

INDIVIDUAL: LUCIANO CASTILLO

Building the Pipeline: Mentoring Minorities from K-12 to Tenure

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EXECUTIVE SUMMARY

Background: Prof. Luciano Castillo’s teaching, research and mentorship efforts have always been intimately connected to a self-imposed mission of creating growth opportunities for students and faculty, particularly those belonging to underrepresented groups in engineering. Prof. Luciano Castillo has directly mentored 275 underrepresented students, including 16 who joined the ranks of the professoriate, two at a top 5 engineering school, 2 NSF-Career Award winners, and 5 tenured associate professors.

Luciano seeks to increase the numbers of URMs in STEM fields by building a pipeline from K-12 to academia (tenure) by creating transformative programs at each level of his mentoring philosophy based on Scholarship, Partnerships, and Professional Development. Further, he is keenly aware that in order to increase the number of URMs in STEM fields, it is fundamental that we bring a significant number of role models to academia; our faculties must match the demographics of our society. He changed the landscape of fluid dynamics; another 16 graduate students are now employed by Fortune 500 companies, including GE Global Research Center, Pratt & Whitney, Sikorsky, GE Aviation, and NASA.

As described in the table below his mentoring philosophy is build around a framework that includes partnerships, scholarship, and professional development, Castillo has created 13 programs (7 at RPI and 6 at TTU) in his 17-year CAREER as faculty: (1) the Visiting Scholar Program, (2) Summer Research Institute, (3) Cash Family Distinguished Lecture, (4) Cash Family Scholarship, (5) Visiting Faculty Program, (6) Cash Family Awards, (7) The Alliance for Graduate Education and the Professoriate, under the name of NSF-AGEP: Central New York-Puerto Rico (8) K-12 Programs (GK-12), (9) Partnerships with International Universities (NSF-PIRE), (10) Innovations for the Third World, (11) Professional Development Programs for Students and Faculty, (12) Graduate Student Seminars, and the (13) MS Program in Mechanical Engineering at the University of Turabo in Puerto Rico.

Mentoring Pillars	Programs/Activities	Outcomes
SCHOLARSHIP	<ol style="list-style-type: none"> 1. Visiting Scholar Program 2. Summer Research Institute 3. Cash Family Distinguished Lecture 4. Cash Family Scholarship 5. Cash Family Awards 6. Visiting Faculty Program 	<ol style="list-style-type: none"> 1. 10 students participated in program, 3 funded grants, 20 publications 2. 52 URMs, 7 K12 teachers, 22 presentations by students, 3 disclosure technologies, 4K-12 students enroll STEM programs in Colleges, 1 startup, 8 K-12, 9 Grad Students 3. 3 Minority World-class Speakers 4. 3 Scholarships 5. 6 award in 2013, 8 in 2014 6. 7 URM Faculty (at RPI), 5 at TTU
PARTNERSHIPS	<ol style="list-style-type: none"> 1. Alliance for Graduate Education: AGEP 2. K-12 Programs (GK-12), Summer Camp, Teaching 3. International Experience 4. Innovations for 3rd World Country 	<ol style="list-style-type: none"> 1. 25 URMs with PhD, 5 Fellowships, 30 J. Articles, 2 AGEP Fellows won NSF Career 2. GK-12 Funded 50% minority, Mentored 65 URMs in Math, 45 Boys & Girls Club, 97 URMs in K-12 3. 3 MOUs, 2 MS Dual Degree, 10 Students in Europe/Australia 4. Partner with Medical Doctors to deploy Renewable Energy
PROFESSIONAL DEVELOPMENT	<ol style="list-style-type: none"> 1. Professional Development for Students & Faculty 2. Graduate Student Seminar, Workshops & Symposiums 3. Master Program in Mechanical Engineering at University of Turabo, Puerto Rico 	<ol style="list-style-type: none"> 1. 16 URMs in STEM Faculty Positions, 7 Prestigious Fellowships, 5 tenured Associate Professor, 2 NSF Career Award at UPRM 2. Over 500 URM participated workshops & symposium 3. 1st Master in Science in Engineering at Turabo, 40 URMs in graduate program

Mentoring Philosophy:

Carlos Castillo-Chavez, Regents Professor and Joaquin Bustoz Professor of Mathematical Biology, visited Luciano Castillo's National Wind Resource Center at Texas Tech University during the summers of 2013 and 2014. During these visits, Castillo-Chavez (no relation to Luciano Castillo) had the opportunity to interact with Dr. Castillo's mentees: undergraduates, graduate students, and young tenure-track faculty. Prof. Castillo-Chavez evaluated the presentations of dozens of students as a judge, learning the details of their research and observing the students' passion and motivation after 8 weeks of intense and fulfilling research experiences in an inclusive and diverse environment. Castillo-Chavez considers himself an expert mentor and a builder of innovative mentorship models [1-6] and, consequently, qualified to assess the monumental efforts of Dr. Luciano Castillo.

