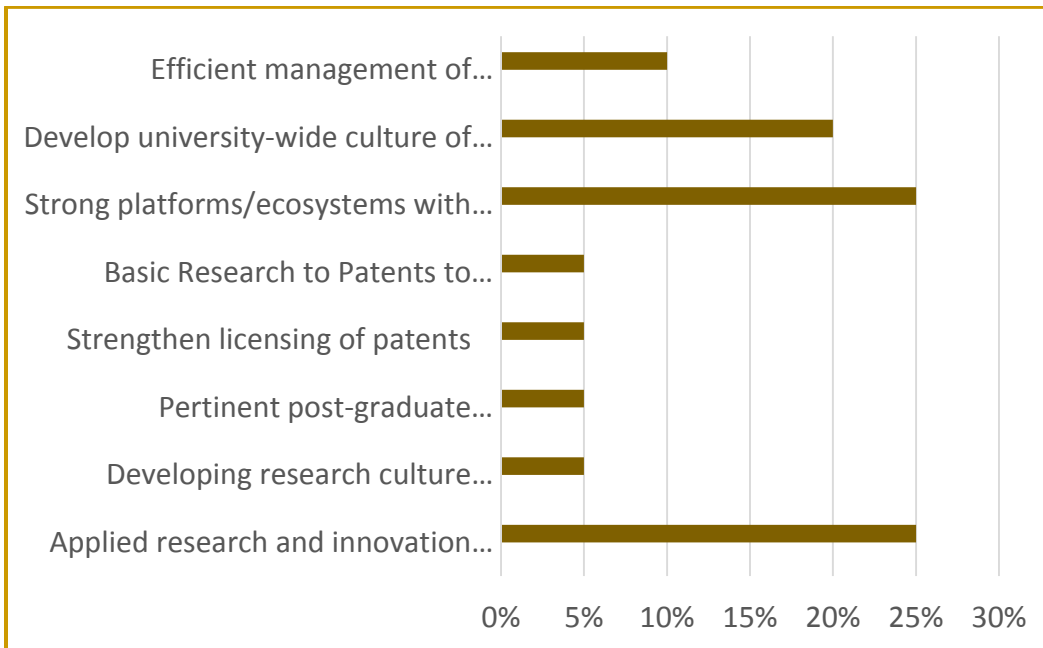
University Research Programs

What are the key opportunities and challenges for university research programs?

Innovation and Commercialization

What are your institution's key goals and challenges in Innovation and Commercialization?

Text of Advance Questionnaire

The University of the Future, a workshop led by Purdue University

Questions for educational, senior business and government leaders

In today's ever changing world, higher education is called to constantly redefine, redesign and reestablish its value proposition. Globalization of businesses and markets, financial melt downs, shortcomings in value systems, the fast-changing nature of organizations with innovation and entrepreneurship as constants, changing generation of people who perform various roles (Gen X, Gen Y and Gen Z working under the same roof), increased access to technology and ever changing technology and communications, emerging countries housing global businesses require new roles to be performed by universities, new skills to be developed in the student and future professionals and effective networks in order to articulate a more pertinent education.

This is the challenge for all countries and in the case of Colombia; there is an important shared purpose to better the quality of education in general and prioritize the advancement of science and technology and innovation and entrepreneurship. The role of the Colombian leaders in the creation of shared value is critical, and even more important is the coming together of educational, senior business and government leaders.

More broadly, peace, prosperity and sustainable development is critical to all of the Americas. Universities throughout the Americas represent ideal points for exchange of people, ideas and approaches and will play key roles in developing partnerships that can address regional/global challenges. Ideally, universities, businesses and government will work collaboratively toward developing the next generation of leaders prepared to address regional/global challenges in education, innovation and collaboration.

We propose to offer a space where these topics can be exposed, discussed and from where co-creation will emerge.

We greatly appreciate your cooperation as one of those leaders who will actively participate in this two-day workshop on the areas of discussion chosen: Undergraduate Education, Research, Innovation/Commercialization and Partnerships (Multi-institutional, international and public/private).

Your thoughts will go a long way in helping this workshop redefine future areas of shared growth for all. A few questions are included below. While the questions are mainly aimed at Rectors, participants from companies, agencies and NGOs are also invited to respond, in order to provide your perspectives on potential programs and partnerships.

