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A Quarter Century of Resounding Success for a University/Federal Laboratory Partnership

Dr. Robert W. Whalin, Jackson State University

Dr. Whalin, Professor of Civil and Environmental Engineering, and Director, Coastal Hazards Center, Jackson State University. He is Director Emeritus of the Engineer Research and Development Center, Vicksburg, MS. He received his PhD in Oceanography from Texas A&M University in 1971 and is a Registered Professional Engineer. Dr. Whalin was Director of Army Research Laboratory (1998-2003; Adelphi, MD), and Technical Director /Director of Waterways Experiment Station (1985-1998; Vicksburg, MS). He has authored/co-authored over a hundred technical papers and reports during his career in private industry, government and academia. His current research interests are nearshore wave transformations, coastal structures, tsunami inundation, hurricane surges, high performance computing, and engineering education.

Prof. Ismael Pagán-Trinidad, University of Puerto Rico, Mayaguez Campus

Ismael Pagán-Trinidad, Professor (1982-date) and Chair (1994-date), Department of Civil Engineering and Surveying, University of Puerto Rico at Mayagüez (UPRM); Principal Investigator/Program Manager of the Educational and Research Internship Program (ERIP) under the UPRM-ERDC (US Army Corp of Engineers) Partnership Agreement (1994-date); Principle Investigator of the Education for Improving Resiliency of Coastal Infrastructure project under the Coastal Resilience Center of Excellence (CRC) sponsored by the Department of Homeland Security (2016-2020); Cofounder and Member of the Latin American and Caribbean Consortium of Engineering Education (LACCEI). He earned a BS in Civil Engineering, MS in Civil Engineering (Environmental) at the University of Puerto Rico at Mayagüez, and conducted PhD (ABD) studies in Hydrosystems at the University of Illinois at Urbana-Champaign (1978-82).

Ms. Evelyn Villanueva, US Army Engineer Research and Development Center

Mrs. Evelyn Villanueva is a Special Assistant to the Director of the Geotechnical and Structures Laboratory (GSL) at the US Army Corps of Engineers (USACE), Engineer Research and Development Center (ERDC) located in Vicksburg, MS. She received a bachelor's degree in Geology from the University of Puerto Rico in Mayagüez and a Master's degree in Geosciences from Mississippi State University (MSU). She assists in the management, coordination and focus of GSL's organizational development activities and internal/external communications. In this role she works closely with the GSL leadership in a manner fully supportive of the mission, philosophy, vision and goals of the Laboratory. Mrs. Villanueva has the leading role in the execution of university initiatives such as the coordination of the ERDC recruiting strategy, the summer internship program and assisting in the development of mutually beneficial research opportunities. She is also the GSL Coordinator for the USACE Career Program 18, Interns Rotational Assignment Program. Mrs. Villanueva is the recipient of the ERDC Outstanding Achievement in Equal Employment Opportunity Award and the ERDC Award for Outstanding Achievement in Human Capital Development.

Dr. David W. Pittman PE, US Army Engineer Research and Development Center

Dr. David W. Pittman is the Deputy Director of the US Army Engineer Research and Development Center, headquartered in Vicksburg, Mississippi. With seven laboratories located in four states, ERDC is the lead research and development organization for the Army Corps of Engineers, and employs over 1,000 engineers and scientists focused on research in military engineering, civil works, environmental quality, installations, and geospatial engineering. Prior to becoming Deputy Director at ERDC, Dr. Pittman served as Director of ERDC's Geotechnical and Structures Laboratory (GSL), and served in several other leadership roles in GSL, after spending ten years of conducting research in the area of airfields and pavements. Dr. Pittman also served as an Assistant Professor of Civil Engineering at Auburn University. Dr. Pittman received his bachelor's and master's degrees in Civil Engineering from Mississippi State University, and his doctorate degree in Civil Engineering from the University of Texas at Austin. He is a registered professional engineer in the State of Mississippi.

A Quarter Century of Resounding Success for a University/Federal Laboratory Partnership

Abstract

The objective of this paper is to evaluate, assess and document initiation and evolution of a vibrant enduring University (Minority Serving Institution, MSI) and federal laboratory partnership originated by the US Army Engineer Research and Development Center (ERDC) to increase the number of highly underrepresented Hispanic engineers in the workforce of about 500 engineers. This unique partnership is viewed by many as the most successful diversity oriented federal laboratory and university relationship in existence. The partnership was initiated in spring 1986 with a career day recruiting trip to the University of Puerto Rico, Mayaguez (UPRM) that has continued for three decades. Experiential learning summer research internships bloomed in 1991 and continue today. The partnership was formalized and institutionalized in 1999 as the Laboratory Director and University Chancellor signed an Education and Research Partnership Agreement authorized by Public Law. A framework was devised to help evaluate and assess the partnership three decades after initiation.