Over the past 19 years, Castillo-Chavez has led the Mathematical and Theoretical Biology Institute or MTBI (2011 PAESMEM) established at Cornell University and at Arizona State University since 2004. Castillo-Chavez created MTBI after receiving a 1992 Presidential Faculty Award and a 1997 PAESMEM Award. Like Dr. Castillo's efforts, Castillo-Chavez' efforts have extended the MTBI pipeline from high school to the postdoctoral level and beyond, after taking over the leadership of the Mathematics Honors Science Program (PAESMEM 2002) in 2004 after the untimely death of Joaquin Bustoz Jr. (PAESMEM 1996). Castillo-Chavez believes that building an inclusive model—where access to individuals from underrepresented groups is important—must be accompanied by building an environment where excellence in education, teaching, and research is at the forefront of the students' experience.

Castillo-Chavez has been recognized with an AAA Mentor Award (2007), Distinguished Service Award by the American Mathematical Society (2010), and the Society of Chicanos and Native Americans in Science (SACNAS) Distinguished Scientist Award (2001). His commitment to excellence has been recognized with membership in the Board of Higher Education at the National Academy of Sciences (2009-2016) and consecutive appointments in President Barack Obama's Committee on the National Medal of Science (2010-2015). He is a Fellow of the American Association for the Advancement of Science, the American Mathematical Society, the American College of Epidemiology, and the Society for Industrial and Applied Mathematics and is the holder of honorary degrees and special appointments in Argentina, China, Mexico, MIT, and the Los Alamos National Laboratory.

Castillo-Chavez's credentials, his two recent visits to Texas Tech, his review of Dr. Castillo's students' success, and a history of successful past AGEP collaborations, makes him qualified to humbly nominate, **without any reservations**, and with a sense of **honor and awe**, Dr. Luciano Castillo, the Don-Kay-Clay Cash Distinguished Chair in Engineering and the former Executive Director/President of the National Wind Resource Center at Texas Tech University, as a candidate for a **2015 PAESMEM** award.

Status Quo: It is no secret that minorities and women are underrepresented in STEM fields (see Table 1). Underrepresented minorities earned only 23.7% of all STEM doctorate degrees awarded in 2010 (NCES). Asians constituted the largest group, receiving S&E doctorates in 2010 (44.8%), followed by Hispanics (24.4%), then African Americans (19.1%).

Overall, minority faculty are less likely than their white counterparts to be tenured, to hold full professorships, to be teaching at Research-I institutions, to receive competitive salaries, and to obtain outside funding. And STEM faculty who are both minority and female are almost nonexistent (Nelson and Rogers, 2005).

Thus, Luciano seeks to increase the numbers of URMs in STEM fields by building a pipeline from K-12 to tenure by creating transformative programs at each level of his mentoring philosophy: Scholarship, Partnerships, and Professional Development.

Field	Underrepresented Faculty
Chemistry	1.6%
Computer Science	2.0%
Physics	3.3%
Biology	3.7%
Electrical Eng.	4.5%

Table 1: Percentage of URM STEM Assistant Professors by field.

Dr. Castillo has been mentoring underrepresented minorities and women for 24 years. His mentoring philosophy has been heavily influenced by Lewis et al.'s (2003) conception of becoming a scientist as “a social process, and the desire of an aspirant is only one factor in this process. An aspiring scientist relies on the judgment and invitation of practicing scientists throughout every phase of the educational and career process” (p. 371).

Dr. Castillo strives to mentor URM students from grade school (K-12) through college to the tenure track, thus building a pipeline of support. He recognizes that for underrepresented students to succeed as tenured faculty, it is critical to work one-on-one in developing research, teaching, and communications skills, while building supportive networks of scholars, as shown in Figure 1.

Fostering science identity and development involves more than focusing on individual factors such as increasing one's level of competence in science, but providing an integrative mentorship approach where Scholarship, Partnerships, and Development are integral (see Figure 1).