In addition to the formal questions, we would be very interested in learning about either an initiative/program that has worked well or a key challenge that you are facing. Please provide a ~ 300 word summary of either a successful program or key challenge in the topic of your choice.

These summaries will be instrumental in the moderated discussions as well as the workshop report.

Questions

Brief description of a successful program or key challenge in one of the workshop focus areas (~ 300 words or less):   *Narrative description from participants*

1. Which are your three priority issues for transforming undergraduate education?

2. What are the primary skills required for future faculty members (professors, instructors)?

3. What are the key opportunities and challenges for university research programs?

4. What are your institution's key goals and challenges in Innovation and Commercialization?

5. What are your goals/expectations for partnerships with:

    a. Single institutions

    b. Networks/consortia

    c. Public/private entities

Thank you for your ideas and welcome to the workshop.

Appendix IV

Post-workshop Structured Interviews

Text of post workshop structured interviews

University of the Future

Questionnaire II

A Workshop led by Purdue University

After the University of The Future workshop took place October 28-29, along with tours and individual engagement with many at Purdue, we would like to have your feedback on the event and gather your ideas on possible next steps. We appreciate your feedback which we consider most valuable for the advancement on the topic of the University of the Future and as a way to deepen our mutual relations and establish actions that your institution and the group of participants would like to carry out individually, as joint projects and as collective projects that that you can lead for the benefit of higher education in Colombia and in the Americas. We appreciate your comments.

We would also like to define one or two projects that will become examples of action taken and that would be presented in our second workshop in a few months in Colombia. Finally, the information gathered will be part of the white paper that we will jointly develop to present to other Colombian universities, business and government.

The event's outcomes

Ideas were generated based on the exposition of *Purdue Moves*, where the university's faculty, staff and administration work together to make higher education more affordable and value-added, provide new opportunities for students, address problems of national and global significance, and contribute towards economic development locally and regionally.

The group came together in a spirit of working and thinking collaboratively striving to build on and spread the important partnerships developed with Colombia.

All of the workshop participants focused on four areas of transformation:

- Teaching and learning, including content and processes.
- Developing the "whole student" beyond just technical knowledge.
- Faculty development, including focused doctoral programs, international programs and mentoring.
- Fostering commercialization through existing innovation centers and new entrepreneurship programs.

Questions

Now we would like to hear your impressions on several of the topics mentioned above.

6. What do you consider to be the most significant experience you brought back from the workshop?

7. Of the following topics, which are of major interests for your institution?

a. _____ Teaching and learning methods
b. _____ The methodology of doing basic and applied research
c. _____ Revision of Educational programs
d. _____ The research centers and labs
e. _____ Student and faculty mobility
f. _____ Transfer of knowledge from Purdue to your institution
g. _____The possibility of developing shared research in science and technology
h. _____ The commercialization of academic knowledge in America
i. _____ A network that interacts in joint projects for the benefit of developing higher education
j. _____ Other
8. Of the above areas of interest, which three are part of your institutions strategic plan?
a.
b.
c.
9. Of the above, which would you like your institution to actively participate?
a.
b.
c.
10. Of the above, which would you like to develop between your institution and Purdue?
a.
b.
11. Of the above, which would you like to work on regionally?
a.
b.
12. Of the above, which would you like your institution to lead in your city and community?
a.
b.
13. Of the above, which would you like to lead for Colombia?
a.
b.
14. Of the alternatives chosen, what are your priorities?
a.
b.

15. On the topic of learning and teaching, what are your primary interests?
    a. _____ Evaluate and transform teacher learning
    b. _____ Send faculty to Purdue so they can better their teacher competencies
    c. _____ Study and implement new methods in teachers teacher and student learning
    d. _____ Integrate Purdue methods of teaching to your institutions methods
    e. _____ Lead a workshop on methods of teaching during the following months
    f. _____ Establish a learning and teaching center for faculty
    g. _____ Establish a program for the transformation of teaching on a national scale
    h. _____ Pursue blended learning program
    i. _____ Design and implement virtual learning programs for teachers