To date there have been 485 experiential learning summer internships, sixty one permanent hires by the ERDC (with 62% retention over 30 years) and twelve professors performed summer research at the ERDC. Laboratory researchers served on graduate committees of ten MS recipients. Researchers currently serve on three graduate committees. Four ERDC researchers have voluntarily received temporary assignments to the UPRM. Other voluntary service to the university is enumerated including service on the Department Advisory Committee. The authors hope the assessment, lessons learned and conclusions provide a way ahead for those federal laboratories and/or corporations who might find it beneficial to establish a diversity oriented enduring partnership with a MSI University. The partnership has eliminated a gross underrepresentation of Hispanic engineers and scientists (under 0.5%) at ERDC over the past three decades, now 5% and rising.

Background

A review of literature regarding university and federal partnerships yielded some interesting observations. A large group of partnership literature focused on federal agency funded partnership initiatives to promote partnerships between Minority Serving Institutions and Carnegie RU(VH), Research University with Very High activity, universities, industries and universities in specific curriculum focused areas of interest to the industry or industry/university partnerships dealing with senior design projects [1,2,3,4,5,6,7,8,9,10]. Two other papers involved university and national laboratory research cooperation and academic development of education and research funded to produce engineers for the agency employment [11,12]. Agency funding in all these cases was a carrot meant to entice or incentivize an agency desired behavior by either the academic community and/or agency laboratories in partnership with a university. None of these efforts involved a mutually beneficial university and federal laboratory

partnership not based on funding as the catalyst. That is the uniqueness of this quarter century plus partnership and the precise reason it is expected to endure in perpetuity.

ERDC experienced a complete (top three leaders) executive leadership change in June 1985. One new leadership thrust was a proactive effort to increase the number of underrepresented minority and female engineers and scientists. Hispanic engineers at the laboratory were nearly non-existent at this time. Additionally, Hispanic engineering students at universities in adjacent states were near non-existent. Laboratory leadership decided to actively recruit at a major Hispanic serving university where Hispanic U.S. citizen graduates were plentiful. The first recruiting visit was made by the military and civilian ERDC executives during a Spring Career Fair hosted by the UPRM and attended by about fifty to a hundred major United States companies and a few federal agencies.

First Five Years

The initial 1986 recruiting trip to the university was considered a success by the ERDC as three job offers were made and two were accepted by civil engineering majors (one BS and one MS). The 1986 trip included a visit to the University Army ROTC program where the Lt. Colonel Commander asked the laboratory Colonel if the laboratory could accommodate a one or two week laboratory experience for some junior ROTC cadets (Science, Technology, Engineering and Mathematics, STEM, majors) as they traveled from the university to summer ROTC training at an Army installation (Engineer School, etc.). This arrangement was finalized and that began a partnership where up to four junior year ROTC cadets visited the laboratory for two weeks each summer. This summer ROTC experience continued for approximately a decade.

Subsequent recruitment visits (led by the civilian laboratory Director) of 1987, 1988, 1989, and 1990 met with more limited success. One to three job offers were made annually, however, these four recruitment trips only resulted in one additional (BS) permanent hire. Another UPRM alumnus (completing dissertation in US) was hired to a permanent position by the laboratory in 1990. This individual accompanied the Director on future recruiting trips and proved to be a dynamic catalyst for enhancing partnership relationships. The Feb. 1991 recruiting trip included a courtesy visit to the Civil Engineering and Surveying Department Chair. The ERDC Director inquired if there were any manner (other than recruiting graduates) in which the laboratory could be an asset to the department. The Chair responded that the Department had a professional practice elective course which he wanted students to capitalize on, particularly graduate students who needed to find short term summer jobs. Many of those that found jobs never came back to school and dropped graduate school. The department was growing and experiential learning student internships at a local civil engineering company or government entity were difficult to obtain for rising seniors and graduate students. The Chair asked if the laboratory could accommodate two or three internships during summer 1991. ERDC made an on the spot commitment to accommodate up to ten experiential learning internships during the summer of 1991. This conversation initiated a summer experiential learning research internship program, thriving to this day.

Summer Experiential Learning Research Internships

The recruiting trip of 1991 was a watershed event for the university and laboratory partnership. The experiential learning summer research internship evolved to be the partnership foundation and it serves many educational purposes. It serves as a formal job experience since students are engaged in real on-going research as any other employee in the labs. This is highly regarded by job recruiters during interviews. Students engage in formal research projects which serves as a first hand research experience, but also and most importantly, it serves as a pipeline and motivation for students to aspire to graduate programs, pursue terminal degrees, and to create a significant labor force for research and educational careers. In spring 1991, a contractual instrument was entered into by the laboratory and the university so the laboratory could host and mentor summer interns. Since 1994 a formal educational component was introduced through which interns would earn three semester hours of academic credit under the overall supervision of a university professor. This initiated a thriving experiential learning summer educational and research internship program. The same university professor is the Program Manager (PM) today, twenty-two years later. There is a Laboratory Partnership Liaison that assists as needed with many of the components of the partnership, but mostly with summer internships. An outline of the selection and mentoring process for summer internships follows:

- Laboratory research engineers and scientists (voluntary mentors) prepare 1-2 page experiential learning research project summaries (by January). The laboratory research engineer budgets for the internship cost from his/her research project.
- Laboratory Contracting Officer forwards research project summaries to university PM.
- University PM develops an intensive promotional (with all STEM academic departments) and orientation program, and students apply on line.
- University PM matches student applicants with research project summaries based on academic merit and mentors interests. Students are interviewed, if necessary.
- Logistics including housing, local transportation, and air transport to the laboratory, etc. are jointly arranged for (operates smoothly with 25 years experience).
- Partnership Liaison ensures that mentors and students are aware of the rules and responsibilities of the internship. University PM and Liaison maintain continuous communication and follow up on students' needs and performance.
- At the end of the summer, University PM travels to laboratory to discuss experiential learning during internship with each student and mentor, receive the research presentation and report, asks questions and records information for the students' grading.

Cumulative Number of Research Interns- Figure 1 illustrates the cumulative number of UPRM research internships since the first nine during summer 1991. A total of 485 Hispanic UPRM students spent the summer at the laboratory through 2015 (25 years).

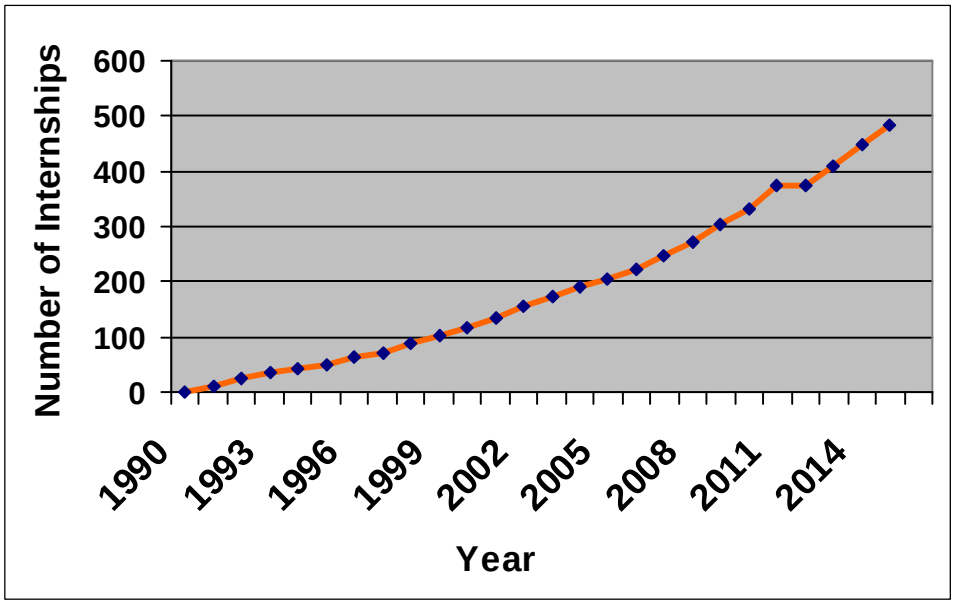

Figure 1 Cumulative Number of Summer Interns

The partnership steadily grew stronger and broader. The total number of summer research internships exceeded 100 in 1999. That milestone helped precipitate a formal Education and Research Partnership Agreement (ERPA) between the University of Puerto Rico, Mayaguez (UPRM) and the U.S. Army Engineer Research and Development Center (ERDC). The 1999 ERPA acknowledges the perpetuity of both institutions commitment. This helped expand the venues and mentors for university interns to many more majors at the university and at federal laboratory locations in various states in the USA. While the university contract PM was Chair, Civil Engineering and Surveying Department and professor, the program strength and broader interests helped expand it throughout the UPRM campus. Summer interns have come from sixteen different departments. Table 1 shows the summer intern students by major and Table 2 shows the ERDC Laboratory where they were mentored.

College	Degree Program
Engineering	Civil, Chemical, Computer, Electrical, Mechanical, & Surveying Engineering
Arts and Science	Biology, Physics, Chemistry, Marine Science, Geology, Computer Science, & Mathematics
Agriculture Science	Agronomy & Horticulture
Natural Science	Environmental Health

Table 1 UPRM Major for Interns

ERDC Laboratory	No. of Interns
Construction Engineering Research, Champaign, IL	46
Coastal and Hydraulics, Vicksburg, MS	80
Cold Regions Research and Engineering, Hanover, NH	31
Environmental, Vicksburg, MS	54
Geotechnical and Structures, Vicksburg, MS	206
Information Technology, Vicksburg, MS	35
Topographic Engineering, Ft. Belvoir, VA	33
Total	485

Table 2 ERDC Laboratory for Interns

The 485 summer internships were 323 male and 162 female or 33.4% female, significantly above the national average (about 20%) for female engineer graduates. The experiential learning of 485 (undergraduate and graduate) Hispanic engineers and scientists at a government research and development laboratory and the ensuing recruitment dividends for the ERDC are major diversity accomplishments discussed in following sections. Figure 2 shows the 2011 cohort, as an example.