Scholarship:

Castillo focuses on *exposing students to key problems of national need* while promoting exposure to world-class researchers, international labs, journal publications, and state-of-the-art facilities. Programs he developed that focus on scholarship include: (1) The Visiting Scholar Program, (2) The Summer Research Institute on Renewable Energy and Medicine, (3) The Cash Family Distinguished Lecture Series, (4) The Visiting Faculty Program, (5) The Cash Family Awards for Research; and (6) The Cash Family Scholarship, for first generation students in college.

Partnerships:

Castillo focuses on internal as well as external partnerships to establish new programs, including (1) Alliance for Graduate Education and the Professoriate (AGEP), and (2) K-12 programs, Summer Camps and Teaching (Indiana Tech and Rensselaer Polytechnic Institute). At TTU he developed (3) the Partnerships for International Research and Education (NSF-PIRE) and (4) Innovations for 3rd World Countries. Other partnerships with leaders on campus were necessary to provide resources and personalized support by establishing teams of excellence as well as a supportive environment fostered by upper administration, faculty, and staff. He also developed partnerships with National Labs and top universities in USA, Puerto Rico, Australia, and Europe.

Professional Development:

Professional development is essential in Luciano's mentorship program. Programs he created for students and faculty are (1) Professional Development Programs, (2) Graduate Seminar Series, Workshops, and Symposiums, and the (3) MS Program in Mechanical Engineering at University of Turabo in Puerto Rico, the first graduate program in their college of engineering. While at RPI, he created a Graduate Student Seminar where discussions and hands-on workshops about funding graduate school led to 4 NSF-GRF, 2 Ford Foundation Awards, 1 NASA Harriet Fellowship, and 1 AT&T Fellowship. Workshops for junior faculty led to 2 NSF CAREER Awards at the University of Puerto Rico- Mayaguez. He founded at Texas Tech a Summer Research Institute where yearly proceedings of mainly URM students' scientific articles and technologies are published [10,11]. Students are trained how to write scientific articles and how to commercialize innovations, among other skills.

The three pillars for Dr. Castillo's mentoring philosophy (Figure 1) are integrative and thus many of the programs overlap and reinforce each other. Impacts and outcomes of Dr. Luciano Castillo's mentoring philosophy are discussed in subsequent paragraphs of this nomination.

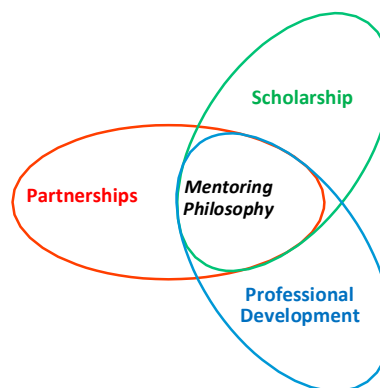


Figure 1: The Three Pillars of Castillo's Mentoring Philosophy

Dr. Luciano Castillo has mentored students for 24 years. Given the small number of Hispanics and African American in academia, **he built programs focused on Building a Pipeline from K-12 through Tenure**. Further, he is keenly aware that **in order to increase the number of URMs in STEM fields, it is fundamental that we bring a significant number of role models to academia**; our faculties must match the demographics of our society. Dr. Luciano Castillo has mentored 16 minority PhDs who are now in academic positions. Five are tenured professors, including two at top 5 ranked programs in the U.S.: Prof. Tequila Harris at Georgia Tech and Prof. Leonardo Chamorro of the University of Illinois-Urbana Champaign. He also mentored 16 graduate URMs in fluid dynamics who are now employed by Fortune 500 companies, including GE Global Research Center, Pratt & Whitney, Sikorsky, GE Aviation, and NASA.

To support the foci of partnerships, scholarship, and professional development, Castillo has created 13 programs in his 17-year CAREER as faculty: (1) the Visiting Scholar Program, (2) Summer Research Institute, (3) Cash Family Distinguished Lectures, (4) Cash Family Scholarship, (5) the Visiting Faculty Program, (6) the Cash Family Awards, (7) The Alliance for Graduate Education and the Professoriate, under the name of NSF-AGEP: Central New York-Puerto Rico (8) K-12 Programs (GK-12), (9) Partnerships with International Universities (NSF-PIRE), (10) Innovations for the Third World, (11) Professional Development Programs for Students and Faculty, (12) Graduate Student Seminars, and the (13) MS Program in Mechanical Engineering at the University of Turabo in Puerto Rico.