16. On the topic of research, what are your main interests?

    a. _____ Establish a research program on specific topic:
    b. _____ Evaluate and compare basic and applied research processes and methodologies
    c. _____ Study and propose joint research projects in the topics of:
    d. _____ Connect with industry for applied and joint research projects
    e. _____ Complement projects that are underway
    f. _____ Use Purdue laboratories for research projects
    g. _____ Do regional, national and global commercialization of research
    h. _____ Lead commercialization efforts in research and education
    i. _____ Do applied and joint research projects on Colombian problems
    j. _____ Send researchers to Purdue for hands on experience and research
    k. _____ Bring Purdue researchers to Colombia to work on teaching and research
    l. _____ Look for scientific and technological solutions applied to Colombia
    m. _____ Work on joint social innovation programs
    n. _____ Look for joint research funding

17. On the topic of education programs, what are your main interest?

    a. _____ Transform program contents
    b. _____ Develop shared courses with Purdue
    c. _____ Develop educational programs in other regions of Colombia
    d. _____ Bring in foreign students to your programs
    e. _____ Send students for credit programs to Purdue
    f. _____ Bring Purdue Students to your university
    g. _____ Develop English as a foreign language for your students
    h. _____ Send students for entrepreneurs certificate programs or courses to Purdue
    i. _____ Do joint executive education for the business community
    j. _____ Start a shared virtual education network
    k. _____ Globalize the contents of your programs

18. On the topic of infrastructure, lab facilities, what are your main interests?

    a. _____ Construct new research facilities in your campus with Purdue assessment?

b.	_____ Construct new research labs to share with other institutions?

c.	_____ Use Purdue's Research Park to do research?

d.	_____ Develop joint research projects in other cities in Colombia?

e.	_____ Learn how Purdue does research and apply it to your institution?

f.	_____ Study how students can be better motivated and involved in research?

g.	_____ Lead the committee that analyzes how to better research in the region?

Other topics

19.	 When do you suggest we hold the next workshop?
20.	Who do you suggest we add to the list of participants?
21.	In what city do you consider that the worskshop should be held in?
22.	Would you assist?
23.	What are the three main experiences that we could be working on starting now?
a.
b.
c.
24.	In addition to presenting the ongiong projects, what other topics should be considered and what conferences (short 15 minutes) should be included?
25.	What activities should the workshop include?

Thank you for your active participation and the time you have given us to advance the definition of joint projects that can better the quality of education in Colombia!

Appendix V

Comparison of US and Colombian University Systems

Overview
This section summarizes the similarities and difference between US and Colombian university systems, government funding models, and typical corporate interactions with universities. While not an explicit theme at the workshop, aspects of this comparison were implied in a number of comments and questions. It is important to understand the similarities and differences between the systems in the two countries in order to develop partnership activities with mutual benefits that are consistent with local programs and funding models. More broadly, the comparison is essential for the transfer of existing programs and "best practices", particularly in terms of evaluating which activities fit within existing systems and which will require structural change.

US Universities, Funding Systems and Company Partnerships
Major US Universities are Research Universities
After World War II, the US government placed a high priority on research and development, initiating major transformations for US universities to become research universities. This transformation has aided the US in defining and maintaining a position of leadership in science and technology. Most major universities in the US now share common attributes, including:
- Broadly focused on "research, teaching and engagement/service," with each faculty member participating in all three components of the mission.
- Research budgets are a significant fraction of overall university budgets.
- Rankings of graduate programs are based on research funding, prestige of faculty (*e.g.* national academy members), and peer rankings.
- For faculty members (professors), research is an integral part of their career.
- Major criteria for promotion/tenure are:
    - establishing an independent research program, and
    - recognition in the technical community.

Opportunities/Pathways for Higher Education
In addition to major research universities, many states have other public and private universities that serve the needs of a broad population. Public options include either branch campuses of leading universities or "compass point" universities (with more of a focus on undergraduate and MS programs), junior/community colleges offering two-year programs, either as stand-alone degrees or in preparation for a four-year college/university, and perhaps technical/vocational training programs. Private colleges and universities exist in many cities, and offer programs in various disciplines. In large cities, colleges and universities can serve both traditional and non-traditional students by providing night courses, weekend programs, and executive programs.