Figure 2 Cohort 2011: Research Interns

Intern Participation in Student Research Symposia- Interns are required by the UPRM academic mentor to submit an abstract to participate in at least one student research symposium to present their research results and acquired professional experiences. Since 2009 students participate in the Ana G. Méndez University System (AGMUS) Annual Conference, a national symposium co-sponsored by NSF and various prestigious recruiting companies where hundreds of students from dozens of universities nationwide participate to present their summer research results. The UPRM summer research interns participate in the oral presentation modality for undergraduate and graduate students. Mentors and faculty from various universities serve as judges who evaluate the quality and relevance of the presentations in various categories. The ERPA interns have been awarded Best Oral Presentations based on their work in competition with hundreds of

participants every year. Figure 3 shows three UPRM students being awarded prizes at the 2013 AGMUS Symposium.

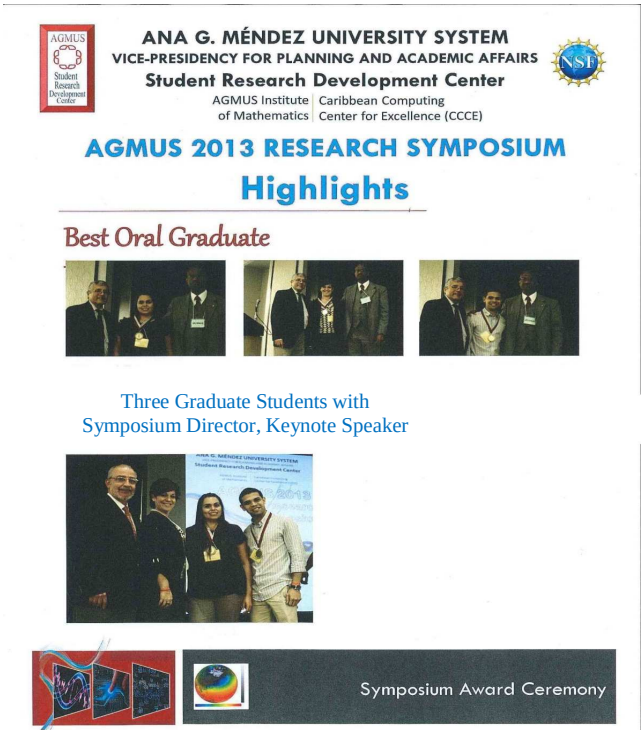

Figure 3: Intern Awards, 2013

Students make presentations on their summer research as other opportunities arise. The summer research experience is much more than an internship job for the summer. Other benefits include different cultural experiences (traveling, customs, language, values, people, food, music, dancing), potential job offers, participation in summer conferences and workshops, MS (or PhD) thesis topics arising from the summer research, potential for extended support during the academic year, and institutional recognition. The most significant achievements have been the academic and personal maturity they demonstrate and the determination to pursue graduate studies after participating in the ERPA.

UPRM Alumni Permanently Employed by ERDC

The summer internship program discussed above, led to a substantial increase in successful recruitment of UPRM graduates after the first five years. An analysis of ERDC recruitment by year since 1986 was performed including permanent hires that experienced summer research internships and those hired directly after graduation.

Permanent Hires- Figure 4 shows permanent hires of summer interns (25) and permanent hires of other university graduates (36) from 1986 through 2014.