Mentoring Scholarship

Luciano's approach is holistic. He recognizes that for underrepresented students to succeed as tenured faculty, it is critical to work one-on-one in developing teaching skills and communication skills, building networks of scholars and scholarship. **Prof. Andres Tejada-Martinez, a first generation Hispanic college graduate** from the inner city, Castillo's mentee, a winner of the NSF-CAREER Award, and a successful tenured Associate Professor at the University of South Florida, wrote:

"I sat in Prof. Castillo's course because it covered new material that I had not been exposed to before and because of the innovative format of teaching adopted by Prof. Castillo. Prof. Castillo's unmatched passion for and knowledge of the subject were reflected through his clearly delivered lectures and discussions. Furthermore, the lectures gave RPI students exposure to professors, researchers, and students at different institutions, as the course was taught via live video conferencing in collaboration with Clarkson University, SUNY Buffalo and the University of California-Santa Barbara. This format, introduced by Prof. Castillo, allowed students to understand different interpretations of turbulence coming from a diverse group of world renowned modelers, experimentalists, and theoreticians from across the country.

I am greatly indebted to Prof. Castillo for suggesting numerous excellent class activities and exercises as I taught a first-year undergraduate engineering course at RPI. His constant, tireless mentoring during this challenging new experience for me was indispensable in helping me prepare lectures and improve classroom techniques. Undoubtedly, Professor Castillo will continue to be a role model for me as I aspire to become full professor."

1) Visiting Scholar Program: 2006-2013

Luciano developed the Visiting Scholar Program while at RPI, in which students can spend from weeks to months to years at institutions such as Johns Hopkins University (JHU), the University of Puerto Rico-Mayaguez, and Universidad del Turabo. Guillermo Araya (completed post-doc in Europe, visiting scholar at JHU), Sheilla Torres (former PhD student & former visiting scholar at JHU now an engineer at Pratt & Whitney), Jorge Bailon Cuba (former post-doc in Germany, was a visiting scholar at University of Puerto Rico, now post-doctoral fellow at UT-Dallas), Jose Lebron (former PhD student & visiting scholar at JHU, now an engineer at Pratt & Whitney), and Gustavo Rivera (former MS student & visiting scholar at JHU, now a PhD student at Cornell) participated in this program.

Other participants of this program at JHU include: Raul Cal (now tenured Associate Prof. at Portland State University and the Chair of the 2016 APS-Division of Fluid Dynamics), and Prof. Victor Maldonado (now Assistant Professor at UT-San Antonio). Prof. Charles Meneveau and Castillo had two undergraduate students in 2008 from Universidad del Turabo, one from RPI, two high school students, and two PhDs from RPI. A major outcome of these visits was that Castillo and Meneveau built strong

collaborative programs, receiving 3 NSF research proposals and publishing 20 articles with URMs and female students (examples are [15-18], see also CV of Dr. Castillo). The program was extended for other students to visit institutions in Europe and Australia, and was also part of a new funded grand (NSF-PIRE) while at TTU.

2) Summer Research Institute on Renewable Energy and Medicine: 2013-present

In 2013, Luciano founded and directed the first Summer Research Institute on Energy, Medicine, and Turbulence-Aeronautics at TTU. Students learned the foundations of math and physics the first two weeks, and the last six weeks conducted research. The uniqueness of this program is that faculty, senior PhDs, undergraduate and graduate students, and K-12 students as well as teachers all work together in teams focused either on research or innovation. This cross-field, cross-generational mentoring provided unique opportunities for mentoring and teaching (vertical alignment for mentoring). In addition, participation of National Academy of Engineering members in the program also provided unique scholarship mentoring for faculty. The eight-week institute enrolled 26 STEM students who were 85% minorities. Of the faculty mentors, 20 were from TTU and 5 were visiting professors (Puerto Rico, Texas); approximately 50% of faculty mentors were female and/or minorities.

Outcomes of program resulted in the following:

- 3 students enrolled in graduate programs, 1 in medical school
- 22 URM presented their research from our program at national conferences [14] and at the American Physical Society-Division of Fluid Dynamics.
- 1 Minority Post-doc became a faculty member in Mechanical Engineering at UT-San Antonio
- 4 K-12 students enrolled in STEM undergraduate programs in USA
- Team of students created a startup on a new biometric watch
- 3 disclosures of technologies with minority students were submitted in 2014
- 4 journal articles were submitted
- 7 K-12 teachers participated in 2 weeks of research and brought wind energy curriculum to their classroom
- A proceedings was published in 2014 [10] and volume 2 will appear in 2015 [11].
- A total of 66 students participated in the program

For the 2014 Summer Institute, 12 participants were TTU students, and the other 30 participants came from US universities (mainly HSBC), Puerto Rico, Mexico, Panama, Cuba, and Argentina. From TTU, 28 faculty and 3 post docs participated, and another 5 visiting faculty from Texas (Profs. W. Anderson, V. Maldonado), North Carolina (Prof. N. Srivastava), Puerto Rico (Prof. G. Carbajal former mentee and AGEF Fellow), and Norway (Prof. M. Tutkun) were part of the program. ***This program was so exceptional the College of Engineering at TTU adapted the entire program.*** Dr. Castillo also provided research opportunities during the regular semester for 25 URMS while at RPI (1999-2011) and TTU (2011-present).