Faculty Roles

Faculty at all ranks are expected to establish and maintain independent research programs. Junior faculty do not formally report to senior faculty, and are expected to define research themes that are distinct from those of their major professors, as well as their senior colleagues, and to obtain independent funding. While collaborative efforts are important, each faculty member needs to be a strong individual contributor.

Effectively, each faculty member is a small businessperson, responsible for acquiring external funding for their research program, supervising graduate students and defining collaborations (internally and externally).

New faculty are typically hired from outside the university, with searches considering a nation-wide/international pool of candidates. Searches typically focus on candidates from top discipline specific programs with an aim to strengthen and diversify research capabilities.

Research Funding in the US

Through federal and state funding, along with investments from companies and non-governmental organizations, there is significant investment in research and development. While a portion of this funding goes into basic research, an important fraction of the funding is aimed at addressing problems of national or global relevance, or priority areas for mission-driven agencies. Research grants provide support for graduate/postdoctoral students and other research staff, partial salary support for participating professors, laboratory expenses, scientific equipment and travel associated with the project.

Attributes of particular relevance to universities include:

Funding sources:
- Majority of funding comes from "external" sources (Federal government, companies, or international agencies. A smaller fraction comes from state, local or internal funds.
  - Federal: competitively-awarded grants (generally peer-reviewed), through multiple agencies, ranging from basic research through applied R&D (typically through mission-focused agencies)
- Federal Grant awards typically cover costs of stipends for graduate students, laboratory costs/fees, travel for program reviews or conferences, and partial faculty salaries (for summer support and a portion of academic-year salary). Funding may also cover costs of research staff and scientific equipment.
- Research grants are administered independently by faculty investigators, with financial support from sponsored programs and business offices. Funds are held separately from the main university budget.

Research infrastructure:
- Can be operated as cost centers – allow usage by multiple users, including external (academic and corporate).
- Funded through faculty start-up packages, external grants, gifts.

Graduate Student Support and Dual-Role as Students/Researchers/Teaching Assistants

Graduate students are an integral part of research and teaching programs at major universities. These students generally serve in dual roles, both as students receiving training in their respective disciplines and as contributors to the research, and through education and engagement missions of the university.

Graduate student support: While some grants are given directly to students (*e.g.,* National Science Foundation or Department of Defense fellowships), the majority of graduate student support is provided to faculty investigators in standard grants. The investigator then identifies a suitable graduate student to work on the project. While citizenship requirements typically apply to fellowships and sometimes to applied R&D projects, grants for basic research frequently allow support of international graduate students.

- Dual role as students and researchers/teachers: During the course of a PhD or MS degree program, students are considered both students, and researchers or "teaching assistants". This has several consequences:
  - The individuals are registered as students, receive access to student services, and take classes (during a portion of their degree program).
  - Students employed as research assistants (RAs) or teaching assistants (TAs) are considered part-time staff of the university, and receive a stipend paid through the university (for RAs, the stipend is typically funded by an external grant).
  - RAs participate in the research mission of the university; collectively, thesis research projects make a significant contribution to the scholarly output of the university, including journal publications, conference presentations, patents and technical reports.
  - TAs participate in the teaching mission of the university, through serving as lecture and laboratory assistants. Advanced TAs may also teach courses, although the majority of courses are taught by faculty. TAs may also be involved in thesis research work, or other research projects.
  - Students supported as RAs or TAs do not pay tuition. The grant supporting the student is charged a "graduate fee remission" in lieu of tuition. Consistent with the dual role of the student, the cost charged to a grant (for graduate fee remission) is typically less than the tuition rate.

Undergraduate Programs

Most major US universities also include significant undergraduate populations. For example, major public universities in the Midwest may have over 30,000 undergraduates and 5,000-8,000 graduate students. In the case of public universities, undergraduate education for state residents is typically the major motivation for funding provided by the state as well as a major source of external visibility. Faculty and teaching assistants are actively involved in teaching of undergraduate courses.

- Most major universities in the US have extensive international programs, including both study-abroad programs and large international-student populations. Universities typically have dedicated international program offices that provide resources to support these efforts.

US universities are located in both major cities and smaller towns. The local context, in terms of housing, local transportation and campus construction, varies significantly between major cities and smaller towns. Particularly in major public universities, it is common for undergraduate students to live on or near campus, and rely on the resources/infrastructure of the university or perhaps a near-by campus town for their housing, meals, healthcare and local transportation.