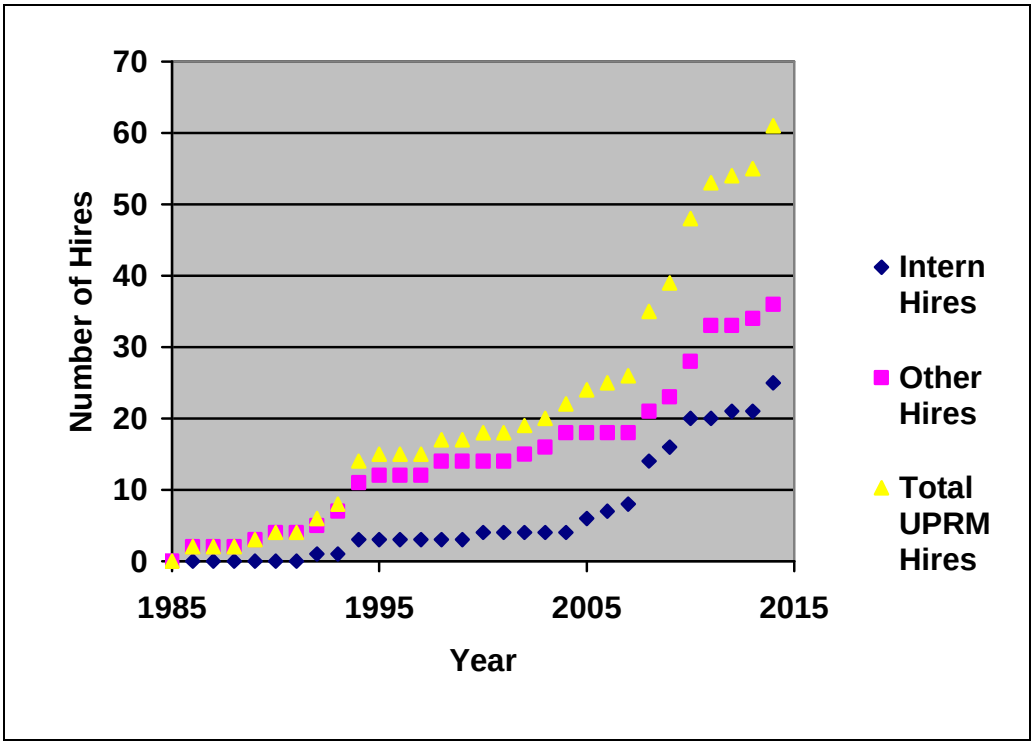

Figure 4 Number of UPRM Alumni Hires by the ERDC

The total is 61 hires (nominally two per year) for the past thirty years. The rate for the past seven years is 5/year. All are Hispanic engineers and scientists.

Retention- It is one thing to recruit and another to retain. An analysis of retention of the 61 permanent hires is displayed in Table 3 which shows retention at ERDC, Corps of Engineers, Department of Army, Federal Government, graduate school, private industry, academia and the USA. In 1986, when the Hispanic focused MSI recruitment effort began, while there were a few Hispanic laboratory employees, there were very few (less than 0.5%), engineers and scientists that identified themselves as Hispanic.

Retention Group	Interns Hired (25)	Others Hired (36)	Total Hired (61)
Laboratory	19/25 (76%)	19/36 (53%)	38/61 (62%)
Corps of Engineers (USACE)	23/25 (92%)	21/36 (58%)	44/61 (72%)
Dept of Army (DA)	24/25 (96%)	21/36 (58%)	45/61 (74%)
Federal Government (FG)	24/25 (96%)	26/36 (72%)	50/61 (82%)
FG + Graduate School (GS)	24/25 (96%)	28/36 (78%)	52/61 (85%)
FG/GS + Defense Industry(DI)	24/25 (96%)	29/36 (81%)	53/61 (87%)
FG/GS/DI + Industry (I)	25/25 (100%)	35/36 (97%)	60/61 (98%)
FG/GS/DI/I/ + Academia (A)	25/25 (100%)	36/36 (100%)	61/61 (100%)
USA	25/25 (100%)	36/36 (100%)	61/61 (100%)

Table 3 Retention Data for ERDC Hires of UPRM Alumni (1986-2015)

Several interesting observations can be made from Table 3. Over the thirty year period, 62% (38/61) of permanent hires are retained, 82% (50/61) are retained in the federal government and all are in the USA (includes one located overseas with a US company). An analysis of retention of hires who served a summer research internship relative to hires with no internship reveals ERDC retained 76% (19/25) of summer interns but only 53% (19/36) of others. Perhaps more striking is the fact that the Corps of Engineers retained 92% (23/25) of interns but only 58% (21/36) of others hired. This strongly indicates that a ten week experiential learning research internship substantially increases retention of permanent hires over a 30 year period. Put in another context, laboratory investment in summer research internships involving experiential learning is an excellent long term human capital investment strategy. Among many factors that may influence the remarkable intern retention rate is the opportunity ERDC personnel and interns have to screen their preferences when recruiting and choosing a long term job.

Professional Development- A major recruiting inducement for the laboratory in 1986 was three large research universities, Mississippi State University, Louisiana State University and Texas A&M University (Carnegie Classification, RU/VH) had graduate extensions (including distance learning) on the ERDC installation in Vicksburg, MS with an engineer coordinator and a university administrative person to facilitate graduate education aspirations of employees. The laboratory paid for tuition and books and strongly encouraged BS hires to pursue a MS degree. Another smaller university is in the commuting area. Major universities are located in the commuting areas of the three ERDC laboratories outside of Vicksburg, MS. Additionally, ERDC has a competitive program where engineers and scientists can apply for 12 months of paid mission compatible education, anywhere worldwide, (salary, tuition, fees, books, living expenses and transportation). Nearly 1% of the engineers and scientists are approved annually for this program. A well planned year at a major university can result in completing coursework for a PhD degree. Dissertation research can be completed in absentia upon return to the laboratory. Reference 13 articulates many of the efforts of the UPRM and the ERDC to encourage professional development of the next generation of engineers and scientists. An analysis of the educational professional development of UPRM engineers and scientists is shown in Table 4 for the 61 hired (1986-2015). Thirty one earned graduate degree.

Degree	Interns Hired (25)		Others Hired (36)		Total Hires (61)	
	Degree Hired	Degree in 2016	Degree Hired	Degree in 2016	Degree Hired	Degree in 2016
BS	20	-	28	-	48	-
MS	4	15	8	13	12	28
Ph.D.	1	1	0	2	1	3

Table 4 Graduate Education of UPRM Alumni Hired by ERDC

Current degree levels of the 38 UPRM alumni retained by the laboratory are shown in Table 5. Four hold PhDs (one when hired), 19 hold MS degrees and 15 hold BS degrees.