3) The Cash Family Distinguished Lecture in Engineering: 2013-Present

With funds from his Cash Family endowment and with support of Dean Sacco, Prof. Castillo created a Distinguished Lecture Series in Engineering. Prof. Fazole Hussain (NAE), the Hugh and Lillie Cullen Distinguished University Chair and Director of the Institute of Fluid Dynamics and Turbulence at the University of Houston, delivered the first lecture and was hired as a Presidential Chair. During our summer institute (2013, 2014) the distinguished lecturers included Richard Tapia (2011 Medal of Science), Carlos Castillo-Chavez, Roosevelt Johnson, Mohamed Gad-el-Hak; Ivan Marusic, Charles Meneveau, Bob Smith (former Provost at TTU), and Al Sacco (Dean at TTU).

4) Cash Family Scholarship: 2013-2014

Dr. Castillo used funds from the endowed chair that he holds to provide scholarships including the Cash family Award and cost of his annual symposium. He thinks that financial support and recognition is part of mentoring. Desiree Rexach from Universidad del Sagrado Corazon received the Cash Family Scholarship to study one semester at Texas Tech during fall 2013. Isaias Justinianes from Universidad del Sagrado Corazon received the Cash Family Scholarship to study one semester, and Moises Santiago received a scholarship for 9 months to conduct research in the medical school at TTU; he is now in medical school.

5) Cash Family Award during Symposiums: 2013-2014

At the end of each summer, Dr. Castillo creates a symposium to celebrate the students participating in their Summer Research Institute. In 2013, the Cash Family Awards included Best Contribution to Science and Medicine, Best Leadership, Best Poster, and Best Research Contribution in Engineering. In 2014, the Cash Family Awards included Best Graduate Student Research in Science, Engineering & Medicine; Best Research Contribution in Science; Best Research Contribution in Engineering; Best Research Contribution in Medicine; Best Leadership; Best Innovative Technology; and Best Mentor. A total of 14 awards were given at 2013 and 2014 events.

6) The Visiting Faculty Program: 2004-2011 (RPI), 2011-present (TTU)

Luciano created a unique Visiting Faculty Program between RPI, Universidad del Turabo, Johns Hopkins University, and University of Puerto Rico-Mayaguez (UPRM). During the summers of 2004-2007, five minority professors from UPRM conducted research in emerging technologies in nano-materials, bioengineering, and transport systems at RPI. This activity resulted in 4 conference papers, 3 journal articles, and 4 proposals. During 2006, Luciano extended this program at the Universidad of Turabo in Puerto Rico. On his arrival to TTU, he duplicated the program with a research theme focused on Renewable Energy and Medicine. TTU had 5 faculty outside of TTU participating in research and mentoring of our URMs. Luciano's goal is creating partnerships to build the human capacity at Hispanic Serving Institutions, which then helps attract more URM students into STEM fields.

At RPI, the program resulted in 1 minority junior faculty from UPRM (Pablo Caceres-Valencia now Full professor and former Department chair) being funded to conduct research with Prof. K. Rajan (2003). It also resulted in funded research for UPRM and 2 conference papers. In addition, four visiting minority faculty were invited and funded for summer (2004) and 3 sabbatical leaves. Three visiting faculty members, all from underrepresented groups, joined the summer research program at TTU; their visit resulted in 2 journal articles [19-20].

Mentoring Partnerships

Dr. Castillo worked very closely with many administrators while at RPI, including the former Vice-Provost for Diversity at RPI, **Dr. Kenneth Durgan**, also the former Assistant Chancellor for Diversity, Equity and Inclusion at the University of Indiana-Purdue University Indianapolis. He wrote:

"Dr. Castillo effectively and continually cultivated as well as nurtured several essential collaborations with our Admissions Department and Deans Council. Lastly, he has developed and maintained the respect plus continued support of the administration. As a result of his efforts, we have dramatically increased the numbers of underrepresented minority students: pursuing their doctorate degrees, receiving considerable financial support and quality advising as well as other resources."