Commercialization

Universities play a significant role in commercialization largely leveraged by the research infrastructure and demonstration of basic concepts in university laboratories. Specific commercialization activities typically are based on patents, and are commercialized either through licensing/technology transfer to an established company or through a start-up effort including faculty/students involved in the invention.

Patent ownership: The Bayh-Dole Act allowed universities/companies to patent research performed under US government funding. This Act represented a fundamental change in the commercialization of research. The licensing to companies is handled through offices of technology commercialization.

Faculty or student start-up companies can license patents from the university (typically inventions by principals in a company). This allows opportunities to apply research results to practical problems. In addition, there is potential for significant financial pay-off (equity stake in company).

Company/University Partnerships

Many US and multinational companies look to universities for well-trained students, as well as innovations, expertise and specialized programs. In order to foster these activities and the links to universities, companies support research or education programs.

Company sponsorship of educational programs/laboratories at universities:
- Helps prepare students well-versed in areas of interest to companies

Company-funded research grants (basic or applied research)
- Leads to research results as well as potential employees

Patent rights negotiated at start of grant/contract
Universities address problems of relevance for companies through:
- Company-funded research programs
- Government sponsored programs (some research programs, including centers, require relevance to companies, and perhaps direct investment from partner companies)

- "Public/Private" partnerships: joint programs between government, companies, often involving universities:
- Joint investments leverage resources, provide benefits for companies and country
- Universities (public or private) can contribute expertise, educational programs, public outreach

Colombian Universities, Funding System and Company Partnerships
Overview of Colombian Universities
While Colombian universities are committed to transformation toward the research university model, they are relatively early in this transformation. The traditional role of Colombian universities has been focused on undergraduate education and master's degree programs.

Access to Higher Education
The Colombian education system does not have the capacity to accommodate a growing demand of graduating high school students. There are no community colleges and until recently, very few technical or technological institutions that met standards of higher education. Equally important, the demand for education has different results depending on student resources. Students with the financial means generally apply to private universities, while students lacking the financial ability to pay for a private university must compete for a scholarship at a private university or compete to study in an official (public) university. In both cases there is a shortage of capacity at universities to guarantee that the demand is met, and that the quality of education is equivalent between the two types of institutions. Many private universities in Colombia have high-ranking programs staffed by professors with excellent qualifications, modern and efficient classrooms, and research laboratories; resources in publicly funded universities, on the other hand, may be scarce. These disparities may sometimes result in lower rankings, and inefficient campuses which affect the quality of education. With a few possible exceptions, funds allocated by the government are not sufficient to improve the research infrastructure of many of the public universities. There is an effort underway for the central government to substantially increase resources for education; Information and Communications Technology is among the priorities for the government of Colombia.

Faculty Roles
Most universities have professors with PhD degrees and instructors with MS degrees, with the ratio between professors and instructors varying from university to university. The relative prioritization of teaching, research, and service programs varies from university to university. On average, approximately 70% of a professor's time is dedicated to teaching and extension activities (such as in company training and consulting), while 30% is dedicated to research which is frequently funded by the university. In many cases the senior professors have been involved mainly in teaching, with the transition toward a research focus occurring relatively late in their careers. The lack of incentives for faculty research has a direct effect on the motivation and dedication to applied research and innovation.

The aspiration of Colombian universities to transform into research institutions underlines the importance of new approaches that must be adopted to encourage change. Recent studies on the importance of the role of the faculty in the quality of education have determined that it is critical to change the culture related to the teaching profession and to expand teaching and research incentives. With the exception of PhD students, and professors with doctoral degrees, many of the faculty do not integrate undergraduate students in their research, nor do they emphasize the importance of research in the classroom.

Since many higher education institutions offer low salaries and incentives for teachers in comparison to other professions in Colombia, higher education as a career is not the preference of qualified candidates with advanced degrees.

Research Funding in Colombia

R&D investment in Colombia (including corporate R&D and university/research laboratory funding) represents a much smaller share of GDP than in the US.