Those holding BS degrees were hired within the last five years and are enrolled part time in graduate degree seeking programs.

Degree	Degree of Retained Interns (19) 2016	Degree of Retained Other (19) 2016	Degree of Total (38) Retained, 2016
BS	6	9	15
MS	11	8	19
Ph.D.	2	2	4

Table 5 Graduate Education of UPRM Alumni Retained by ERDC

Career Advancement- Career advancement of the thirty-eight university alumni hired and retained at the laboratory is evaluated by displaying the grade hired and their current grade. The laboratory has a Pay for Performance compensation and evaluation system where annual raises are based on job performance and Pay Bands encompass multiple General Schedule (GS) grades. DB-03 is not applicable to laboratory research positions. Table 7 displays the Pay Band Career progression of 38 alumni retained. The thirteen remaining at DB-02 were hired within the last five years. Several should be promoted to DB-04 in 2016. Career progression shown in Table 6 is comparable to that for the total laboratory population. It is highly significant that one alumnus attained a Senior Executive Service (SES) leadership position.

Pay Band	Number Hired	Number 12/31/2015
DB02 (GS5-11)	37	13
DB04 (GS12-14)	1	24
DB05 (GS15)	0	0
SES	0	1
ST	0	0

Table 6 Career Progression of UPRM Alumni Retained

Evolution of ERDC and UPRM Partnership

The 1991 and 1992 time frame marked the start of a true partnership between the laboratory and the university. Two major events turned the relationship from a sustained recruiter of graduates (source of jobs for MSI graduates) to a mutual university and laboratory partnership. The first was initiation of experiential learning summer research internships in 1991, described above, which shortly (1995) evolved into an Educational and Research Internship Program (ERIP) where students earned three semester hours credit while performing research and being mentored at the laboratory. With this event, the laboratory started to become a part (albeit small) of the university education program and university students became a part (small) of the laboratory research enterprise. The second major event was the 1999 execution of an Education and Research Partnership Agreement (ERPA) between the laboratory and the university which unequivocally formalized the partnership. The ERPA was signed by the ERDC Director and the University Chancellor in 1999 and remains in effect "…..in perpetuity until modified or terminated by either institution." The Education and Research Partnership Agreement is authorized and governed pursuant to Title 10, Section 2194 of the United States Code. The laboratory leadership chose to use this law, which authorizes laboratories to enter

into partnerships with educational institutions, to help facilitate relationships with the MSI university (UPRM) leading to recruitment of underrepresented minority engineers and scientists.

UPRM Faculty Perform Summer Research at ERDC- Shortly after the first experiential learning summer cohort in 1991, faculty began occasionally spending the summer at the laboratory performing research with a team of laboratory researchers. Funds to support salary and transportation for the faculty professor are paid by the government. This has averaged about one professor every two years since 1992. Table 7 shows the rank of the faculty member, year research was performed and the laboratory hosting the faculty member.

Faculty	Summer	Laboratory
Professor	1993	Environmental
Associate Professor	1996	Environmental
Assistant Professor	1998	Environmental
Assistant Professor	2000	Geotechnical & Structures
Assistant Professor	2001	Geotechnical & Structures
Assistant Professor	2003	Geotechnical & Structures
Assistant Professor	2004	Geotechnical & Structures
Associate Professor	2010	Geotechnical & Structures
Associate Professor	2011	Geotechnical & Structures
Associate Professor	2012	Geotechnical & Structures
Assistant Professor	2015	Environmental
Associate Professor	2015	Information Technology

Table 7 Faculty Research at ERDC

ERDC Researchers Serve on Graduate Committees- Starting in 2001, ERDC engineers began serving on Civil Engineering and Surveying Department Graduate Committees on a case by case basis. Sometimes it was the Committee for a summer intern performing thesis research related to the internship. Sometimes it was a graduate student performing research for a professor funded by the laboratory. There are a number of circumstances where it is appropriate for PhD laboratory researchers to serve on Graduate Committees of university students. In every instance, UPRM followed a formal approval process for appointing the ERDC person to a faculty position in the Civil Engineering and Surveying Department. There is no compensation from UPRM to the laboratory person for this voluntary service. Salary and travel expenses for the laboratory engineer are absorbed by the laboratory either from an overhead account or as a relevant project cost depending on the circumstances. Table 8 below lists twelve graduate committees served on by seven different ERDC engineers since 2001. Three are pending graduation and ten graduated between Dec. 2001 and Jan. 2016.