1) The Alliance for Graduate Education and the Professoriate, under the name of NSF-AGEP: Central New York-Puerto Rico: 2002-2009

The AGEP program was designed to increase the number of underrepresented students in academia by building partnerships with other academic institutions. Dr. Luciano Castillo put together an Alliance among Rensselaer Polytechnic Institute, Cornell University, University of Puerto Rico-Mayaguez (UPRM), with Syracuse University as the lead institution; later Johns Hopkins joined the team. Luciano put together the team, led a successful proposal, and eventually led the alliance. The program demonstrated great success in recruiting students and mentoring minority and female graduate students since its conception in 2002. Some of the outcomes include more than 25 minority students in PhD programs and 10 PhDs placed in academia, including at Georgia Tech, UT- San Antonio, Portland State University, University of Turabo, and University of Puerto Rico-Mayaguez. The mentoring of minority faculty led to two NSF CAREER awards and 3 NSF Fellowships. Approximately 200 students participated in a two-day Graduate School Symposium held in Puerto Rico in 2003. This successful event was organized and chaired by Castillo. By means of the Visiting Scholar Program and the International Program developed by Luciano, the program co-advised students among institutions, including partners in Europe and Australia.

Engaging top-level administrators in this AGEP project was a key element in getting more support and commitment at the University level. Luciano has been instrumental in creating this type of support at RPI and at other institutions (i.e. UPRM, U. Turabo). Doing so ensures the survival of the program for the long-term while establishing an infrastructure that can be duplicated at any other institution. Top-level

support from institutional leadership is also key for institutional transformation to occur. At the administrative level, the additional support was given to help alleviate the financial issues of students, coordinate the student programs, and monitor student progress.

2) GK-12 Programs: Building Bridges from High School to Graduate School—Inspiring Students Through Discovery-Based Activities in Energy & the Environment: 2008-2012

Nine graduate students are participating in this program of which 1/3 are from underrepresented groups (female and Hispanic). As co-PI, Castillo used his partnerships with institutions in Puerto Rico to recruit female and URM into the program. Table 3 shows the impact of other programs involving K-12 included participation in the Summer Research Institute for teachers and students.

Mentoring & K-12 Teaching	Outcome
Teaching Minority Students in Pre-College Engineering Math program, Buffalo (1988-1996)	65 URM students learned pre-calculus.
Teaching/Mentoring Buffalo Engineering Awareness for Minorities (BEAM): K-12, SUNY Buffalo	Helped 45 inner city boys and girls to build and design bridges and wooden airplanes on Saturdays.
Teaching/Mentoring Engineering and Science Director for Summer Camp for Inner City Children: K-12 Indiana Tech (1998)	Taught science and math to 30 inner city boys in a summer camp at Indiana Tech (70% minority-Hispanic & African American).
Teaching High School Math Teachers: K-12 Indiana (1997-1998)	Taught/mentored 97 K-12 minority students pre-calculus and calculus. Population 100% African American; 1 went to medical school, 2 to engineering graduate school, and 1 to law school.

Table 3: Impact of K-12 Programs and activities.

3) Partnerships with International Universities: 2000-2014

Castillo collaborates with international universities to provide students a unique research and cultural experience not possible at a single institution. The intended outcome is to provide students with a sense of collaboration, global awareness (exposure to different ways of solving a problem, different culture), and professional networking (see few articles published with mentees [8,9,20]).

In 2004, Luciano established a Memorandum of Understanding between RPI and Victoria University in Australia and Chalmers University of Technology in Sweden. At TTU, he established agreements with the University of Rome, Italy; Danish Technological University, Denmark; the University of Oldenburg, Germany; and the University of Western Ontario, Canada. In Sweden, Castillo led a dual MS program between Chalmers University and RPI. During the fall of 2004, an undergraduate student, Don Chao (Hispanic student, now at Sikorsky), conducted undergraduate and Master’s research with Professor Turan at Victoria University in Australia and Professor Castillo at RPI. Two other PhD students also went to Australia, including Dr. B. Brzek (PhD 2007, now lead Engineer at GE Global Research), and Don Chao. In Sweden, Mr. David Walker (now top manager at GE Global Research), Prof. Victor Maldonado (now Assistant Professor at University of Texas- San Antonio), Dr. K Newhall (former MS student and mentee, now at Courant Institute at NYU), and Prof. Raul Cal (tenured Associate Prof.) all participated in this program. Examples of publications with international mentors and mentees are found in [21-25].