Colciencias, the Colombian science foundation, is the government institution that provides funding for research projects and grants. It has two basic purposes: to fund research, and to give grants for post graduate studies with an emphasis on PhDs. The largest portion of the resources available is dedicated to student grants, leaving few resources for research projects. A fundamental element lacking in the research community is the existence and availability of laboratories and facilities; this requires significant investment on the part of public universities. Private universities are improving their capacity in this regard, but since public universities rely on government allocations of funds, capacity improvement is difficult to implement in the near future. The range of agencies funding university research is much more limited than in the US.

Funding to stimulate universities to make advancements in matters of science, technology, innovation and entrepreneurship is essential. While Colombia falls behind in basic and applied research, there is growing awareness of the need to advance. Recently, Colombia's government committed a fraction of the energy and mining royalties (*Regalias*) to be used to fund R&D; state governments are tasked with deciding upon strategic areas and processes for distributing these funds.

A 2009 law in the System of Science, Technology and Innovation (CTI) seeks improved impact on Colombia's commercial sector. To meet this objective, strategies exist for increased interaction among international and national scientific communities with the commercial sectors of the economy. The result has been increased motivation for researchers and institutions responsible for the generation and application of knowledge to address and find solutions to meet the needs of business and society in general.

There is a need to establish a system of research centers where the university is a vital part of ambitious challenges. This change depends on creating the conditions to strengthen faculty research skills. There is also growing awareness by government to make it a priority to invigorate a high-quality community of researchers.

Incentives for private companies to invest and fund research projects through tax exemptions (175%) for resources used to fund research have been established by the government.

Graduate Student Support and Role in Teaching/Research

Most graduate students are supported by company scholarships or with personal funds and loans. A small percentage of scholarships from the government are dedicated to public institutions of higher education. At the PhD level, students participate in specific areas of research. PhD students spend 70% of their time teaching which leaves 30% for courses and research projects. At the Master's (MS) level, it is not customary for candidates to teach. Most Master's programs are not research oriented, leaving minimal time for students to engage in research.

Undergraduate Programs

The average duration of undergraduate programs is five years, but some universities are transitioning to four-year programs that are based on achieving a certain number of credits for completion of the curriculum. The majority of programs use traditional classroom instruction methodologies including lectures focused on theory rather than application. The undergraduate programs run from January to late June and from August to December with a one-week break during each semester. Summer courses are offered with few credits and are not offered in all subjects required for a program.

Due to globalization, most programs require a second language which must be tested before graduation and is not part of the formal curriculum.

Exposure to research at the undergraduate level is not mandatory except for the final semester project.

Internships are provided at the national level and are performed during the last semester of the undergraduate program. Some private universities have exchange programs with other countries, but not all are required to study abroad. More recently, private universities are emphasizing innovation and entrepreneurship, and students are self-motivated to study in these areas.

There is high regional mobility of students to the major cities because of the quality of the regional universities. High demand exists to attend universities in Bogota, Medellin, and Cali and at institutions in Barranquilla, Cartagena or Manizales.

The cost of education is high in private universities ($12 million Colombian pesos per semester) and subsidized in public institutions. Threats of student strikes interrupting the semester increase the risk that students will not complete their studies in the expected five years at public institutions.

Commercialization

Many universities and other organizations are establishing offices of technology commercialization in order to foster entrepreneurship.

There is a growing concern about the lack of commercialization of research from the universities. Yet most universities have been primarily focused on teaching, and not research. University administrators are embracing the need to broaden their focus towards research to build expanded learning experiences to include research and innovation.

The business community has an opportunity to reap the benefits offered by research and innovation by collaborating with universities, yet there remain barriers for direct interaction.

Company/University Partnerships

While university/company partnerships exist, they are generally much less developed than in the US. It is not common for companies to invest in university programs, either for research or student project experiences. Companies do not typically hire PhD-level scientists or engineers, and do not have a clear value-proposition for doing so. PhD graduates are reluctant to return to work in universities because they do not have access to proper laboratories and incentives to work in the university.

Leading universities and companies are beginning to engage in joint projects which improve processes and innovation. This represents an opportunity for growth of the university system and is the reason many universities and other organizations are establishing offices of technology commercialization to foster entrepreneurship.

A cultural shift to realize the advantages of hiring PhD graduates must occur. Many companies do not understand the benefits that scientists can offer in their organizations, and universities have not advocated how graduates add value and impact on the economic sustainability of business.