Name	Months	Appointment	Committee	Graduation
#1	3	Ad Honorem	Member	Dec. 2001
#2	1	Ad Honorem	Member	May 2003
#2	2	Ad Honorem	Member	May 2004
#3	6	Ad Honorem	Member	Aug. 2003
#4	6	Ad Honorem	Member	May 2004
#4	7	Ad Honorem	Member	Dec. 2004
#4	9	Ad Honorem	Member	May 2012
#5	24	Ad Honorem	Member	Dec. 2012
#6	12	Adjunct Prof.	Chair	Dec. 2012
#6	24	Ad Honorem	Member	Pending
#7	24	Ad Honorem	Member	Pending
#7	6	Ad Honorem	Member	Pending
#8	6	Adjunct Prof.	Chair	Jan. 2016

Table 8 Service on MS Committees by ERDC Engineers

Temporary Assignment of ERDC Researchers as Department Faculty- Another indication of the maturing nature of the UPRM/laboratory partnership is the short term assignment (voluntary) of an ERDC researcher to the UPRM Civil Engineering and Surveying Department. Three ERDC researchers have participated in this type of activity that is accomplished on a case by case basis with full knowledge and concurrence of the ERDC supervisor and leadership and with formal approval of the UPRM. Again, these arrangements are supported by the ERDC at no cost to the UPRM. Sometimes the UPRM initiates discussions of their need and on other occasions the ERDC researcher may inquire if an arrangement would be helpful. Table 9 shows examples of three such individual assignments over the past fifteen years.

Lab. Engineer	Period	Appointment	Activity
#1	18 months (2001/2002)	Ad Honorem	Resource for PhD, Teach Solid Waste Management
#2	18 months (2001/2002)	Visiting Prof. (Ad Honorem)	Taught INCI 6076, mentor, INCI 6995 Resource for PhD Enviro. Engineering.
	15 months (2002/2003)	Ad Honorem (Assistant Prof.)	Lecture, mentor, develop research proposals
#3	8/14/2012	Visiting Lecturer	Short Course

Table 9 ERDC Engineers Temporarily Assigned to UPRM

ERDC Service to Department- An important aspect of ERDC service to the Civil Engineering and Surveying Department was participation in ABET accreditation activities. An ABET accreditation requirement for all programs is an external Advisory Board composed of practicing engineers with Department interactions. The ERDC has been a part of the Civil Engineering and Surveying Department accreditation activities for the past three (every six years) cycles in the capacity of service on the (External)

Department Advisory Board and/or being an on site participant during preparations for the ABET visit and/or during the visit itself.

Three major conferences (2006, 2007 and 2008 Latin American and Caribbean Consortium of Engineering Institutions International Conference) were co-sponsored by the university and the laboratory. Conference co-sponsorships occur as opportunities of mutual interest arise and are within the core mission of each partner. Co-sponsorship discussions are ongoing regarding a 2016-2017 winter season conference. Conference participation by UPRM and ERDC researchers occurs regularly and joint papers occur periodically. Examples include The Thirteenth Pan-American Congress of Applied Mechanics (PACAM XIII) in Houston, TX and the 2011 Human Capital Management Defense Conference where they won a Third Place Award in the Most Innovative Recruiting Program Category.

Assessment

The UPRM and ERDC partnership described was not incentivized by agency or ERDC funding of the UPRM. The origin of the initiative was federal government policy to strive for a workforce with demographics reflective of the national population or reflective of the demographics of the population of engineers and scientists. Laws, policy, executive orders and regulations encouraged recruitment strategies for all government organizations to ameliorate the disparity that exists for underrepresented groups in any government organization. A compilation of the metrics documented throughout the paper forms the framework for the partnership assessment. Table 10 summarizes eight activities along with a metric for each activity and a column that provides the authors evaluation of the benefit (either ++ or +). All eight activities are deemed beneficial (+) to both entities, however, in some cases, the activity was deemed very beneficial (++) to one or both organizations.

Framework Activity	Metric	Benefit UPRM/ERDC	
Hispanic Experiential Learning Internships (1991-2015), 25 years	485 total 19.4/year	++	+
Hispanic Engineer/Scientists hired (1986-2015), 30 yrs.	61 (2/year)	+	++
Hispanic hires retained at Labs	38 (62%)	+	++
Hispanic retained by Corps	44 (72%)	+	+
Faculty research at Lab (1993-2015)	12 (0.55/year)	++	+
Lab researchers on Committees (2001-2015)	13 (0.87/year)	+	+
Lab researchers assigned to university (2001-present)	52 months (3.2 mo./year)	+	+
Institutionalization of Partnership	ERPA (1999)	++	++

Table 10: Metric and Benefit of Major Partnership Activities

Additionally, ERDC research funding has been received by UPRM faculty periodically as an outgrowth of faculty summer research or for continued graduate research by students who were experiential learners. Letters of support were prepared by the laboratory for

UPRM proposals when appropriate, usually with a commitment for ERDC participation (unfunded) when the research directly benefits mission areas.

From the UPRM perspective there is a strong interest in every partnership to enhance education and research outcomes. From the educational perspective, lets focus on student outcomes as defined for ABET accreditation purposes. It suffices here, as an example, to address the UPRM Civil Engineering Undergraduate Program Student Outcomes (what students are expected to learn by the time they graduate).

The breadth and depth of the scope of work student interns performed are at highest level compared with curriculum contents. Students have multiple experiences ranging from laboratory and field work, mathematical modeling, engineering mechanics evaluation, environmental processes, design experiments, apply state of the art technology, use computer software and programming skills, among others. Students are required to write a technical proposal, two to three technical reports, one final technical paper, one technical poster and to give at least two oral technical presentations. They also write an essay on values they cultivate while at the Education Research Internship Program, ERIP. Students' work is evaluated and corrected by mentors and the faculty to warranty completeness and correctness.