A major outcome of these collaborations was the funding of a large NSF Partnerships for International Research and Education (PIRE) program focused on Wind Energy led by Johns Hopkins University. **Prof. Raul Cal, a former AGEP fellow, now tenured associate professor** writes:

"Luciano is able to put students from different universities and different regions/countries in contact. This develops the student and brings exposure to the student. Consequently, Luciano is also able to expand the network of the student. Luciano is able to make students realize their full potential and bring out the maximum in them; he is able to polish them. The proof of such an idea is the fact that three of his students have obtained NSF and National Academy of Science and Engineering (NAE) Graduate Fellowships. I am included in this group receiving the Post-Doctoral Fellowship from NAE."

4) Innovations for 3rd World-countries: 2014-present

Castillo is now bringing innovations in renewable energy at TTU to help solve the lack of hospitals in Africa. In collaboration with the School of Medicine at Texas Tech-Health Science, a project led by Dr. Sammy Deep could help save many lives in Cameroon. Luciano is working with his students to bring new innovations to provide renewable energy and clean water solutions to hospitals located in remote villages in Cameroon where neither one is accessible. This is a project he is currently developing and expects to deploy during the summer of 2015. His sense of bringing innovation into the classroom and research led to students creating 1 startup and 3 disclosures of technologies (with URM students).

Mentoring-Professional Development:

Dr. Castillo firmly believes the importance of personal and professional development as part of effective mentoring. A former PhD student, **Dr. Xia Wang, an Associate Professor at Oakland University**, has received several competitive grants, and she recently received the SAE Ralph R. Teetor Educational Award from the Society of Automotive Engineering, the New Investigator Research Excellence Award at Oakland University, and the Robert T Knap Award, [24]. She writes:

“He created incredible opportunities for his students to get involved in research activities in Canada, Australia, Italy, Sweden and Puerto Rico, which remarkably widened our vision and provided invaluable connection to leading scientists and mentors. Also he brought us to visit government agencies such as National Science Foundation (NSF) and Office of Naval Research (ONR) and introduced us to scientists and program directors. Consequently, I was able to understand better the entire process of funding proposals and better yet my role as professor. Actually, through our trips to NSF and ONR, I found other mentors and received grants, which are an invaluable treasure to my career. I would never imagine getting to know these leaders without the thoughtful arrangements by Prof. Castillo.”

1) Professional Development Programs for Students and Faculty: 2002-2011

While at RPI, Castillo created Graduate Student Seminars tailored to train students on how to successfully submit fellowship proposals and application to jobs. Discussions and hands-on workshops about funding graduate school led to 4 NSF-GRF, 2 Ford Foundation Awards, 1 NASA Harriet Fellowship, and 1 AT&T Fellowship. Workshops for Junior Faculty in Puerto Rico led to 2 NSF CAREER Awards.

2) Graduate Seminar Series, Workshops and Symposiums: 2004-2011

Other major events hosted in Puerto Rico coordinated and chaired by Dr. Castillo include:

- International Symposium on Aerospace, Turbulence & Sustainability, May 2007. More than 200 minority students participated (with Castillo as chairman of conference)
- Mini-Symposium on Graduate School, April 2008 at the University of Puerto Rico-Mayaguez
- NSF Workshop on Proposal Writing, June 2005
- NSF Workshop on Fellowships & Graduate Education, October 2005
- Graduate School Symposium, May 2006
- RPI Seminar series for Graduate Students (55 students participated on bi-weekly seminar).
- More than 300 students (URMs) participated in these events hosted in Puerto Rico (University of Puerto Rico- Mayaguez (2003) and Universidad del Turabo (2010).

3) MS Program in Mechanical Engineering: 2010-2012

With a former mentee, Assoc. Prof. Gerardo Carbajal, Luciano created the first Master in Science program at the University of Turabo in the College of Engineering. Luciano led its development, and he also established the necessary partnerships for the program to be successful. Some of the graduate students from PR that participated in the Summer Research Institute came to TTU to carry out their research during the summers of 2013 and 2014 (see publications of students from University of Turabo in our proceeding from 2013 [10-11]). Currently, the program has 40 graduate URM students.

Impact of Mentoring URMs & Female PhDs Placed in Academic Positions

The former PhD advisor of Dr. Castillo, **Prof. William K. George, the Marie Curie Professor at Imperial College in England and former Professor at Princeton**, wrote:

“No one has done more to change the demographics of the fluid mechanics and turbulence community than Luciano Castillo. His highly successful NSF programs involving the Puerto Rican universities, Princeton, Syracuse, RPI, and the Johns Hopkins University has almost by itself changed the ethnic mix at fluids and turbulence meetings. While many contributed to its success, it was always Luciano’s idea and initiative. It was

his energy that kept everyone enthused, and his sheer commitment and time that kept it filled with high quality Hispanic students, a number of whom are joining the ranks in the USA as professors themselves.”