Table 11 presents the authors' judgement of the level of exposition and experience interns receive at the ERIP which are related to learning objectives as defined by the student outcomes. Furthermore, the high levels of research content broaden students' knowledge of creative and research work.

	Level of Exposition/Experience at ERIP		
Student Outcomes (SOs)	**Low**	**Average**	**High**
a. math/science/engineering…			X
b. conduct experiments…			X
c. engineering design…		X	
d. multi-disciplinary teamwork...			X
e. problem solving…			X
f. professionalism & ethics…			X
g. communication skills…			X
h. broad educ. & global impact...		X	
i. lifelong learning…		X	
j. contemporary issues…			X
k. modern tools & techniques…			X

Table 11. Civil Engineering Student Outcomes (SO)

Attainment of these Student Outcomes will help Civil Engineering Degree Program graduates achieve the requirements to be prepared to attain the Program Educational Objectives. As per the most recent tendencies for the requirements of professional practice [14], students who participate in the ERIP are better prepared for professional practice because of their intense engineering experiences reflected by Table 11.

Lessons Learned

Building a sustained mutual laboratory and university partnership between geographically distant organizations unfamiliar with one another is hard work that requires sustained leadership commitment that gradually builds trust through actions, not words. This is particularly true when the interaction is between a Minority Serving Institution and a predominantly caucasian federal laboratory. Good words are necessary but not sufficient to build trust. The first five years described was successful but did not build a mutual partnership. Trust had not yet been engendered; to the degree necessary for a true partnership; nothing had occurred to damage mutual trust, but nothing had happened for the UPRM to believe the ERDC was truly interested in being an asset to and a part of the academic enterprise. The well intended ERDC arrived at the UPRM annually to recruit good students (like many other companies and laboratories) and then disappeared for another year and returned-to recruit more good students.

The 10 week experiential learning research internships for UPRM students at the laboratory propelled the ERDC into the role (albeit a very small role) of becoming part of the academic fabric of the university. The summer internships cost the university nothing and helped them fulfill a need for more experiential learning opportunities for an increasing student population. In hindsight, had the laboratory thought about this earlier, the relationship may have reached the 1991 point one or two years sooner (not more). Time and consistency are necessary ingredients to build trust among organizations geographically separated and with different cultures. In this case, time was needed for initially recruited UPRM alumni to acclimate to jobs, determine if they could have a positive and rewarding career, become comfortable with new cultural surroundings and for word of mouth to relate positive vibrations back to the campus.

Consistency of laboratory leadership commitment was achieved by the ERDC Director leading every recruitment trip to the university from 1986 through 1998- the first 13 years of the relationship. The last two years were transition years to another laboratory SES who led the partnership for the next several years. Consistency of university commitment was achieved by the same UPRM PM for the program from 1991 to the present.

The ERDC hired (1990) an engineer who was an alumnus of the university with a BS degree in 1982 before the beginning of the relationship. He was a key person in helping the evolving relationship reach fruition. He accompanied the Laboratory Director on recruiting trips from 1991 forward and provided invaluable insight regarding UPRM culture. He had instant credibility with UPRM students and professors. He was a key ERDC person helping arrange logistics for the experiential learning summer research interns. He and his spouse and family became defacto parents and a surrogate family for

some students in the summer cohorts. As alumni were recruited over the years, a larger and larger support group for the summer cohorts emerged. By the mid to late 1990's there were so many alumni working at the laboratory that ERDC became the employer of choice for graduates of the Civil Engineering and Surveying Department.

Summary and Conclusions

A description and analysis of results from a 30 year relationship between a laboratory (ERDC) and a MSI university (UPRM) was presented. The authors believe this robust partnership can serve as a model [with modifications to fit specific objectives] for other academic institutions and laboratories or companies that would find it beneficial to have a similar MSI partnership. A concise summary of the successful strategy follows:

- Sustained Leadership commitment (Executive to Chair and/or Dean)
- Unwavering sustained recruitment of graduates
- Retention is increased by recruitment of research interns (experiential learners)
- Laboratory is part of the academic program
  - -Experiential learning involvement is a natural path to follow.
  - -Service on graduate student committees
  - -Teach short courses
  - -Temporary assignment to university (Visiting or Adjunct Professor)
  - -ABET accreditation participation
- Faculty become part of laboratory research
  - -Summer research at laboratory
  - -Proposal partners
  - -Use of unique laboratory equipment for research
  - -research contracts received
- Trust builds over time

The UPRM/ERDC partnership described was largely responsible for eliminating the gross underrepresentation of Hispanic engineers and scientists (less than 0.5%) in 1986 to the level today of practically 5%. The mutual partnership between the laboratory and the MSI university is now a part of the culture of both institutions. The authors are confident this partnership will be sustained, "in perpetuity" as the Education and Research Partnership Agreement states.

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