Over many years, he has mentored one-on-one, advising **16 minority PhDs who are now in academic positions; five are tenured professors including 2 at top 5 ranked Georgia Tech and University of Illinois-Urbana Champaign. Two of his mentees received the NSF-CAREER Award. He also mentored 16 graduate students in fluid dynamics who are in Fortune 500 companies** (e.g., GE Global Research Center, Pratt & Whitney, Sikorsky, GE Aviation, and NASA).

Impact in Academia

1. Raul Cal, Assoc. Prof. at PSU, Conference Chair, APS-Division of Fluid Dynamics,
2. Victor Maldonado, Asst. Prof. at UT- San Antonio, RPI Innovation Award,
3. Andres Tejada-Martinez, Assoc. Prof., University of Central Florida, NSF-Career Award Winner,
4. Leonardo Chamorro, Asst. Prof., Urbana-Campaign,
5. Tequila Harris, tenured Assoc. Prof., Georgia Tech, NSF-Career Award Winner,
6. Gerardo Carbajal, Assoc. Prof., University of Turabo, Cash Family Mentor Award,
7. Eduardo Castillo, Asst. Prof., University of Turabo,
8. Xia Wang, tenured Assoc. Prof., Research Award at Oakland University,
9. Silvina Cancelos, Asst. Prof., University of Puerto Rico-Mayaguez,
10. Guillermo Araya, Research Assoc. Prof., TTU,
11. Dr. Jorge Bailon-Cuba, Postdoctoral Fellow, UT-Dallas; NYU,
12. Dr. Katherine Newhall, Postdoctoral Fellow, NYU,
13. Oscar Curet, Asst. Prof., Florida Atlantic University,
14. Dr. Humberto Bocanegra, Postdoctoral Fellow, TTU.
15. David Claudio, Asst. Prof., Montana State University, NSF-Graduate Fellowship,
16. Maria Vasquez, Assist. Teaching Professor, Montana State University, AT&T Fellowship.

Awards & Recognitions

Castillo has published over 150 articles, co-edited 4 books (one as single author), 37 lectures, 69 invited lectures (USA, Europe, Latin America, and Australia), and 3 invited papers at professional societies including one in Europe. In terms of innovations, he has 1 patent submitted and 3 disclosures of technologies in areas related to energy and medical technology. He is also a Fellow of the American Society of Mechanical Engineers (ASME). He is the Don-Kay-Clay Cash Distinguished Chair.

In 2002, Luciano received the Martin Luther King Jr. Faculty Award from RPI for his contributions to mentoring of URMs students and faculty, and in 2005 he received the Minority Faculty Award from La Sociedad de Damas Sigma Delta Sorority for his mentorship and contributions to the success of all Rensselaer Students. As an Assistant Professor, he mentored the SHPE chapter which grew to 200 members and won the national Chapter of the Year award. He led the NSF-AGEP grant for many years, recruiting more than 25 URM graduate students to RPI. He has given 6 invited keynote lectures and 13 lectures on diversity across the U.S. In terms of scientific contributions, some of his awards include the Robert T. Knapp Award of ASME (with a female PhD student) on complex flows; the Rensselaer Trustee Faculty Award (2005, 2008); and the NASA Faculty Fellowship (2002, 2003). In addition, he has been Associate Guest Editor of the *Journal of Turbulence*, *AIAA*, and *Physics of Fluids*. Examples of keynote lectures on his research include the Academy of Medicine, Engineering & Science of Texas.

Luciano sees his mentees as unique with specific skills and needs that drive their interest in a given field. He still uses his framework for mentoring but tailors to the needs and career goals of the mentees. **Prof. Raul Cal, a tenured Associate Professor at Portland State University** who is leading the American Physical Society- Division of Fluid Dynamics—an unheard task for a young scholar like him—has been Castillo’s mentee since he was an undergraduate student at RPI. He writes: *“He has offered the best opportunities that have helped me grow not only because I was his student, but because he has a desire to be a pillar in my development as a professional. This is in my definition of a true mentor; since he is able to give the utmost for my advancement. He has shown commitment towards his students by always finding ways to promote not only education, but also diversity within his surroundings. A proof of such success and structure has been the AGEP-NSF grant that Luciano received for mentoring and developing minority students. I am a product of this program.”*

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